Effects of Feed Restriction During the Rearing Period and Age at Photostimulation on the Reproductive Performance of Turkey Hens

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(Received for publication November 13, 1989)

ABSTRACT An experiment with Nicholas parent-stock turkey breeder hens was designed to determine the effects of feed restriction during the rearing period and age at photostimulation on reproductive performance. Hens reared on *ad libitum* intake of conventional corn-soybean diets (*ad libitum*), skip-1-day per week (skip-1-day), and 95% of *ad libitum* (95%) were placed into cages and photostimulated when they reached a target body weight of 10 kg or at the conventional age of 29 wk. A 3 × 2 factorial design was used, with five replicates of three hens for each treatment. All birds were fed for *ad libitum* access during the breeding period. More eggs were set from 95% birds than from *ad libitum* or skip-1-day birds ($P<.05$); there was no difference between *ad libitum* and skip-1-day birds. Photostimulating based on 10 kg of BW versus 29 wk of age had no effect on total eggs set. There was no effect of rearing feed restriction on fertility or hatchability. Photostimulating based on 10 kg rather than 29 wk of age reduced fertility and hatchability ($P<.05$). The results of this study indicate that optimum reproductive performance is attained by restricting the feed consumption of turkey breeder hens to 95% of *ad libitum* during the rearing period. No benefits were gained from photostimulating at 10 kg of BW versus 29 wk of age.

(*Key words*: feed restriction, photostimulation, age, reproduction, turkey breeder hens)

1990 Poultry Science 69:1522–1528

INTRODUCTION

There has been a renewed interest in the use of feed restriction programs for turkey breeder hen candidates. This has been stimulated by the success with broiler breeders, and because the primary turkey breeding industry has shifted some of its selection emphasis toward growth to the female lines. Hester and Stevens (Purdue University, West Lafayette, IN, personal communication) conclude that feed restriction programs used in the past reduced BW and delayed sexual maturity without affecting egg weight, fertility, or hatchability. The results for egg production were more variable. Jones *et al.* (1976), Andrews and Morrow (1978), and Voitle and Harms (1978) showed that restricted-fed hens produced significantly fewer eggs, whereas Potter *et al.* (1978), Owings and Sell (1980), Nestor *et al.* (1981), and Ferket and Moran (1986) showed no effect of feed restriction on total egg production.

Early photostimulation of turkey breeder hens has resulted in smaller eggs, increased incidence of prolapse, lower hatch of fertile eggs (Helm, 1984), a higher proportion of nonlayers, smaller poults, and slower growing poults (Leighton, 1981). Herron and Whitehead (1985) showed that turkey hens stimulated at 24 wk of age laid 13 more eggs per hen than those stimulated at 30 wk. These researchers suggested that when turkey hens are held out of lay until the relatively late age of 30 wk, they become excessively fat. Nicholas Turkey Breeding Farms (1986) state that the optimum age and BW for photostimulating turkey breeder hens is 29 wk and 10 kg, respectively. Breeder hens have the potential to weigh well over 11 kg by 29 wk of age.

The objectives of this experiment were twofold: 1) to compare the reproductive performance of turkey breeder hens reared on *ad libitum* or restricted feeding programs, and 2) to determine if photostimulating at a target BW of 10 kg, regardless of age, was preferable to photostimulating at the conventional age of 29 wk, regardless of BW. The feed restriction programs tested in this experiment were chosen because they maintained the immature hens at BW relatively close to the target weights recommended by Nicholas Turkey Breeding Farms (1986) and so allowed a comparison of quantitative feed restriction with that based on time allocation.

TABLE 1. *Composition of rearing diets*

Ingredient	Diets[1] S1	S2	G1	G2	D1	D2
	(%)					
Corn	39.00	37.80	38.00	56.37	56.00	55.70
Barley	9.35	22.00	30.00	20.00	26.39	32.00
Soybean meal (48% CP)	39.00	34.00	26.33	18.50	13.00	8.00
Fish meal (60% CP)	7.00	...	...	...	...	...
Ground limestone	1.50	1.50	1.50	1.30	1.00	.90
Calcium phosphate (20% P)	2.00	2.50	2.00	1.70	1.50	1.30
Fat (animal-vegetable)	1.00	1.00	1.00	1.00	1.00	1.00
Iodized salt (.015% KI)	.30	.35	.35	.35	.35	.35
DL-methionine	.10	.10	.07	.03	.01	...
Vitamin mix[2]	.50	.50	.50	.50	.50	.50
Mineral mix[3]	.25	.25	.25	.25	.25	.25
Calculated analysis						
CP, %	27.4	22.2	19.4	16.1	14.1	12.3
Energy, kcal of ME/kg	2,825	2,819	2,851	2,983	3,007	3,025
Methionine, %	.60	.46	.39	.31	.27	.23
Lysine, %	1.73	1.25	1.04	.78	.63	.50
Calcium, %	1.54	1.19	1.08	.91	.75	.67
Available P, %	.77	.63	.52	.45	.41	.36

