THE EFFECT OF PHOTOPERIOD, LIGHT INTENSITY AND WATTAGE POWER ON EGG COMPONENTS AND EGG QUALITY

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Abstract

A total number of 840 birds were used in this experiment to study the effect of photoperiod, light intensity and wattage power on egg quality of Dandarawi chicken. The birds were classified into seven groups, (120 birds of each) two for the light intensity, two for photoperiod, two for wattage power and one as a control for all treatments. The traits studied were: Egg components (egg weight, egg shell weight, yolk weight and albumen weight): Egg quality (specific gravity, egg shell thickness, albumen quality, yolk index, yolk colour). The results obtained in this study could be summarized as follows: 1- Egg components: The egg weight decreased as light intensity increased. The shell percentage was higher by using an intensity of 60 luxes as compared with 15 and 240 luxes. The yolk percentage increased as a light intensity decreased, the opposite was observed with albumen percentage. The increase in the light intensity was associated with a decrease of maximum egg weight. Egg weight shell and yolk percentages increased as photoperiod increased, while albumen percentage decreased with increasing photoperiod. Photoperiod accelerated and increased the maximum egg weight, since it was 46.8 grams at 38 weeks and 46.1 at 40 weeks for the groups exposed to 20 and 18 hours of light. The egg shell and yolk percentages decreased and albumen percentage increased as the age increased. Such decrease continues to 38 and 34 weeks for the groups kept at 20 and 18 hours, respectively, after which there was no decrease. Egg weight decreased as the wattage power increased. The use of 200 watt lamp power as a source of light seems to be stressful for hens. Egg shell percentage was not significantly affected by wattage power but yolk percentage was significantly decreased as the wattage power increased, while the albumen percentage increased by the increase in wattage power. ***Egg quality:*** *There were no significant differences in specific gravity due to the light intensity treatments. While shell thickness, yolk colour and yolk index decreased as the light intensity increased. Hough units decreased by about of 0.6 and 2.4 units for the groups exposed to 60 and 240 luxes, respectively, as compared with that exposed to 15 luxes. However, Hough unit decreased as photoperiod increased. Specific gravity and yolk colour were not affected by lamp power, while shell thickness, yolk index and Hough unit decreased significantly with increasing lamp power, this may be due to the stressful effect resulted from high lamp power.*

Key words: Dandarawi fowl, photoperiod, light intensity and wattage power, egg quality

INTRODUCTION

The influence of light is a resultant of period, intensity, and colour and wattage power of the lamp. Classen and Riddell, 1989 [4] suggested that birds exposed to increasing photoperiod appeared to be more active. Several workers have examined the effect of light programme on physiological stress of broilers. Buckland *et al*. (1976)[2] found higher concentrations of plasma corticoids in broilers housed under continuous day lengths than those exposed to intermittent light programmes. Freeman et al. (1981)[6] found no differences in plasma corticoid concentrations when comparing continuous light with 12L:12D, but the adrenal glands were enlarged and plasma free fatty acid concentrations were elevated in birds housed on 24L:0D. The effect of day length on physiological stress in broilers needs further studies.

As for the effect of light on egg production, it was reported by many workers

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that light regulates the timing of oviposition in the fowl (Morris, 1978; Bahatti and Morris, 1977)[12] [3].

Most of programmes involved in reducing photoperiod during rearing in windowless hours have given poor yield because of excessively delayed maturity. Although larger eggs can be obtained by delaying maturity in this way, the cost of producing egg yield is too great (Morris, 1967a) [10].

The rate of ovulation of hens maintained on continuous light is no higher than that of hens of similar age maintained on a standards photo schedule of 14L: 10D (Morris, 1979) or 16L: 8D (Wilson and Cunningham, 1981)[18], because the interval between successive LH release in hens on continuous light is generally greater than the releases of LH during midsequence of hens having cycles of light and darkness (Wilson and Cunningham, 1981)[18].

Some investigators indicated that 10 luxes was an adequate light intensity for maximum egg production (Ostrander *et al*., 1960)[14]. However, Morris and Owen (1966) [13] and Morris (1966b)[9] found that the maximum egg production was at 25 lux.

Skoglund et al. (1975)[15] found that the hen day egg production per bird for 50 weeks was 226.9, 225.3, 221.8, and 215.1 eggs per hen for groups exposed to 5.38 luxes, progressive increase of light intensity up to 107.64 luxes for the last three months, 21.53 luxes and 53.82 luxes , respectively. The authors concluded that the hens exposed to 5.38 lux had the highest egg production but the difference between treatments was not significant. Baughman and Brake (1987) [1] reported that exposure to low light intensities during the growing period would improve breeder performance in the laying house. The aim of this study was to investigate the effect of photoperiod, light intensity and wattage power on egg component and egg quality.

