

COMPARING HATCHABILITY, INCUBATION LENGTH AND CHICK QUALITY FROM THREE EGG SIZES FROM TWO MODERN BROILER STRAINS

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DESCRIPTION OF PROBLEM

Due to the demand from consumers for white meat, there has been an increase in the selection for increased muscle. This increase in meat yield has many negative effects on reproduction (Hocking et al., 2004). There have been relatively few changes in incubation technology and the selection for increased meat yield has increased the potential for increased heat production (Hulet, 2001).

Incubation length can be influenced by several factors including, but not limited to, egg size, age of parent flock, and genetics. Zawalsky, 1962, found that large eggs hatch later when compared to other egg sizes. Middle age parent flocks tend to have the shortest incubation period. Genetics also influence incubation length (Suarez et al., 1997). Determining strain specific incubation parameters may allow for optimal incubation conditions and improved hatchability. Knowing approximate incubation lengths for various genetic strains may improve chick quality by preventing dehydration in the hatcher.

Hatchability is affected by age of parent flock, genetics, egg weight, and egg storage. Older flocks tend to have the poorest hatchability (Lapao, 1999). It has also been found that as the length of storage increases hatchability decreases (Lapao, 1999). Morris et al. 1967 found that intermediate sized eggs hatch the best, while large and small extremes don't hatch as well.

Factors affecting chick quality are pre-incubation storage conditions, time in the hatcher, and egg size. Tona et al. 2003 found that increased incubation storage equates to poorer chick quality. When chicks are held in the hatcher, they have a reduction in chick weight that continues through 49 d (Wyatt et al., 1985). Larger eggs tend to have significantly poorer quality chicks as compared to other egg sizes (Kanderka et al., 2004). Chick quality is of importance to both the broiler breeder producer who is paid based on saleable chicks and the broiler producer who wants high quality chicks that will become fast growing, uniform broilers. Like hatchability parameters, there are several factors associated with chick quality.

The objectives of this study were to determine if there were differences in incubation length, hatchability, and chick quality, between three egg sizes from two modern genetic strains.

MATERIALS AND METHODS

The University of Alberta Faculty of Agriculture, Forestry, and Home Economics Animal Care Committee approved this research protocol according to the Guidelines set by the Canadian Council on Animal Care.

Egg Collection

Fertile hatching eggs (n = 1200) were collected from each of two modern genetic strains at 28 wks (Strain 1) and 30 wks (Strain 2). Three egg weight categories were selected for this trial based on the average egg weight determined from a sample of 84 eggs for each strain. The egg weight categories were: Strain 1, small 50-52g, average 54-56g, and large 58-60g; Strain 2 small 54-56g, average 58-60g, and large 62-64g. All eggs were individually numbered and weighed. Each egg was candled to ensure that eggs with cracks were not used and that all eggs were set with the air cell up.

Egg Incubation

All eggs were placed into a 5000 egg capacity Jamesway single stage incubator at a dry bulb and wet bulb temperature of 37.5°C and 28.0°C respectively. On 7 and 14 d of incubation all eggs were candled to remove infertile eggs and eggs containing non-viable embryos. All eggs deemed to be non-viable were broken open to assess fertility and if fertile approximate day of embryonic mortality. On day 18 eggs were transferred to a 5000-egg capacity Jamesway hatcher. The eggs were grouped into sections of 18 to provide statistical replication. A sub-sample of 150 eggs from each strain and egg weight category were placed into pedigree hatch baskets.

Hatchability and Chick Quality

At 487.5 hours of incubation, eggs were monitored every 5 hours to determine time of hatching. At 21.5 d of incubation, all chicks were removed from the hatcher. All healthy chicks were then counted, weighed, and shank length and chick length measured. Any unhatched eggs remaining were broken open to determine approximate day of embryonic mortality. Chicks were culled based on hatchery industry standards and any weak, abnormal or unhatched live embryos were euthanized via cervical dislocation. Chick body length was measured from the tip of the beak to the tip of the longest toe. Shank length was measured on the left shank of each chick.

Statistical Analysis

All data were analyzed using the General Linear Models procedure of SAS. Any percentage data were transformed prior to analysis using Arc-Sine transformations. The experimental unit consisted of 24 groups of 18 eggs per each of the control and experimental groups. Probability was assessed at $P < 0.05$.