[1]Fed as follows: Starter 1 (S1) from 0 to 4 wk of age; Starter 2 (S2) from 4 to 8 wk; Grower 1 (G1) from 8 to 14 wk; Grower 2 (G2) from 14 to 20 wk; Developer 1 (D1) from 20 to 25 wk; and Developer 2 (D2) from 25 to 29 wk.

[2]Supplied per kilogram of diet: vitamin A, 8,000 IU; vitamin D_3, 1,600 IU; vitamin E, 11.0 mg; riboflavin, 9.0 mg; pantothenic acid, 11.0 mg; vitamin B_{12}, 13 μg; niacin, 26 mg; choline, 900 mg; vitamin K, 1.5 mg; folic acid, 1.5 mg; biotin, .25 mg; and antioxidant, 125 mg.

[3]Supplied per kilogram of diet: manganese, 55 mg; zinc, 50 mg; copper, 5 mg; iron, 30 mg; and selenium, .1 mg.

MATERIALS AND METHODS

A completely randomized 3 × 2 factorial design was used to test three levels of feeding during the growing period and two levels of age at photostimulation. The six treatments were as follows: 1) fed *ad libitum* during the growing period (*ad libitum*) and photostimulated at a BW of 10 kg; or 2) photostimulated at 29 wk of age; restricted by skip-1-day per week during the growing period (skip-1-day); and 3) photostimulated at a BW of 10 kg; or 4) photostimulated at 29 wk of age; restricted to 95% of *ad libitum* during the growing period (95%); and 5) photostimulated at a body weight of 10 kg; or 6) photostimulated at 29 wk of age. The hens were reared in floor pens on litter using conventional corn-soybean diets (Table 1). The skip-1-day program started at 4 wk of age with feeders removed every Tuesday morning at 0090 h and replaced every Wednesday morning at 0900 h. The 95% birds were fed 95% of the average daily amount consumed by the *ad libitum* hens starting at 2 wk of age. Because there were five replications per treatment, and three hens per replication, each treatment consisted of 15 hens. Thus, a total of 90 commercial parent-line hens (Nicholas Turkey Breeding Farms, Sonoma, CA) were used in this experiment.

The birds were moved to individual raised wire cages (60 cm × 40 cm × 65 cm) located in an environmentally controlled room. Hens designated to Treatments 1, 3, and 5 were placed in the cages when they reached an average BW of 10.0 ± .1 kg, whereas hens for Treatments 2, 4, and 6 were placed when they reached 29 wk of age. Four hens per rearing program were randomly selected for carcass analysis immediately after placing at 10 kg of BW and again after placing the other treatment birds at 29 wk of age. These birds were killed by cervical dislocation, and their carcasses were subsequently frozen. The intact carcasses from each replicate were ground through a meat grinder[1] three times, and a representative sample was weighed, freeze-dried to constant

[1]Autio Model 801 B, Autio Company, Astoria, OR.

weight, and then reweighed. The freeze-dried sample was finely ground using a blender.[2] Each sample was analyzed in duplicate for crude fat using the Soxhlet method (Association of Official Analytical Chemists, 1980) and for crude protein by the Kel-Foss method (Association of Official Analytical Chemists, 1980). All caged birds were given 14 h of light daily (0300 to 1700 h) with a conventional turkey breeder diet (Table 2) available *ad libitum.* Semen collected from 10 to 12 commercial parent-line toms (Nicholas Turkey Breeding Farms) was artificially inseminated into hens at 14 and 17 days after placing and at weekly intervals thereafter. The experiment ended when the birds reached 47 wk of age.

