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The Effect of Acute Cold Exposure on Body Weight in Broiler Chicks

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ABSTRACT

This study investigated the effects of cold-stress on body weight gain in broiler chicks. Two hundred sixty-four one-day-old broiler chicks were randomly divided into 3 treatments. One treatment was designated as the control group, and the birds remained at 22°C. The birds of the other two treatments were exposed to 16°C or 7°C temperatures for 75 minutes. Fifty percent of the birds in each treatment were males. The birds were weighed on Day 1 and then weekly for 6 weeks. Analysis of the data revealed significant differences between the treatments for both sexes for the first-day weights. Weights for weeks 1-6, however, were not significantly different. Birds huddled together to stay warm during their cold exposure, and this may have prevented them from chilling thoroughly.

INTRODUCTION

Prior to 1930 the poultry market relied upon a dual-purpose chicken to supply both meat and eggs. As the industry evolved, however, growers began to rear birds specialized to either lay eggs (White Leghorns) or to supply meat (Broilers), terminating the reign of the dual-purpose chicken. In 1934 the average marketed weight of the broiler was 2.86Kg, and it reached marketing age at 13 weeks, 4 days. In 1994, though, the average broiler weighed 4.50Kg at market and was 6 weeks of age. It is no surprise that the broiler industry is very competitive. Companies are in a never-ending race to produce the heaviest, healthiest bird in the least amount of time. (Nesheim, 1979)

To achieve a bird's full growth potential, growers must take care to supply birds with all necessities. Chicks must be vaccinated against many diseases. Feed formulas must be devised to supply the birds with the proper amounts of energy, protein, and essential vitamins and minerals. Lighting programs must be established to yield a minimal number of illumination hours with optimal performance. Care must also be taken to remove any stress factors that may reduce growth, such as temperature or noise.

A great deal of research has focused on the stressing effects of temperature extremes, in particular cold stress. As adults, chickens maintain an average body temperature of 40.5°C. At hatch, however, chicks are somewhat poikilothermic and are unable to maintain this temperature. Because their thermogenetic ability does not develop until two to three weeks of age, they must be

supplied a constant source of heat. This is the reason that chicks are brooded in their pens for the first two to three weeks after hatching (Kleiber and Winchester, 1933; Koskimies, 1962).

Early researchers suggested that homeothermy may result from increased insulation (down and feathers) and increased rate of metabolic heat production, as well as a decreased ratio of surface area to body mass (King and Farner, 1961; Whittow, 1965; Bernstein, 1973). In fact Wekstein and Zolman (1971) found that depilated chicks could not maintain the same core temperature as insulated chicks of the same age when exposed to cold temperatures. They hypothesized that down contributes significantly to cold stress regulation but that thermogenesis does develop independently of down.

Carlson (1966) demonstrated that most neonate mammals elicit some sort of non-shivering thermogenetic response to cold. He also determined that adrenal medullary release of norepinephrine is responsible for catabolizing lipids in brown adipose tissue, which increases body heat.

Chicks, like newborn mammals, do not shiver but huddle together in response to acute cold exposure. They must, therefore, also have some sort of non-shivering response to cold to prevent their body temperature from dropping too far. Research has shown that circulating catecholamine levels rise significantly in cold-stressed birds (Freeman, 1966; Wekstein and Zolman, 1968; El-Halawani et al, 1973). Epinephrine and norepinephrine increase glycogen degradation in the muscles and the liver, increasing blood

sugar levels, and are responsible for increased oxygen consumption, which is also characteristic of the non-shivering chick response (Freeman, 1966; Wekstein and Zolman, 1968).

Corticosterone secretion by the adrenal cortex also significantly increases with acute exposure to cold (El-Halawani et al, 1973; Buckland et al, 1974; Scott and Washburn, 1986). Corticosterone is responsible for increasing metabolism by increasing blood sugar levels. It has also been demonstrated that cold stress significantly reduces body weights and gains for chicks (Sagher, 1975; Scott and Washburn, 1986) and increases susceptibility to bacterial infection (Thaxton, 1978). Based on these studies, it appears corticosterone is beneficial to the adaptability of the chick to cold temperatures, but may be detrimental to early growth and to the immune response.

To avoid the possibility of cold-stressing chicks, care must be taken in transport of the birds from the hatchery to the houses, particularly if a long ride is necessary. During winter months there may be sufficient opportunity for the trucks to be chilled by ambient temperatures unless precautions are taken.

