Comparison of Broiler Performance and Economics in Conventional and Light-Tight Floor Pen Houses with Continuous and Intermittent Light Programs

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SUMMARY

Broilers grown in a conventional-type house under natural lighting with intermittent lighting at night were compared to continuous (24-hour) lighting in two experiments. Broiler growth and feed conversion at seven weeks were not affected by treatments in either experiment. Economic evaluation of the different treatments showed savings ranging from 2.43 to 4.39 cents per bird for the intermittent treatments compared to continuous lighting.

Broilers were also grown in a light-tight house to further evaluate the effect of intermittent light on broiler performance. There were no significant differences in mean body weights, feed conversion, feed consumption, and mortality at seven weeks of age between treatments for this experiment. Economic evaluation showed savings of .25 to 1.36 cents per bird for the intermittent treatment over the continuous lighting treatment.

COMPARISON OF BROILER PERFORMANCE AND ECONOMICS IN CONVENTIONAL AND LIGHT-TIGHT FLOOR PEN HOUSES WITH CONTINUOUS AND INTERMITTENT LIGHT PROGRAM

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Intermittent lighting is a system of varying periods of light and dark in a cyclic manner over 24 hours in contrast to continuous lighting for 24 hours.

Intermittent lighting may be an easy and low cost way to increase body weight gains and feed efficiencies in broilers (Buckland et al., 1973; McDaniel et al., 1977). Bird density may be increased because of less stress on the birds (Buckland et al., 1971, 1976).

Buckland et al. (1973, 1976) reported that a long light period (13 hours) interrupting the intermittent lighting cycle adversely affected broiler body weight gain and feed conversion when compared to other intermittent lighting treatments and continuous lighting. Quarles and Kling (1974) compared lighting treatments of 1/4 hour light (1/4 L): 2 hours dark (2D), recycled and 12 hours continuous light followed by intermittent light (1/4 L:2D) for 12 hours with continuous (24L:0D) lighting. There were no significant differences in broiler body weight between treatments at four or seven weeks. Feed efficiency was significantly improved at seven weeks by the two intermittent treatments.

The studies reported here were conducted to determine if intermittent lighting during the night would be compatible with the continuous natural lighting during the day found in open curtain-type houses still used in the broiler industry. Economic comparisons were made to determine monetary gains or losses from lighting, feed consumption, and body weight gains when comparing the intermittent lighting treatments to continuous lighting.

EXPERIMENTAL PROCEDURES

Experiments 1 and 2 were conducted at different times in an uninsulated, naturally ventilated, curtain-type house. Experiment 3 was run later than the first two experiments in an uninsulated, fan ventilated, light-tight house. Each house contained eight pens, with each pen measuring 3 meters x 4.5 meters.

Each experiment had four treatments with two replicates or pens per treatment. Approximately 70 day-old Hubbard broiler chicks of each sex were assigned to each pen and each bird was allowed .096 square meter floor space in all experiments.

Brooding methods and equipment in all experiments were similar to those described by Dorminey and Nakaue (1977).

In Experiments 1 and 2, the natural daylight was an integral part of the lighting system. The intermittent programs in these two experiments were carried out during the dark (night) periods of each day. The total lighting program would then consist of continuous natural light (NL) + intermittent light recycled during the night period.

In Experiment 1, the natural light period was approximately eight hours. The light treatments were continuous (24L:0D) lighting; 8 hours natural light (NL) + 1-3/4D:3/4L, recycled during the night; 8NL + 1-1/2D:1/2L, recycled during the night; 8NL + 3/4D:1/4L, recycled during the night.

In Experiment 2, the length of daylight was increasing rapidly. Therefore, to standardize the long light period from the start to the end of the experiment, artificial lights were provided from 5 a.m. to 6:30 a.m. and again from 6 p.m. to 7:30 p.m. at the beginning of the experiment to give a total of 14-1/2 hours of continuous light during the day. The light treatments were continuous (24L:0D) lighting; 14-1/2L:9-1/2D; 14-1/2L + 2-1/2D:1L, recycled during the night; and 14-1/2L + 3/4D:1/4L, recycled during the night. Light intensities were measured with a Weston illumination meter, and they ranged from 38 lux in the corners to 215 lux in the center of the rooms during the daylight hours.

The light treatments in Experiment 3 were continuous (24L:0D);1/4L:3/4D, recyled; 1L:3D, recycled; and 10 hours continuous light followed by intermittent light (1/4L:2D) for 14 hours. The light intensities ranged from 3.2 lux in the corners and 5.4 lux in the center of the pens. All the light in this experiment was provided artificially.

Dayton time clocks were used to regulate the light and dark periods in all the experiments. One 25-watt light bulb suspended about 2 meters above the center of the pen provided the light in each pen when needed.

During the first week, birds were provided with continuous light, after which intermittent treatments were begun in Experiments 1 and 2. In Experiment 3, intermittent lighting was initiated at three days of age.