The parameters measured in this experiment were feed consumption, BW, egg production, egg weight, fertility, hatchability, and poults per hen. Feed consumption was measured on a weekly basis by giving preweighed feed allocations to each replicate group (three hens) throughout the week and then weighing back all of the unconsumed feed on Fridays. Body weights were recorded every Friday, and egg production was recorded daily with the date and replicate number being written on each egg as it was collected. Egg weight, fertility, and hatchability were measured on a weekly basis. Eggs were set in an incubator[3] every Wednesday and candled on subsequent Wednesdays to remove infertile eggs and dead germs. In order to eliminate any variation that might have existed among the four quadrants of the incubator, each setting of eggs was incubated for 1 wk in each of the quadrants. After 26 days of incubation, the eggs were transferred to a hatcher.[4] Poults hatched, pipped eggs, and dead in shell embryos were recorded during the afternoon of the 28th day of incubation.

Tests of significance (P<.05) concerning carcass composition data were made using the T value calculated for testing the hypothesis that the means of two groups of observations in a data set are equal. The remaining data were analyzed by ANOVA. Tests of significance (P<.05) were made on data recorded at weekly intervals from placing for percent hen day production, egg weight, BW, and feed consumption. Tests of significance (P<.05) were also made on cumulative data from placing until 18 wk of photostimulation for the number of days to first egg, total egg production, eggs set per bird, percentage of fertile eggs, percentage hatch of fertile eggs, poults per bird, and total feed intake. The null hypothesis (all treatment means are equal) was tested by the *F* ratio for the treatment sum of squares, and when there was significant evidence (P<.05) to reject this hypothesis, the alternate hypothesis (some of the treatment means differ) was accepted. The main effects of rearing program, photostimulation determinant, and their interaction were tested by the respective *F* ratios. Further partitioning of the rearing program main effect was accomplished by the use of Duncan's multiple range test (Steel and Torrie, 1980). Statistical Analyses were completed using the TTEST and General Linear Models (GLM) procedures developed by the SAS Institute (1985).

TABLE 2. *Composition of breeder diet*

Ingredient	(%)
Corn	50.10
Barley	25.20
Soybean meal (48% CP)	16.20
Ground limestone	4.75
Calcium phosphate (20% P)	1.65
Fat (animal-vegetable)	1.00
Iodized salt (.015% KI)	.30
DL-methionine	.05
Vitamin mix[1]	.50
Mineral mix[2]	.25
Calculated analysis	
CP, %	15.0
Energy, kcal of ME/kg	2,860
Methionine, %	.31
Lysine, %	.72
Calcium, %	2.21
Available P, %	.44

[1]Supplied per kilogram of diet: vitamin A, 8,000 IU; vitamin D_3, 1,600 IU; vitamin E, 11.0 mg; riboflavin, 9.0 mg; pantothenic acid, 11.0 mg; vitamin B_{12}, 13 μg; niacin, 26 mg; choline, 900 mg; vitamin K, 1.5 mg; folic acid, 1.5 mg; biotin, .25 mg; and antioxidant, 125 mg.

[2]Supplied per kilogram of diet: manganese, 55 mg; zinc, 50 mg; copper, 5 mg; iron, 30 mg; and selenium, .1 mg.

RESULTS

Hens on Treatments 1, 3, and 5 reached an average body weight of 10 kg at 26, 28, and 29 wk of age, respectively. Although it was

[2]Model 33B179, Waring Products Division, Dynamics Corporation of America, New Hartford, CT.

[3]Model 28I, The Robbins Incubator Company, Denver, CO.

[4]Model H5, The Robbins Incubator Company.

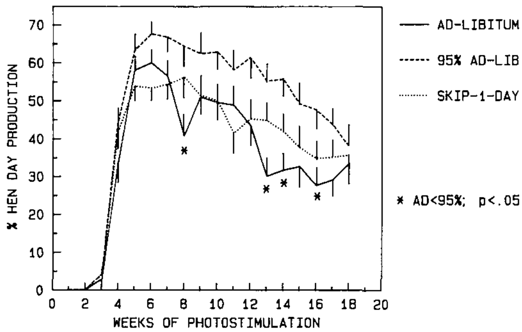

FIGURE 1. Effect of rearing program on turkey hen egg production. Vertical bars are standard errors.