RESULTS AND DISCUSSION

Egg Weights

Egg weight at setting, egg weight at transfer, and percent weight loss for strain 2 was significantly greater than for strain 1 (Table 1). This may be attributed to the fact that the eggs collected from strain 2 were from a flock that was 30 wk of age compared to strain 1 which was 28 wk of age. This is similar to results found by (Shanawany, M. M., 1984.) which found that older flocks lay larger eggs. Egg weight at setting and weight at transfer was largest in the eggs

from the large egg weight category followed by average and small egg weight categories. This was expected since eggs were selected within specific weight ranges.

Percent weight loss was greatest in the small eggs; followed by average and then large eggs each losing significantly less. This may be due to the fact that small eggs have a higher surface to volume ratio and that there is an increase in the amount of water removed (Table 1).

Fertility, Hatchability, Embryonic Mortality, and Culled Chicks

Strain 2 had a significantly better fertility compared to strain 1. Again this may be attributed to the fact that the strain 2 flock was younger than the strain 1 flock (Table 2). Hatchability of eggs from flock 2 was poorer than for flock 1 however hatchability of fertile eggs was not significantly different between strain 1 and strain 2. There were no significant differences in embryonic mortality or cull chicks between strain 1 and strain 2. No significant differences were found between egg weight categories for fertility, hatchability, and hatchability of fertile eggs. Hatchability of saleable chicks from fertile eggs was significantly lower in the large eggs compared to the small and average, which did not differ from each other. Lower hatchability in the large egg weight category may be attributed to the fact that significantly more embryos died during late (15-21 d) of incubation, compared to the small and average egg weight categories, which were not significantly different from each other. The number of cull chicks between the strains was not significantly different from each other (Table 2). There were also significantly more cull chicks from the large egg weight category as compared to the average and small egg weight categories.

Chick Weights, Chick length, and Shank Length

Chick weight, chick length, shank length, and chick weight to length ratio was significantly larger in strain 2 as compared to strain 1 (Table 3). Percentage shank was significantly larger in strain 1 as compared to strain 2. Chicks from the large egg weight category had the largest body weight at hatch as well as the longest shank, compared to the average and small egg weight categories. Chick length was longest in the chicks from the large egg weight category however the chicks from the small egg weight category were significantly longer than the chicks from the average egg weight category (Table 3). The difference of 0.85mm between the small and average egg weight categories may not be applicable to real world applications. Chick weight to length ratio followed a similar trend to that of chick weight in which the largest weight to length ratio was found in the chicks from the large egg weight category followed by average and small egg weight categories. Chicks from strain 2 had a greater percent shank as compared to chicks from strain 1. Chicks in the average egg weight category had the greatest percentage of shank followed by the large egg weight category and small egg weight category (Table 3).

Time of Hatch and Chick Yield

Percent chick yield was greatest in chicks from strain 2 as compared to strain 1. Chicks from the large egg weight category had the greatest percent chick yield followed by average and small categories respectively. Chicks from strain 2 hatched more quickly as compared to chicks from strain 1. The chicks from the small eggs hatched first followed by the chicks from the average and then large egg weight categories.

CONCLUSIONS AND APPLICATIONS

1. Strain 2 egg set weights were significantly larger compared to strain 1.
2. Fertility was lower in the eggs from strain 1.
3. No difference between hatchability of fertile or number of culls between strain 1 or 2.
4. Chick weight, length, and weight to length ratio were largest in strain 2 chicks.
5. Percent chick yield was greater in strain 2 chicks.
6. Hatchability of saleable chicks from fertile eggs was lowest in the large eggs.
7. Higher late incubation mortality in the large eggs.
8. Large chicks had the greatest cull rate.
9. Chicks from small eggs were quickest to hatch, with no differences between the other egg weight ranges.

This study indicates that each strain may have its own hatching profile. Further studies should be undertaken to determine strain specific incubation conditions in order to optimize hatchability and chick quality.

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TABLE 1. Egg weight at setting and transfer, percent egg weight loss at transfer for each strain and egg weight category