The purpose of this study was to validate the claim that acute cold exposure of newly-hatched chicks will reduce their weight gain and to compare the effects of two different degrees of coldness. The study was inspired by a project conducted by Lacy at the University of Georgia in 1994. He discovered that chicks subjected to a 12.8°C stress for 45 minutes were significantly lighter at 35 days of age than the control group (Lacy, 1994).

MATERIALS AND METHODS

Broiler chicks for this study hatched from broiler breeder eggs collected at the LSU Agricultural Center Poultry Science research farm in Baton Rouge, LA. On Day 1 newly-hatched chicks were removed from the hatcher, sexed and wing-banded. They were divided randomly into three treatments. Each treatment consisted of 88 birds. Fifty percent were males and 50% were females.

Treatment 1 was designated as the control and remained at room temperature (22°C) while the other two treatments were cold-stressed. The birds in Treatment 2 were kept at 16°C for 75 minutes, and those in Treatment 3 were kept at 7°C for 75 minutes. The chicks in each treatment were placed together in 0.46m x 0.61m plastic chick trays during their exposures.

Upon removal of the treatments from their perspective temperatures, the chicks were weighed to the nearest 0.1g on a Mettler PM4600 digital scale. The birds were then housed in six 1.52m x 3.05m pens. The pens were equipped with automatic water dispensers, manual chick waterers, chick feeder lids, and gas-burning brooders hung above the pen and designed to warm up to 100 chicks. Each pen received 44 birds, 7 males and 7 females from each of the three treatments and two additional birds randomly selected among the three treatments. In this manner all three treatments were nearly equally represented in each of the six pens. The birds were fed a standard starter ration (Table 1) ad libitum and were maintained on a constant lighting cycle with 60 watt lightbulbs.

Table 1. Broiler Starter Diet for the Experiment.

Ingredient	(%)
Corn	54.74
Soybean Meal - 44	34.00
DIKAL-21	2.00
Oyster Shell flour	1.50
Microingredients	0.25
Salt	0.50
Choline	0.13
DL-Methionine	0.13
Tallow	6.75
Calculated Analysis:	
Protein (%)	20.00
Metabolizable Energy (Kcal/Kg)	3070
Calcium (%)	1.14
Phosphorus (%)	0.72

The birds were weighed weekly for six weeks. Following the final weighing on Day 42, the recorded data were analyzed on the SAS system, while the mean comparisons were made by Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Analysis of the body weight data (Tables 2 and 3) for males and females on Day 1 (Figures 1 and 2) reveals a significant difference ($P<0.003$ and $P<0.006$, respectively). For the males both cold-stressed treatments were significantly different from the control. For the females only the 16°C treatment was significantly different from the control. In neither case were the two cold-stressed treatments significantly different from each other. The significant differences may be attributed to different rates of yolk metabolism between the controlled and the stressed birds. Those that were stressed probably digested their yolk stores more rapidly to generate some body heat.

The six weekly weighings showed no significance for males or females (Tables 2 and 3; Figures 3, 4, 5, and 6). At week six, though, female weights had a significance level of $P<0.09$. At this level the control was statistically different from Treatment 2, held at 16°C, but neither were significantly different from the third treatment, which was held at 7°C. This significance, however, should not be emphasized. Tables 2 and 3 indicate that P-values were very inconsistent from week to week, ranging from below 0.4 to above 0.9. The significance at week 6 is probably attributed to chance.

The failure to show a significant difference among the treatments for weekly weights may have been due to insufficient exposure to the cold. Most of the previous research on this subject is based upon treatments that were exposed for longer

Table 2. Weekly male Broiler Body Weight (g) as Influenced by Cold Exposure.

Treatment	Weeks of Age						
	0	1	2	3	4	5	6
Control	44.2^{A}	120^{A}	331^{A}	658^{A}	1119^{A}	1621^{A}	2006^{A}
16°C-75min	42.8^{B}	122^{A}	330^{A}	662^{A}	1132^{A}	1623^{A}	2009^{A}
7°C-75min	41.7^{B}	120^{A}	325^{A}	659^{A}	1141^{A}	1643^{A}	2034^{A}
P of F	.0032	.68	.62	.95	.43	.62	.48