Broiler starter was fed from day-old to three weeks of age, and broiler finisher from three to seven weeks of age. The ration composition is listed in Table 1. Feed and water were provided *ad libitum*.

Birds were bulk weighed by sexes and feed consumption determined at four and seven weeks for each experiment.

Data from each of these experiments were analyzed using a one-way analysis of variance. Treatment means were separated using Duncan's multiple range test (Steel and Torrie, 1960), when significances were observed.

Economic evaluations were calculated for Experiments 2 and 3. Electrical costs for lighting, feed costs, and revenue from sale of the birds were compared between the continuously lighted group and the intermittently lighted groups in each experiment. All the other costs in the experiments were considered to be equal. Electrical cost was calculated at the 1977 rate of 2.21 cents per kilowatt hour. Electrical consumption for lighting was calculated by adding up the total hours of light used in each treatment throughout each experiment. Feed costs for the starter and finisher feeds were 12.5 and 11 cents per pound, respectively, in Experiment 2. Revenue received per pound live weight for this experiment was 30 cents. In Experiment 3, feed costs were 13 and 12 cents for the starter and finisher feeds, respectively, and 27 cents per pound live weight for bird revenue.

RESULTS

Mean body weights, feed conversion, and feed consumption data for seven weeks of age for Experiment 1 are presented in Table 2. The data showed no significant differences between treatments for mean male, female, and combined body weights, feed conversion, and feed consumption. Mortality was not affected by the light treatment during the experiment.

There were also no significant differences in mean male, female, and combined sex body weights, feed conversion, and feed consumption between any of the treatments at seven weeks of age for Experiment 2 (Table 3). However, feed consumption was numerically lower, ranging from 0.20 to 0.23 kilograms per bird for the intermittent lighting treatments compared to the continuous lighting. Light treatment did not affect mortality.

The economic evaluation (Table 4) shows electrical savings from 0.38 to 0.43 cents per bird and feed savings of 6.0 cents per bird for Treatments 2, 3, and 4, compared to Treatment 1. The overall savings were 2.43, 4.39, and 3.38 cents per bird for Treatments 2, 3, and 4, respectively, when compared to Treatment 1, which was the continuous lighting.

No significant differences between treatments at seven weeks for mean body weight, feed conversion, and feed consumption were observed in Experiment 3 (Table 5). Because of relatively warm daytime temperatures (32 to 37°C) during the fifth to the seventh week, mean body weights were lower overall than in the first two experiments. Mortality was not affected by light treatments.

All three intermittent lighting programs in Experiment 3 produced savings per broiler, ranging from 0.25 to 1.36 cents (Table 6). The greatest advantage was obtained from Treatment 2 (1/4L:3/4D, recycled) with 1.36 cents savings per bird. The cost differences between treatments were small compared to Experiment 2 and may be attributed to the hot weather during the experiment.

These three experiments show that intermittent lighting regimes under both conventional and light-tight housing are workable systems. Electrical costs for lighting may be reduced as much as 0.4 cents per bird and the feed costs by 6.0 cents per bird. Overall savings in the experiments ranged from 0.25 to 4.39 cents per bird when compared to continuous lighting. An intermittent system of 1/2 to 1 hour of light followed by 2 hours of dark would seem to be the best with continuous natural light during the day. A system of 1 hour light and 3 hours dark would be a good system in a light-tight house.

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Table 1: Composition of broiler starter and finisher rations

Ingredients	Starter %	Finisher %
Corn, Yellow	55.02	56.00
Soybean meal, solvent 47.5%	32.75	33.50
Fat, animal	4.00	5.00
Fish meal, herring	3.00	--
Alfalfa meal, dehydrated 17%	2.00	2.00
Defluorinated phosphate	1.75	1.75
Limestone flour	0.75	1.00
Salt, iodized	0.25	0.25
Trace mineral premix[1]	0.10	0.10
Vitamin premix[2]	0.25	0.25
DL-methionine, 98%	0.08	0.10
Zoamix, 25%[3]	0.05	0.05
Baciferm, 40g/lb[4]	+	+
Calculated analysis:		
Protein, %	23.00	21.00
Metab. energy, kcal/kg.	3091	3135
Calcium, %	1.10	1.10
Avail. Phosphorus	0.48	0.44
Methionine + cystine	0.86	0.81

[1]Supplied per kilogram of ration: Calcium, 97.5 mg.; Manganese, 60 mg.; Iron, 20 mg.; Copper, 2 mg.; Iodine, 1.2 mg.; Zinc, 27.5 mg.

[2]Supplied per kilogram of ration: vit. A, 3304 I.U.; vit. D, 1111 I.C.U.; riboflavin, 3.3 mg.; d-pantothenic acid, 5.51 mg.; niacin, 22.01 mg.; choline, 191 mg.; vit. B_{12}, 5.51 mcg.; vit. E, 1.1 I.U.; vit K, .55 mg.; folacin, .22 mg.