MATERIAL AND METHODS

A total number of 840 birds were used in this experiment. The birds were classified into seven groups, (120 birds each): two for the light intensity treatments; two for photoperiod treatments, two for wattage power, and one was used as a general control.

a-Light intensity treatments

First: Birds were exposed to 80 luxes for 8 hours light during the growing period and then 240 luxes for 16 hours light during the laying period.

Second: Birds were kept at 20 luxes for 8 hours light during the growing period and then to 60 luxes for 16 hours during the laying period. The light intensity was measured using luxmeter.

b-Photoperiod treatments

First: Birds were exposed to 16 hours light (with intensity of 5 luxes during the growing period) then to 20 hours light (with intensity of 15 luxes during the laying period).

Second: Birds were exposed to 12 hours light (with intensity of 5 luxes during the growing period) then to 18 hours (with 15 luxes during).

c-Wattage power treatments.

First: Birds were kept at 200 watt incandescent bulb for 8 hours light during the growing period, then 16 for hours light during the laying period with the same wattage power.

Second: Birds were kept at 100 watt incandescent bulb for 8 hours light and 16 hours light during the growing and laying period, respectively.

d-General control group.

Birds were kept at 40 watt incandescent bulb throughout the experimental period with 8 hours photoperiod and 5 luxes intensity during the growing period and 16 hours with 15 luxes intensity during laying periods.

RESULTS AND DISCUSSIONS

Egg components: Effect of light intensity, average egg weight, shell, albumen and yolk percentages as affected by light intensity are presented in Tables (1, 2, 3 and 4). The differences of egg weight are significant between 15 and the two other treatments. The egg weight and yolk% decreases as light intensity increases. The opposite trend was observed with albumin and shell%, the differences were highly significant (Table 5). These results are in agreement with the findings of Felts *et al*. (1990)[5] who found that egg weight of turkeys decreased as light intensity increased.

With respect to the effect of age, it can be noticed that egg weight and albumen percentage increase as the age increases, while shell and yolk percentages decrease as the age increases (Tables 1, 2, 3, and 4). **Effect of photoperiod**: It can be shown from Tables, 1, 2, 3 and 4 that egg weight increases as photoperiod increases. The difference is not significant. This result is in agreement with the finding of Morris (1968) who found that egg weight increased with the increase photoperiod from 10-hours to 14 and 18 hours.

With respect to the effect of photoperiod on egg component, Tables (1, 2, 3 and 4) show that shell and yolk % are increases with the increase of photoperiod, while albumen percentage % with increasing photoperiod. Lewis *et al*. (1994)[8] reported that food intake increases linearly with photoperiod (1.25g/hour). The increase in feed intake with longer photoperiods is associated with a higher calcium intake.

With respect to the effect of photoperiod and age interaction on egg components (Tables, 1, 2, 3 and 4), photoperiod accelerate and increase the maximum egg weight for the groups exposed to 20 and 18 hours light. The egg shell and yolk percentages decreases and albumen percentages increases as the age increases. Analysis of variance Table (5) shows that the effect of photoperiod on egg components is not significant.

Effect of wattage power: Results of egg weight and its components as affected by wattage power are given in Tables 1, 2, 3 and 4. Egg weight decreases as the wattage power increases. The reduction in the groups illuminated by 100 and 200 watts is about 0.9 and 2.7 grams, respectively compared with 40 watts. The differences between egg weight as affected by wattage power are significant (Tables 1, 2, 3 and 4). Analysis of variance (Table 5) shows that the effect of wattage power on egg weight, yolk and albumen percentage are highly significant, while it is not significant on shell percentage.

Table 1 (24) Effect of light treatments on egg weight at different ages

Age (weeks)	Light intensity (Lux)		Photo period (hr)		Wattage power (watt)		control*	Average
	240	6 0	20	18	200	100		
30 - 32	42.6	42.7	43.1	42.5	40.5	42.9	42.2	42.4^{d}
33 - 34	41.7	43.1	43.7	44.6	41.2	43.3	43.2	43.0^{c}
35 - 36	42.5	43.6	45.0	45.5	42.5	44.0	45.2	44.0^{b}
37 -38	42.2	43.6	46.8	45.9	43.0	43.8	46.9	44.7^{a}
39 - 40	43.3	43.4	46.2	46.1	43.1	44.7	45.5	44.6^{a}
41 - 42	44.0	44.5	46.2	45.9	42.9	45.4	46.2	45.0^{a}
Average	42.9^{c}	43.5^{b}	45.6^{a}	45.2^{a}	42.2^{d}	44.0^{b}	44.9^{a}	