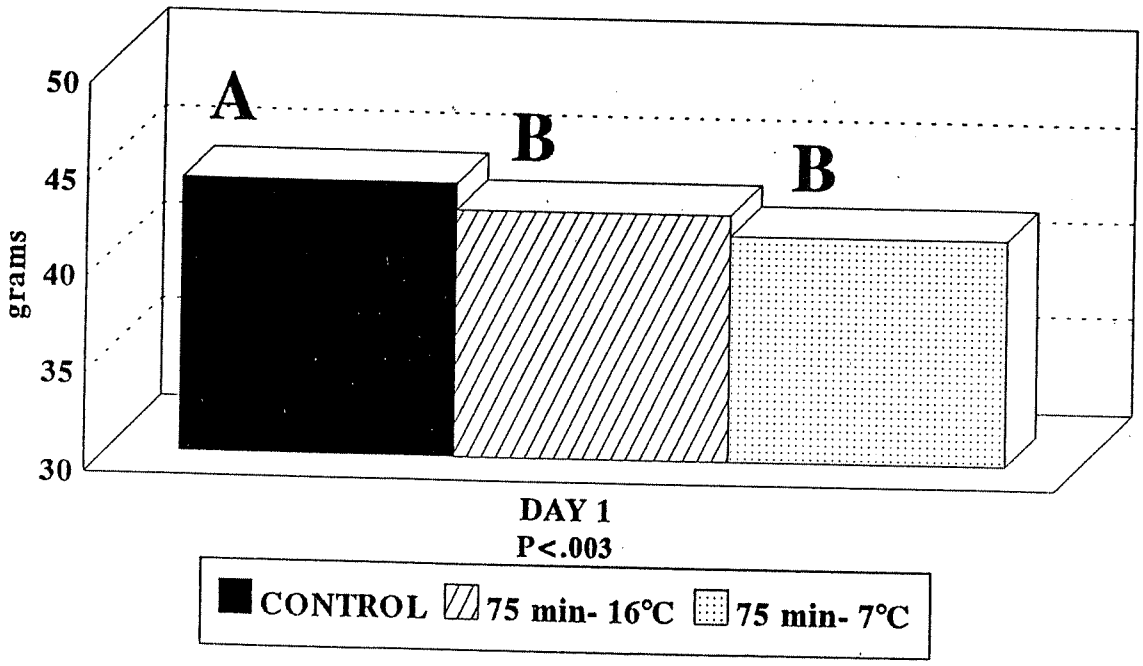
^{A,B}Duncan's Multiple Range Test conducted at P<.05. Means with different superscripts are significantly different.

Table 3. Weekly female Broiler Body Weight (g) as Influenced by Cold Exposure.

Treatment	Weeks of Age						
	0	1	2	3	4	5	6
Control	43.9^{A}	120^{A}	320^{A}	626^{A}	1017^{A}	1403^{A}	1732^{A}
16°C-75min	40.8^{B}	118^{A}	319^{A}	612^{A}	1009^{A}	1391^{A}	1690^{B}
7°C-75min	42.3^{AB}	119^{A}	318^{A}	613^{A}	1012^{A}	1403^{A}	1704^{AB}
P of F	.0057	.88	.97	.39	.82	.70	.09