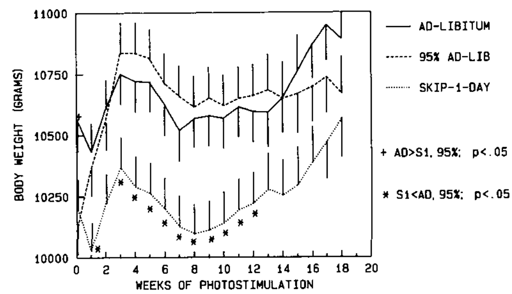

FIGURE 2. Effect of rearing program on laying cycle body weight. Vertical bars are standard errors.

expected that these age differences would cause numerous interactions between rearing program and photostimulation determinant, this occurred only with the egg weight data. Consequently, most results are summarized as main effects of rearing program and photostimulation factor.

The carcass composition data of turkey hens killed at 10 kg of BW and 29 wk of age are presented in Table 3. There were no significant differences (P>.05) in dry matter, fat, or crude protein content between *ad libitum* hens killed at 10 kg (26 wk) and those killed at 29 wk of age. Similarly, there were no significant differences between the carcass composition parameters of skip-1-day hens killed at 10 kg (28 wk) and those killed at 29 wk of age. The 95% hens reached a body weight of 10 kg at 29 wk of age.

The effect of rearing program on turkey hen egg production is presented in Figure 1. The 95% hens had the best overall laying performance with their hen-day production being significantly higher (P<.05) than those of *ad libitum* hens at 8, 13, 14, and 16 wk after photostimulation. Figure 2 shows the effect of rearing program on laying cycle BW changes. The *ad libitum* hens were significantly heavier (P<.05) than skip-1-day and 95% hens at placing, but after the first 2 wk of photostimulation, the 95% hens gained enough weight to reach that of *ad libitum* birds. From 3 to 12 wk of photostimulation, the skip-1-day birds remained significantly lighter (P<.05) than *ad libitum* and 95% hens. There were no significant differences (P>.05) in BW from 13 wk of photostimulation until the end of the experi-

TABLE 3. *Carcass compositions of turkey hens at 10 kg and 29 wk of age*[1]

Treatment				
Rearing program	Lighting program	Dry matter	Fat[2]	Crude protein[2]
		(%)		
Ad libitum	10 kg	41.8 ± 1.4	46.8 ± 3.1	44.4 ± 2.8
	29 wk	44.0 ± .9	51.5 ± 1.3	41.5 ± 1.6
Skip-1-day[3]	10 kg	44.3 ± .7	50.6 ± 1.3	41.3 ± 1.3
	29 wk	42.8 ± 1.1	48.2 ± 2.0	44.4 ± 2.2
95%[4]	29 wk	40.6 ± .9	44.0 ± 1.7	49.6 ± 1.9

[1]Values are $\bar{x}$ ± SEM.

[2]As a percentage of dry matter.

[3]Birds were restricted-fed by skipping 1 day/wk.

[4]Hens weighed an average of 10 kg at 29 wk of age. Hens in this group were provided with 95% of the feed consumed by the *ad libitum*-fed group.

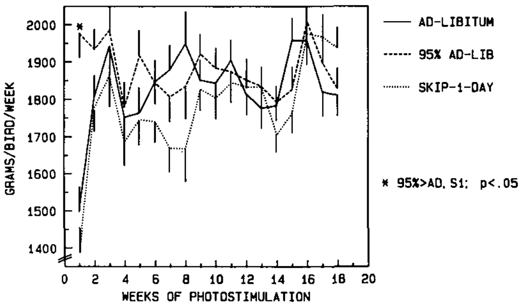

FIGURE 3. Effect of rearing program on laying cycle feed consumption. Vertical bars are standard errors.

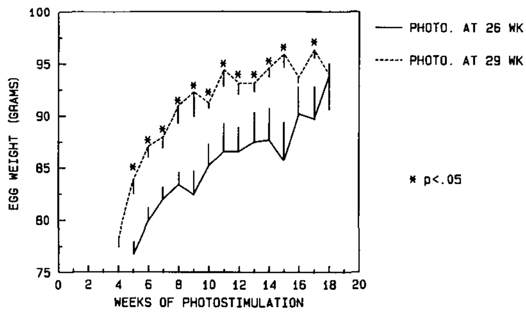

FIGURE 5. Egg weight of turkey hens reared skip-1-day and photostimulated at 28 or 29 wk of age. Vertical bars are standard errors.

ment. The effect of rearing program on laying cycle feed consumption is presented in Figure 3, and although there was no definite feed consumption pattern, the 95% birds consumed significantly more (P<.05) feed during the 1st wk of photostimulation than did *ad libitum* and skip-1-day hens.