* 15 lux, 16 hr, and 40 watt

Table 2 (25) Effect of light treatment on shell percentage at different ages

Age weeks	Light intensity (Lux)		Photo period (hr)		Wattage power (watt)		control*	Average
	240	60	20	18	200	100		
30 - 32	10.4	11.3	10.8	10.9	10.9	11.4	11.3	11.0^{a}
33 - 34	11.0	10.7	10.6	10.4	10.4	10.9	10.6	10.7^{b}
35 - 36	10.3	10.9	10.4	10.7	10.2	10.2	10.6	10.5^{bc}
37 -38	10.4	11.3	10.4	10.2	9.8	10.8	9.5	10.4^{c}
39 - 40	10.0	10.7	10.8	10.9	9.8	9.8	10.3	10.3^{c}
41 - 42	10.1	11.0	9.8	9.9	10.9	10.4	9.9	10.3^{c}
Average	10.4^{b}	11.0^{a}	10.6^{b}	10.5^{b}	10.3^{b}	10.6^{b}	10.4^{b}	

* 15 lux, 16 hr, and 40 watt

Table 3 (26) Effect of light treatments on egg yolk percentage at different ages

Age weeks	Light intensity (Lux)		Photo period (hr)		Wattage power (watt)		control *	age average
	240	60	20	18	200	100		
30 - 32	34.6	35.7	36.7	36.9	35.0	34.7	36.7	35.7^{a}
33 - 34	34.2	34.7	34.7	34.0	32.7	34.0	34.6	34.1^{b}
35 - 36	34.0	32.5	35.0	34.3	32.5	34.6	34.5	33.9^{b}
37 -38	32.9	35.3	33.0	33.4	31.6	33.1	33.0	33.2^{c}
39 - 40	32.4	34.0	34.6	33.0	30.5	31.2	34.6	32.9^{c}
41 - 42	32.9	32.8	34.1	33.9	32.0	31.7	34.6	33.2^{c}
Average	33.5^{b}	34.2^{ab}	34.9^{a}	34.7^{a}	32.4^{d}	33.2^{c}	34.5^{a}	

* 15 lux, 16 hr, and 40 watt

Table 4 Effect of light treatment on albumen percentage at different ages

Age weeks	Light intensity (Lux)		Photo period (hr)		Wattage power (watt)		control *	Average
	240	60	20	18	200	100		
30 - 32	55.0	53.1	52.4	52.2	54.1	53.9	52.0	53.3c
33 - 34	54.9	54.6	54.7	55.6	56.9	55.1	54.8	55.2b
35 - 36	55.7	56.6	54.5	55.0	57.3	55.1	55.0	55.6b
37 -38	56.7	53.3	56.5	56.4	58.6	56.0	57.5	56.4a
39 - 40	57.6	55.4	54.6	56.0	59.7	59.0	55.1	56.8a
41 - 42	57.0	56.1	56.1	56.2	57.2	57.8	55.4	56.6a

* 15 lux, 16 hr, and 40 watt

Table 5 Analysis of variance of the effect of light treatments on egg weight and its components

Source of variation	d.f	MS			
		Egg weight (g)	Shell %	Yolk %	Albumen%
Light intensity (LI)	2	121***	15***	41***	62***
Age	5	57***	3***	41***	40***
Age x LI	10	13**	3**	17**	29***
Photoperiod (PhP)	2	3	0.61	7.2	5.9
Age	5	136***	4.61***	86.8***	101***
Age x PhP	10	4	1.7	4	4
Wattage power (WP)	2	218***	2.5	157***	161***
Age	5	86***	9.4***	87***	112***
Age x treat	10	8	3.2***	14	22*

* Significant at 0.05 ** Significant at 0.01 *** Significant at 0.001

Egg quality Effect of light intensity: As presented in Tables (6 and 7), there are no significant differences in specific gravity due to light intensity treatments. However, shell thickness decreases as light intensity increases. This result is in harmony with the result of Siopes (1984)[17] who found that the light intensity treatments had no affect on egg size or specific gravity. The reduction in shell thickness may be due to the reduction of feed consumption and hence calcium intake. Skogland et al. (1975) [15] found that the groups exposed to 5.38 luxes consumed more feed than those exposed to 53.82 luxes. While, Hulet et al. (1992) [7] found no significant differences in shell thickness among hens exposed to light intensity of 53.8 or 161.4 luxes. There were no significant differences in specific gravity between different light intensities (Tables 6 and 7), while there are significant differences in shell thickness among the groups exposed to 15 lux and the groups exposed to 60 or 240 luxes. It is shown from Tables (8 and 9) that yolk colour and yolk index decreases as the light intensity increases but the differences were not significant. Analysis of variance (Table 11) shows that the effect of light intensity treatments on specific gravity and yolk colour are not significant. While shell thickness, yolk index and Hough unit is high significantly affected by light intensity treatments.