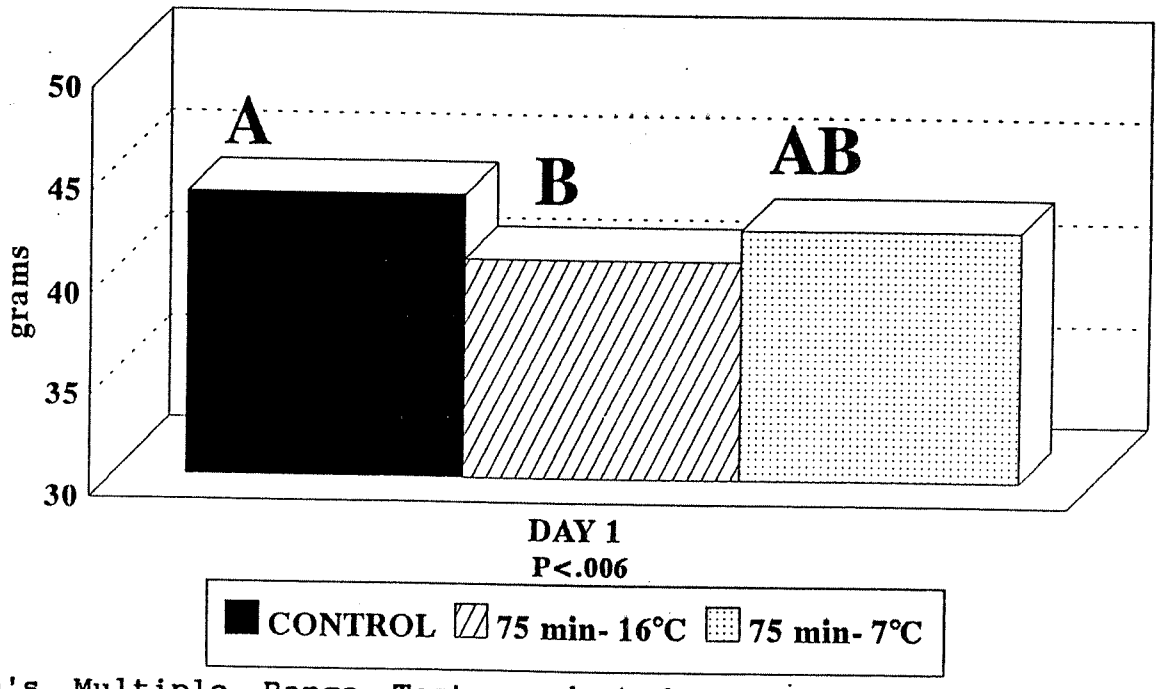
^{A,B}Duncan's Multiple Range Test conducted at P<.05. Means with different superscripts are significantly different.

Figure 1. MALE CHICK WEIGHT (g) DAY 1 (following treatment)



[A,B]Duncan's Multiple Range Test conducted at P<.05. Means with different superscripts are significantly different.

Figure 2. FEMALE CHICK WEIGHT (g) DAY 1 (following treatment)



[A,B]Duncan's Multiple Range Test conducted at P<.05. Means with different superscripts are significantly different.