[3]Provided gratuitously by Salsbury Laboratories, Charles City, Iowa.

[4]Provided gratuitously by International Minerals Co., Terre Haute, Indiana. Suggested at a level of 0.05 percent.

Table 2. Effect of 8 hours of natural light (NL) with three intermittent light programs during the night on broiler performance at 7 weeks of age, (Experiment 1)[1]

Treat. No.	Light program light(L):dark(D)	Mean body weight[1] Male	Female	M + F	Feed/gain[1]	Feed consumed[1]	Mortality
	(hours)	(grams)	(grams)	(grams)	(ratio)	(kg/bird)	(%)
1	24L:0D	2003[a]	1637[a]	1819[a]	2.21[a]	4.03[a]	3.2
2	8NL + [1-3/4D:3/4L recycled during the night]	2008[a]	1658[a]	1833[a]	2.23[a]	4.09[a]	3.2
3	8NL + [1-1/2D:1/2L recycled during the night]	1973[a]	1556[a]	1764[a]	2.22[a]	3.88[a]	1.8
4	8NL + [3/4D:1/4L recycled during the night]	1987[a]	1587[a]	1783[a]	2.18[a]	3.85[a]	1.8

[1]Means with different superscripts within a column were significantly different, ($P < 0.05$).

Table 3. Effect of 14-1/2 hours light followed by two intermittent light programs during the night on broiler performance at 7 weeks of age, (Experiment 2)[1]

Treat. No.	Light program light(L):dark(D)	Mean body weight[1]			Feed/ gain[1]	Feed consumed[1]	Mortality
		Male	Female	M + F			
	(hours)	(grams)	(grams)	(grams)	(ratio)	(kg/bird)	(%)
1	24L:0D	2061[a]	1635[a]	1845[a]	2.11[a]	3.88[a]	6.0
2	14-1/2L:9-1/2D	2008[a]	1592[a]	1790[a]	2.05[a]	3.65[a]	9.3
3	14-1/2L + [2-1/2D: 1L recycled during the night]	2018[a]	1633[a]	1816[a]	2.08[a]	3.68[a]	2.8
4	14-1/2L + [1/4D:3/4L recycled during the night]	2004[a]	1620[a]	1807[a]	2.05[a]	3.66[a]	5.0

[1]Means with different superscripts within a column were significantly different, ($P < 0.05$).

Table 4. Economic evaluation for broilers exposed to 14½ hours continuous light followed by either no light or intermittent light during the night hours, (Experiment 2)

[1]Treat. No.	[2]Electrical Savings/Loss	Feed Savings/Loss	Revenue Savings/Loss	[3]Total Loss or Gain
	(¢/bird)	(¢/bird)	(¢/bird)	(¢/bird)
1	-	-	-	-
2	+0.43	+6.0	-4.0	+2.43
3	+0.39	+6.0	-2.0	+4.39
4	+0.39	+6.0	-3.0	+3.39

[1]See Table 3 and text for lighting programs.

[2]Savings or loss in each category column (electrical, feed, and revenue) are calculated by comparison to the cost values for the control group (Treatment 1, 24-hour lighting) in this experiment.

[3]This column calculated by adding all the pluses and subtracting all the minuses for each row.

Table 5. Effect of three intermittent light programs in light-tight house on broiler performance at 7 weeks of age, (Experiment 3)[1]

Treat. No.	Light program light(L):dark(D)	Mean Body weight Male	Female	M + F	feed/gain	feed consumed	Mortality
	(hours)	(grams)	(grams)	(grams)	(ratio)	(kg/bird)	(%)
1	24L:0D	1889[a]	1543[a]	1716[a]	1.97[a]	3.38[a]	3.6
2	1/4L:3/4D recycled	1893[a]	1541[a]	1717[a]	1.94[a]	3.34[a]	3.6
3	1L:3D recycled	1929[a]	1558[a]	1744[a]	1.95[a]	3.42[a]	2.1
4	10L + 2D:1/4L recycled	1899[a]	1577[a]	1738[a]	1.96[a]	3.42[a]	3.6

[1] [a]Means with different superscripts within a column were significantly different ($P < 0.05$).

Table 6. Economic evaluation for broilers exposed to intermittent light in light-tight house, (Experiment 3)

[1]Treat. No.	[2]Electrical Savings/Loss	Feed Savings/Loss	Revenue Savings/Loss	[3]Total Loss or Gain
	(¢/bird)	(¢/bird)	(¢/bird)	(¢/bird)
1	-	-	-	-
2	+0.36	+1.0	-	+1.36
3	+0.36	-1.0	+1.6	+0.96
4	+0.25	-1.0	+1.0	+0.25

[1]See Table 5 and text for lighting programs.

[2]Savings or loss in each category column (electrical, feed, and revenue) are calculated by comparison to the cost values for the control group (Treatment 1, 24 hour lighting) in this experiment.

[3]This column calculated by adding all the pluses and subtracting all the minuses for each row.