Treatment	Egg weight at setting (g)	Egg weight at transfer (g)	Egg weight loss from setting to transfer ^A (%)
Egg Source			
Strain 1	55.1 ^b ± 0.02 (1003) ^B	49.2 ^b ± 0.03 (1003)	10.3 ^b ± 0.03 (1003)
Strain 2	59.0 ^a ± 0.02 (1089)	53.0 ^a ± 0.03 (1089)	10.7 ^a ± 0.03 (1089)
Egg size			
Small ^C	53.3 ^c ± 0.02 (705)	47.5 ^c ± 0.04 (705)	11.0 ^a ± 0.06 (705)
Average ^D	56.9 ^b ± 0.02 (685)	51.0 ^b ± 0.04 (685)	10.4 ^b ± 0.06 (685)
Large ^E	61.0 ^a ± 0.02 (702)	54.8 ^a ± 0.04 (702)	10.1 ^c ± 0.06 (702)
Egg Source x Egg Size			
Strain 1 x Small	51.4 ^c ± 0.03 (344)	45.6 ± 0.05 (344)	11.3 ± 0.08 (344)
Strain 1 x Average	54.8 ^d ± 0.03 (318)	49.0 ± 0.06 (318)	10.6 ± 0.08 (318)
Strain 1 x Large	59.0 ^b ± 0.03 (341)	52.9 ± 0.05 (341)	10.2 ± 0.08 (341)
Strain 2 x Small	55.3 ^c ± 0.03 (361)	49.4 ± 0.05 (361)	10.7 ± 0.08 (361)
Strain 2 x Average	58.9 ^b ± 0.03 (367)	52.9 ± 0.05 (367)	10.2 ± 0.08 (367)
Strain 2 x Large	62.9 ^a ± 0.03 (361)	56.6 ± 0.05 (361)	10.0 ± 0.08 (361)
Probability			
	Prob > F		
Egg Source	<0.0001	<0.0001	<0.0001
Egg Size	<0.0001	<0.0001	<0.0001
Egg Source x Egg Size	<0.0001	0.0519	0.1200

^A Egg weight loss = (egg weight at setting – egg weight at transfer) / egg weight at setting x 100.

^B Number of eggs.

^C Small = eggs weighing 50–56g

^D Average = eggs weighing 54-60g

^E Large = eggs weighing 58-64g

^{a-b} Means within a column and effect with different superscripts are significantly different ($P < 0.05$).

TABLE 2. Percentage fertility, hatchability, hatchability of fertile, early dead, mid dead, late dead, and culled chicks for strain and egg weight category

Treatment	n	Fertility ^A (%)	Hatchability ^B (%)	Hatchability of fertile ^C (%)	Hatchability of saleable chicks of fertile (%)	Early ^E (%)	Mid ^F (%)	Late ^G (%)	Cull chicks ^H (%)
Egg Source									
Strain 1	66 ^I	89.4 ^b ± 0.65	79.8 ^b ± 1.13	89.3 ± 1.05	86.2 ± 1.26	4.6 ± 0.81	0.6 ± 0.22	4.7 ± 0.60	3.1 ± 0.59
Strain 2	66	96.7 ^a ± 0.65	86.9 ^a ± 1.13	89.8 ± 1.05	87.1 ± 1.26	6.1 ± 0.81	0.3 ± 0.22	3.5 ± 0.60	2.8 ± 0.59
Egg Size									
Small ^K	44 ^J	94.0 ± 0.80	85.5 ± 1.40	91.0 ± 1.29	89.4 ^a ± 1.49	5.6 ± 0.99	0.5 ± 0.27	1.8 ^b ± 0.74	1.6 ^b ± 0.72
Average ^L	44	91.53 ± 0.80	82.3 ± 1.40	89.9 ± 1.29	87.5 ^a ± 1.49	5.0 ± 0.99	0.6 ± 0.27	4.3 ^b ± 0.74	2.4 ^b ± 0.72
Large ^M	44	93.6 ± 0.80	82.2 ± 1.40	87.9 ± 1.29	83.0 ^b ± 1.49	5.5 ± 0.99	0.1 ± 0.27	6.1 ^a ± 0.74	4.9 ^a ± 0.72
Probability					Prob > F				
Egg Source		<0.0001	<0.0001	0.8860	0.9692	0.1674	0.3812	0.2834	0.9931
Egg Size		0.2090	0.3605	0.4973	0.0168	0.8627	0.4046	0.0003	0.0040
Egg Source x Egg Size		0.0501	0.1358	0.6379	0.8653	0.9808	0.4231	0.5756	0.9533

^A Fertility = (number of fertile eggs / number of eggs set) x 100.

^B Hatchability = (number of hatched eggs / number of eggs set) x 100.

^C Hatchability of fertile = (number of hatched eggs / number of fertile eggs set) x 100.

^D Hatch of Saleable chicks of fertile = (number of saleable chicks / number of fertile eggs set) x 100.

^E Early dead embryos = (number of dead embryos between 1 to 7 days of incubation / number of fertile eggs set) x 100.

^F Mid dead embryos = (number of dead embryos between 8 to 14 days of incubation / number of fertile eggs set) x 100.

^G Late dead embryos = (number of dead embryos between 9 to 21 days of incubation / number of fertile eggs set) x 100.

^H Cull chicks = (number of chicks culled / number of fertile eggs set) x 100.

^I Number of experimental units; experimental unit = 66 groups of 18 eggs.