Figure 3. MALE CHICK WEIGHT (g) WEEKS 1-3

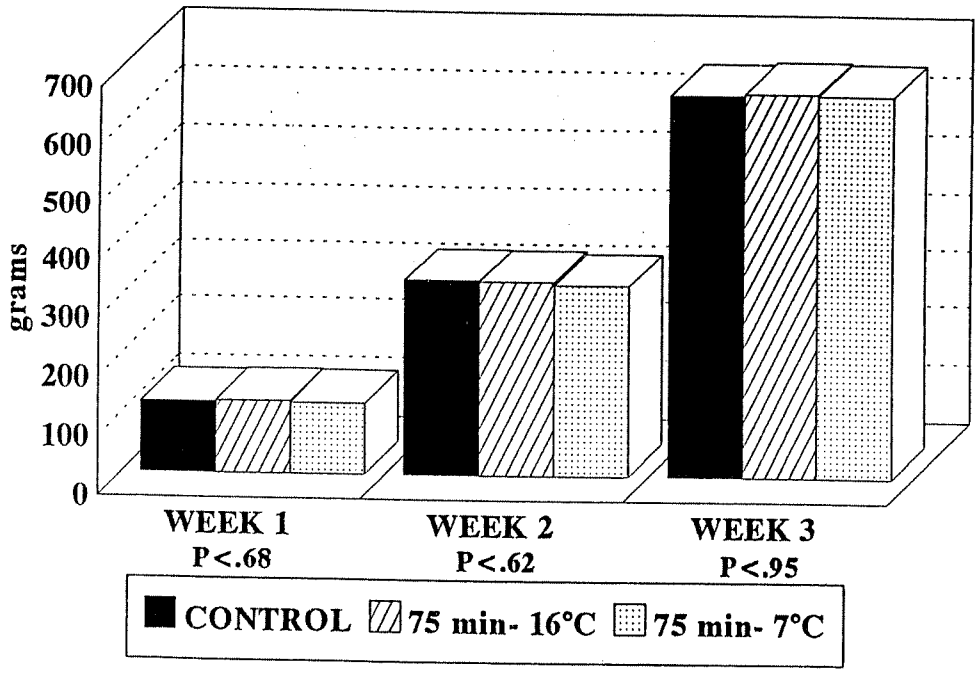


Figure 4. FEMALE CHICK WEIGHT (g) WEEKS 1-3

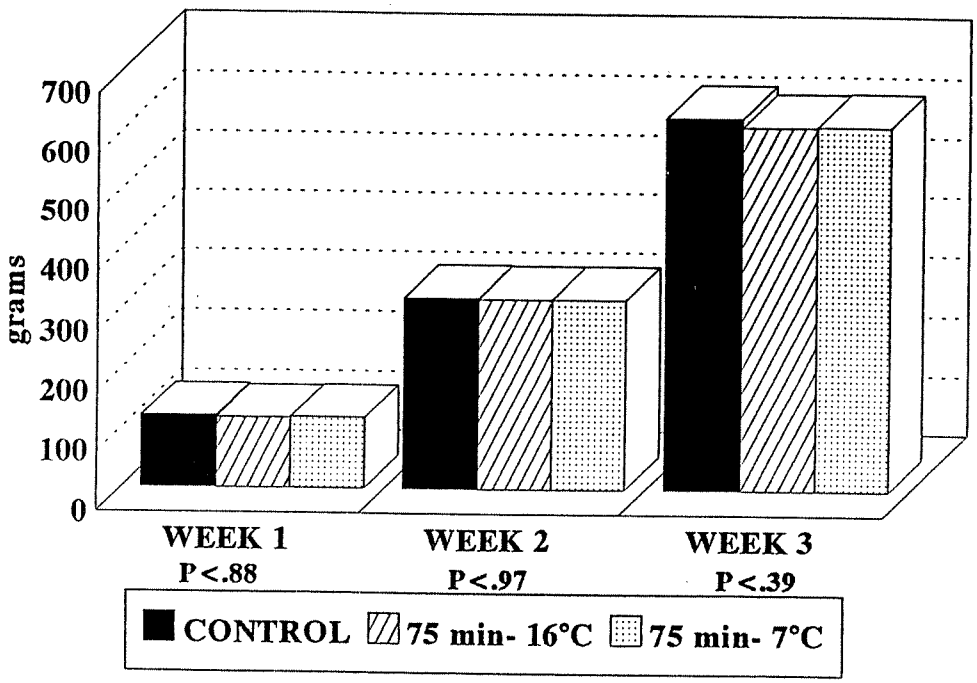


Figure 5. MALE CHICK WEIGHT (g) WEEKS 4-6

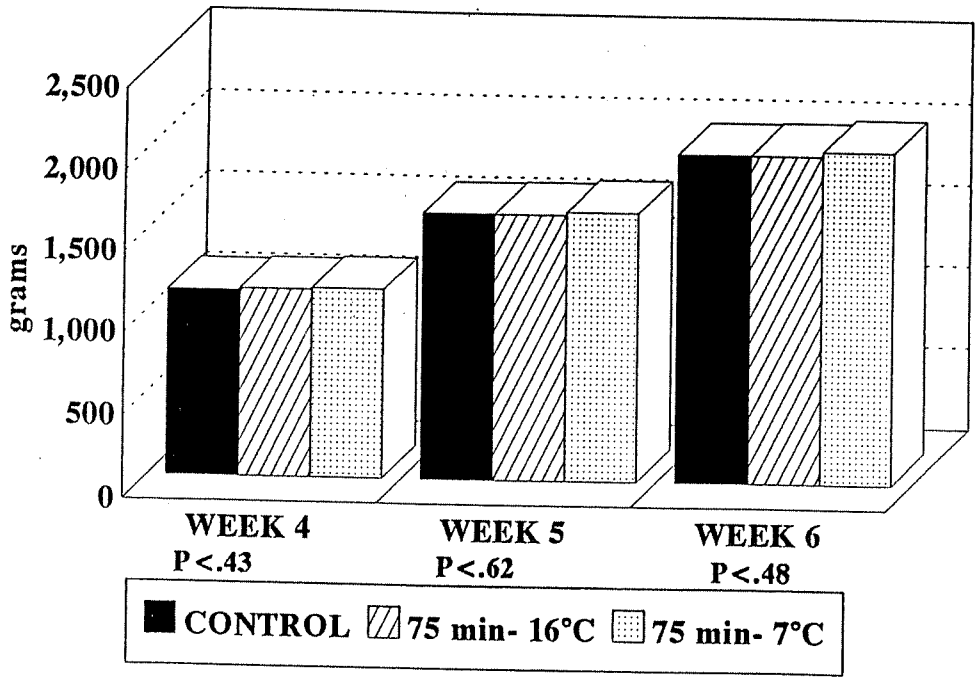
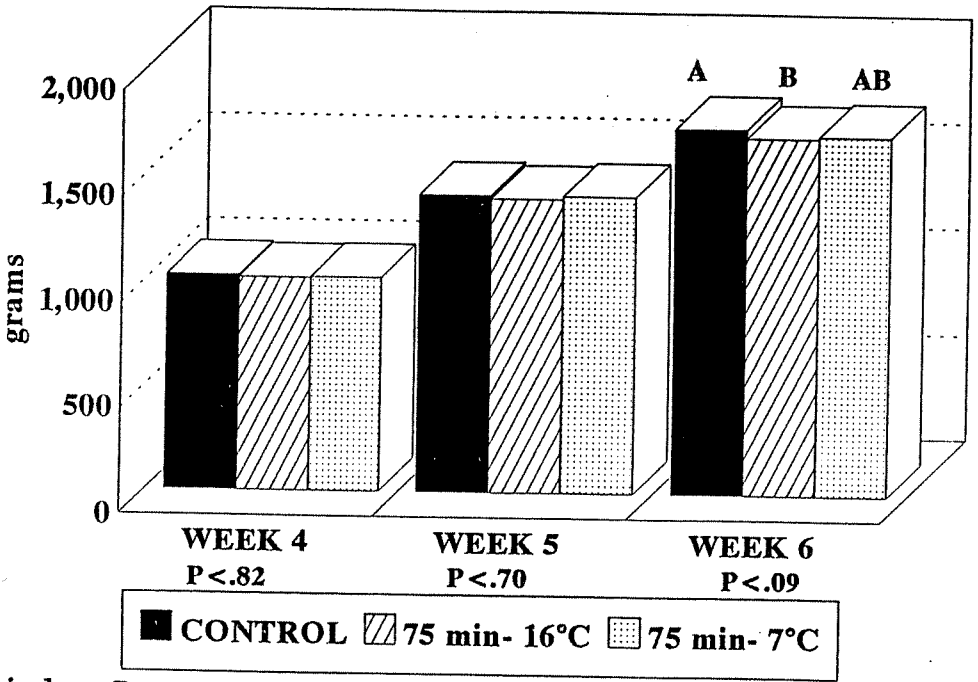