Effect of photoperiod: As shown from Tables 6 and 7, shell quality (shell thickness and specific gravity) decreases as photoperiod increases. Specific gravity decreases insignificantly by prolonged light period, the shell thickness decreases significantly for the groups kept at 18 and 20 hours light as compared with the group exposed to 16 hours light. The increase in shell thickness under 16 hours maybe partially due to the lengthening of shell deposition in the shell gland as indicated by long time intervals between ovipositions (Sauveur and Mongin, 1983) [16]. Morris (1973) [11] found that shell thickness increased with increasing dark period despite of the same light period. The author attributed this increase to three reasons. Firstly, it is possible that eggs spent longer time than usual in the shell glands, since the average interval between ovipositions was 27h (14L: 13D) as compared with the control (14L: 10D). Secondly, the birds were able to deposit calcium carbonate at a greater rate because they had longer time to accumulate calcium since the last oviposition. A third possibility is that shell thickness is improved because eggs are laid during the dark period and thus the later stages of shell calcification coincide with a period of absorption of calcium from the gut. Analysis of variance (Table 11) shows that the effect of photoperiod treatments on specific gravity and yolk colour are not significant, while shell thickness, yolk index and Hough unit are high significantly affected by photoperiod.

Effect of wattage power: It is shown from Tables 6, 7, 8, 9, and 10 that specific gravity and yolk colour are not affected by lamp power, while shell thickness, yolk index and Hough unit decreased significantly with increasing lamp power. This may be due to the stressful effect resulted from high lamp power. Analysis of variance (Table 11) shows that the effect of wattage power treatments on specific gravity and yolk ocular are not significant. While shell thickness, yolk index and Hough unit is high significantly affected by wattage power.

With respect to the effect of age on egg quality it is shown from Tables 6 and 7 that yolk index and colour decreases as the age increases, except for the treatments of 20, and 18 hours photoperiod and 100 watt lamp where the yolk quality did not decreases after 38 weeks.

As shown from Tables 8 and 9, egg shell quality expressed as shell thickness and specific gravity decreases as the age increases. All light treatments resulted in increase shell thickness after the age of 40 weeks, expect for the treatment of 60 luxes which led to increase shell thickness after 38 weeks of age.

Albumen quality expressed as Hough unit decreases, as the age increase (Table 10). While treatments of 240 luxes, 20 hours and 100 watts led to increase Hough unit after the age of 38 weeks and after 36 weeks for the group exposed to 200 watts. Analysis of variance (Table 7) shows that age and interaction of age and light treatments on egg quality are highly significant. Except for the interaction of age and light, treatments were not significant in regard to specific gravity.

Table (6) Effect of light treatment on specific gravity at different ages

Age weeks	Light intensity(Lux)		Photoperiod (hr)		Wattage power (watt)		Control *	age average
	240	60	20	18	200	100		
30 - 32	1.137	1.097	1.098	1.100	1.085	1.096	1.096	1.100[a]
33 - 34	1.097	1.099	1.101	1.100	1.093	1.099	1.097	1.097[a]
35 - 36	1.081	1.086	1.082	1.084	1.078	1.080	1.085	1.083[b]
37 -38	1.076	1.078	1.087	1.083	1.074	1.080	1.085	1.080[b]
39 - 40	1.072	1.078	1.075	1.075	1.066	1.076	1.079	1.074[b]
41 - 42	1.066	1.073	1.068	1.076	1.062	1.071	1.075	1.076[b]
Average	1.087[a]	1.085[a]	1.083[a]	1.085[a]	1.083[a]	1.083[a]	1.086[a]	

** 15 lux, 16 hr, and 40 watt*

Table 7 Effect of light treatment and age interaction on egg shell thickness

Age weeks	Light intensity (Lux)		Photo period (hr)		Wattage power (watt)		Control *	age average
	240	60	20	18	200	100		
30 - 32	379	382	373	367	371	369	379	374[a]
33 - 34	356	378	352	370	358	363	355	362[b]
35 - 36	352	352	349	349	334	355	357	350[c]
37 -38	330	333	354	352	325	349	356	343[d]
39 - 40	325	340	353	343	322	330	346	337[e]
41 - 42	331	318	347	352	324	334	360	338[ed]
Average	345[c]	350[bc]	347[ab]	350[ab]	339[d]	349[bc]	359[a]	