^J Number of experimental units; experimental unit = 44 groups of 18 eggs.

^K Small = eggs weighing 50–56g

^L Average = eggs weighing 54–60g

^M Large = eggs weighing 58–64g

^{a-b} Means within a column and effect with different superscripts are significantly different ($P < 0.05$).

TABLE 3. Hatched chick weights, chick length, shank length, percent shank, chick weight to length ratio, and percent chick yield for each strain and egg weight category

Treatment	Chick weight (g) ^A	Chick length (mm) ^A	Shank length (mm) ^A	Percent shank (%) ^{A,L}	Chick weight to length ^{A,M}	Percent chick yield (%) ^{A,N}
Egg source						
Strain 1	38.6 ^b ± 0.04 (927) ^B	179.7 ^b ± 0.14 (927)	28.1 ^b ± 0.05 (927)	15.7 ^a ± 0.03 (927)	21.5 ^b ± 0.03 (927)	71.0 ^b ± 0.09 (410)
Strain 2	41.3 ^a ± 0.04 (1039)	183.3 ^a ± 0.14 (1039)	28.3 ^a ± 0.05 (1039)	15.4 ^b ± 0.03 (1039)	22.5 ^a ± 0.03 (1039)	71.4 ^a ± 0.09 (443)
Egg size						
Small ^C	36.9 ^c ± 0.06 (682)	180.9 ^b ± 0.17 (682)	27.7 ^c ± 0.07 (682)	15.3 ^c ± 0.04 (682)	20.4 ^c ± 0.07 (682)	70.4 ^c ± 0.11 (289)
Average ^D	40.0 ^b ± 0.06 (641)	180.0 ^c ± 0.17 (641)	28.3 ^b ± 0.07 (641)	15.7 ^a ± 0.04 (641)	22.2 ^b ± 0.07 (641)	71.3 ^b ± 0.11 (282)
Large ^E	43.1 ^a ± 0.06 (643)	183.6 ^a ± 0.17 (643)	28.6 ^a ± 0.07 (643)	15.6 ^b ± 0.04 (643)	23.5 ^a ± 0.07 (643)	71.9 ^a ± 0.11 (282)
Egg Source x Egg Size						
Strain 1 x Small	35.4 ^f ± 0.08 (331)	180.5 ^d ± 0.24 (331)	27.9 ^c ± 0.10 (331)	15.7 ^b ± 0.05 (331)	19.6 ^f ± 0.06 (331)	70.2 ± 0.16 (140)
Strain 1 x Average	38.8 ^d ± 0.08 (293)	176.6 ^e ± 0.26 (293)	28.1 ^c ± 0.10 (293)	15.9 ^a ± 0.06 (293)	22.0 ^d ± 0.06 (293)	71.1 ± 0.16 (136)
Strain 1 x Large	41.8 ^b ± 0.08 (303)	181.9 ^c ± 0.25 (303)	28.4 ^b ± 0.10 (303)	15.6 ^b ± 0.06 (303)	23.0 ^b ± 0.06 (303)	71.5 ± 0.16 (134)
Strain 2 x Small	38.3 ^e ± 0.08 (351)	181.2 ^c ± 0.25 (351)	27.4 ^d ± 0.09 (351)	15.1 ^c ± 0.05 (351)	21.2 ^e ± 0.05 (351)	70.6 ± 0.15 (149)
Strain 2 x Average	41.2 ^c ± 0.08 (348)	183.4 ^b ± 0.25 (348)	28.6 ^b ± 0.10 (348)	15.6 ^b ± 0.05 (348)	22.5 ^c ± 0.05 (348)	71.4 ± 0.15 (146)
Strain 2 x Large	44.2 ^a ± 0.08 (340)	185.3 ^a ± 0.24 (340)	28.9 ^a ± 0.10 (340)	15.6 ^b ± 0.05 (340)	23.6 ^a ± 0.05 (340)	72.2 ± 0.15 (134)
Probability	Prob > F					
Egg Source	<0.0001	<0.0001	0.0280	<0.0001	<0.0001	0.0007
Egg Size	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Egg Source x Egg Size	0.0007	<0.0001	<0.0001	0.0013	<0.0001	0.4253

^A Saleable chicks.

^B Number of observations.

^C Small = eggs weighing 50–56g

^D Average = eggs weighing 54-60g

^E Large = eggs weighing 58-64g

^L Shank length / chick length x 100.

^M Chick weight / chick length x 100

^N Chick weight /set weight x 100.

^{a-b} Means within a column and effect with different superscripts are significantly different ($P < 0.05$).