Figure 6. FEMALE CHICK WEIGHT (g) WEEKS 4-6



[A,B]Duncan's Multiple Range Test conducted at P<.05. Means with different superscripts are significantly different.

periods. Sagher (1975) and Scott and Washburn (1986), who specifically tested for body weight gain, exposed their treatments for 4 hours and 24 hours, respectively; however, Freeman (1966) and Lacy (1994) did conduct studies in which chicks were exposed for only a short time- 30 and 45 minutes, respectively. Freeman's research at the molecular level could, no doubt, detect even minute responses to the shortest of cold exposures, but Lacy's success is puzzling. Because his results were never published but, rather, appeared in an informal article in Poultry Times, his protocol is unclear. It is quite possible that Lacy separated each bird individually from the rest in the treatment during cold exposure, allowing the chick nothing to huddle against, but his technique is uncertain. Many of the researchers have employed this method of isolating chicks upon exposure (El-Halawani et al, 1973; Wekstein and Zolman, 1968; Freeman, 1966; Sagher, 1975).

In order to simulate actual industry conditions in which chicks are allowed to interact, the chicks in this study were not separated upon cold exposure. Additionally, the decision to expose them for a period of 75 minutes is to simulate the transport time from the hatchery to the grower houses. It is this period which offers the greatest risk of acute cold exposure for the chicks. It may have been these decisions, though, which prevented the data from separating significantly and, thus, supporting prior research.

During this six-week study there were only two mortalities. A bird from the 7°C treatment died during the second week, and a bird from the 16°C treatment died in the third week.

CONCLUSION

Based on this study, day-old chicks exposed to cold environments do not have a significantly reduced weight gain compared to the control; however, further research is warranted.

Growers must take care not to allow broiler chicks to be cold-stressed before the development of their thermoregulatory systems. If research conducted by Sagher (1975), Scott and Washburn (1986), and Lacy (1994) is valid, money will be lost when the broilers are marketed. They will be significantly lighter if they had been cold-stressed. It is important for the grower to ensure that the broiler houses are properly heated before the chicks arrive. The air may be the appropriate 29.4-32.2°C, but the litter on the pen floors may still be chilled if the houses are not warmed long enough in advance.

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