The egg weights of turkey hens reared *ad libitum* and stimulated at 26 or 29 wk of age are presented in Figure 4. Although eggs laid by *ad libitum* hens stimulated 3 wk before their recommended age were significantly lighter (P<.05) than those from hens stimulated at 29 wk, there were no significant differences (P>.05) between skip-1-day hens stimulated 1 wk ahead of schedule (28 wk) and those stimulated at 29 wk of age (Figure 5). Because birds restricted to 95% of *ad libitum* reached 10 kg at 29 wk of age, an equivalent comparison for this treatment is not appropriate. There was no effect of rearing program on egg weight (P>.05).

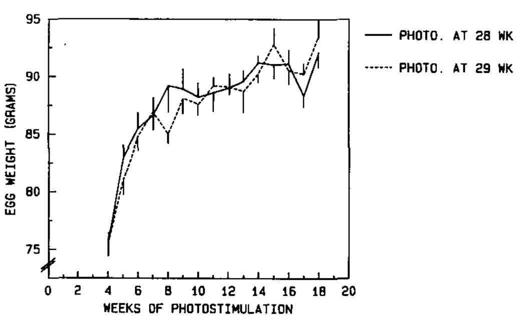

FIGURE 4. Egg weight of turkey hens reared on *ad libitum* feed intake and photostimulated at 26 or 29 wk of age.

The effects of rearing program and photostimulation factor on reproductive performance are presented in Table 4. There was no significant effect (P>.05) of feed restriction during the rearing period on the number of days to first egg, percentage fertility, and percentage hatch of fertile eggs. The 95% rearing treatment resulted in significantly more (P<.05) eggs per bird, significantly more (P<.05) eggs set per bird, and a significantly greater (P<.05) number of poults per hen relative to hens fed *ad libitum* during rearing. There were no significant differences (P>.05) between skip-1-day and *ad libitum* hens for any of the reproductive parameters measured. Photostimulating when the birds reach a BW of 10 kg rather than waiting until 29 wk of age had no significant effect (P>.05) on cumulative egg production, eggs set per bird, or poults per hen. However, the number of days to first egg was significantly greater (P<.05) for hens stimulated at 10 kg, whereas fertility and hatchability were significantly higher (P<.05) for hens stimulated at 29 wk of age.

The data in Table 5 show the effects of rearing program and photostimulation factor on breeder feed consumption. Hens reared on the 95% program consumed significantly more (P<.05) breeder feed than hens reared on the skip-1-day program, although both these groups showed no significant difference (P>.05) to *ad libitum* birds in this respect. Hens stimulated at a BW of 10 kg consumed significantly more (P<.05) breeder feed than hens stimulated at 29 wk of age.

TABLE 4. *Effects of rearing program and photostimulation factor on reproductive performance*[1]

Treatment	Time to first egg[2]	Cumulative eggs per bird	Eggs set per bird	Fertility	Hatch of fertile eggs	Poults per hen
	(days)	——— (no.)	———	——— (%)	———	(no.)
Rearing program[3]						
Ad libitum	22.8	44.0^{b}	33.4^{b}	89.4	75.9	22.9^{b}
Skip-1-day	21.1	47.7^{ab}	37.2^{b}	92.6	73.9	25.8^{ab}
95%	22.1	59.1^{a}	47.7^{a}	90.2	74.9	32.0^{a}
SEM	.6	4.0	3.4	2.0	2.5	2.6
Stimulation factor						
Weight	23.6^{a}	54.2	40.8	86.1^{b}	70.6^{b}	25.4
Age	20.4^{b}	46.4	38.0	95.4^{a}	79.3^{a}	28.4
SEM	.5	3.3	2.8	1.6	2.0	2.1

^{a,b}Values within treatment groups with no common superscripts are significantly different (P<.05).

[1]Photostimulation for each treatment was 18 wk.

[2]After photostimulation.

[3]Skip-1-day = birds were restricted-fed by skipping 1 day per week; 95% = birds were fed 95% of feed consumed by the *ad libitum*-fed group.