** 15 lux, 16 hr, and 40 watt*

Table 8 (31) Effect of light treatments on yolk colour at different ages

Age (weeks)	Light intensity (Lux)		Photo period (hr)		Wattage power (watt)		control *	age average
	240	60	20	18	200	100		
30 - 32	7.07	7.07	6.75	6.97	7.12	7.2	7.18	7.05[ab]
33 - 34	7.95	6.90	7.00	7.15	6.93	6.90	6.95	6.97[b]
35 - 36	6.60	6.95	7.20	7.15	6.60	6.98	7.13	6.94[b]
37 -38	7.15	7.03	7.10	6.95	7.15	7.00	7.10	7.07[a]
39 - 40	6.98	6.85	7.00	7.05	7.14	7.00	6.88	6.98[ab]
41 - 42	6.85	6.95	7.07	7.10	6.92	7.10	7.05	7.00[ab]
Average	6.93[a]	6.95[a]	7.06[a]	7.02[a]	6.97[a]	7.03[a]	7.04[a]	

** 15 lux, 16 hr, and 40 watt*

Table 9 Effect of light treatment interaction on egg yolk index at different ages.

Age (weeks)	Light intensity (Lux)		Photo period (hr)		Wattage power (watt)		control *	age average
	240	60	20	18	200	100		
30 - 32	48.4	49.7	52.4	51.3	51.4	52.6	51.9	51.7[a]
33 - 34	50.4	48.4	51.5	47.9	45.8	51.5	50.9	49.4[b]
35 - 36	51.8	47.6	49.1	50.7	51.4	49.1	49.4	49.9[b]
37 -38	47.0	48.7	47.8	47.4	44.3	47.8	49.6	47.7[c]
39 - 40	46.0	50.8	45.7	50.5	45.6	45.7	47.0	47.2[c]
41 - 42	46.1	46.9	43.9	47.6	43.3	44.9	44.7	45.1[d]
Average	49.3[ab]	49.7[a]	50.2[a]	49.4[ab]	47.9[b]	48.6[a]	48.8[a]	

** 15 lux, 16 hr, and 40 watt*

Table 10 Effect of light treatments on Hough unit at different ages

Age weeks	Light intensity (lux)		Photoperiod (hr)		Wattage power (watt)		control *	age average
	240	60	20	18	200	100		
30 - 32	80.5	80.9	82.1	80.0	81.6	81.2	81.2	81.0[a]
33 - 34	80.2	86.3	77.0	77.6	76.1	82.2	84.5	80.5[a]
35 - 36	77.4	83.5	83.5	80.4	71.2	82.9	80.8	79.9[a]
37 -38	75.0	77.8	77.6	77.7	80.1	76.0	82.1	78.0[b]
39 - 40	78.1	74.6	79.3	77.2	77.3	78.6	76.2	77.3[b]
41 - 42	75.5	74.8	80.4	79.9	76.4	81.8	76.3	77.9[b]
Average	77.8[cd]	79.6[ab]	78.8[bc]	79.9[ab]	77.1[d]	80.4[a]	80.2[a]	

** 15 lux, 16 hr, and 40 watt*

Table 11 Analysis of variance of the effect of light treatments on egg quality traits

Source of variation	d.f	MS				
		Specific grave	Shell thick	Yolk colour	Yolk index	H U
Light intensity (LI)	2	NS	52***	0.41	27	187***
Age	5	0.01***	103***	0.55*	90***	563**
Age x LI	10	0.4	27***	0.29	63**	105**
Photoperiod (PhP)		NS	5	0.05	23	65*
Age	5	.007***	48***	0.29	495***	132***
Age x PhP	10	.007***	8	0.28	103***	127***
Wattage power (WP)	2	NS	127***	0.15	170***	443***
Age	5	S	126***	0.59**	343***	151***
Age x treat	10	NS	14***	0.39*	71*	231***

* Significant at 0.05 ** Significant at 0.01 *** Significant at 0.001

CONCLUSIONS

It can be concluded that the adequate light intensity for Dandarawi laying hens maintained in closed confinement to obtain higher egg quality is 15 lux, but increases of the intensity to more than 60 luxes, decreases the egg quality. It can be concluded that the use of 200 watt lamp power as a source of light seems to be stressful for hens.

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