DISCUSSION

Previous work on quantitative feed restriction by Jones *et al.* (1976), Andrews and Morrow (1978), Potter *et al.* (1978), Voitle and Harms (1978), and Owings and Sell (1980) showed that restricting feed intake to 80% or less of *ad libitum* would reduce the number of eggs laid or have no effect on total egg production. The level of quantitative feed restriction tested in the present experiment was less severe but more prolonged, and it actually improved reproductive performance. Cumulative egg production, eggs set per hen, and poults per hen were greater for 95% reared hens compared with *ad libitum*-reared hens. There was no effect of restricting to 95% of *ad libitum* on days to first egg, egg weight, fertility, or hatchability. Potter *et al.* (1978) found that limiting feed to 80% from 22 to 38 wk of age delayed sexual maturity, whereas Voitle and Harms (1978) discovered that restricting to 75% from 11 to 30 wk had no effect on the number of days to first egg. Jones *et al.* (1976), Potter *et al.* (1978), and Owings and Sell (1980) found no effect of quantitative feed restriction on egg weight, fertility, or hatchability.

TABLE 5. *Effects of rearing program and photostimulation factor on breeder feed consumption*[1]

Treatment	Total feed intake
	(g/bird)
Rearing program[2]	
Ad libitum	32,948^{ab}
Skip-1-day	32,012^{b}
95% *Ad libitum*	33,782^{a}
SEM	474
Stimulation factor	
Weight	33,769^{a}
Age	32,058^{b}
SEM	387

^{a,b}Values within treatment groups with no common superscripts are significantly different (P<.05).

[1]18 wk of photostimulation for each treatment.

[2]Skip-1-day = birds were restricted-fed by skipping feed 1 day per week; 95% = birds were fed 95% of feed consumed by the *ad libitum*-fed group.

Jones *et al.* (1976) and Potter *et al.* (1978) limited the feed accessibility of breeder hen candidates to 6 or 9 h/day on Mondays, Wednesdays, and Fridays only. These researchers concluded that feed restriction by time allocation delays sexual maturity, possibly decreases egg production and egg weight, but has no effect on fertility or hatchability. The use of the skip-1-day rearing program in the present experiment had no effect on the number of days to first egg, total egg production, fertility, or hatchability. The 95% hens consumed more feed and gained more weight than the *ad libitum* and skip-1-day hens during the first 2 wk of photostimulation. This compensatory growth may have been advantageous, since the *ad libitum* and skip-1-day hens lost weight during the 1st wk, but the 95% hens gained approximately 250 g. The skip-1-day birds did not seem to compensate for early feed restriction as they continued to have the lightest body weights throughout most of the experiment.

Herron and Whitehead (1985) suggested that when turkey hens are held out of lay until the relatively late age of 30 wk, as compared with 24 wk, they become excessively fat. The results of the present experiment show that there is no difference in the carcass fat content between *ad libitum*-fed hens killed at 26 and 29 wk of age or between skip-1-day hens killed at 28 and 29 wk of age. Photostimulating hens at a BW of 10 kg rather than waiting until 29 wk of age increased the number of days to first egg and reduced fertility and hatchability. Egg weights were lighter for *ad libitum* hens photostimulated 3 wk ahead of schedule, whereas photostimulating skip-1-day birds 1 wk before the recommended age of 29 wk had no effect. Herron and Whitehead (1985) found that hens stimulated at 24 wk of age laid smaller eggs than those stimulated at 30 wk, and although the eggs from the birds stimulated early had a reduced hatchability, more eggs were actually laid.

It seems that optimal reproductive performance can be attained by BW control during the rearing period, but only if the birds are subjected to a mild form of quantitative feed restriction. Restricting intake to 95% of *ad libitum* from 2 to 29 wk of age resulted in more eggs per bird, whereas removing feeders 1 day/wk from 4 to 29 wk of age had no discernible effect. Photostimulating turkey hens when they reach a target BW of 10 kg (if this is reached earlier than 29 wk of age) rather than waiting until 29 wk of age seems to reduce fertility and hatchability. When turkey hens are reared on a program that allows them to reach a BW of 10 kg at a relatively early age, then egg size may also be reduced by photostimulating at this time.

ACKNOWLEDGMENTS

This work was supported by the Ontario Ministry of Agriculture and Food. Poults were kindly donated by Cuddy Farms Ltd., Strathroy, Ontario, Canada.

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