IMPACT OF VARIOUS LIGHTING SOURCE (INCANDESCENT, FLUORESCENT, METAL HALIDE AND HIGH PRESSURE SODIUM) ON THE PRODUCTION PERFORMANCE OF CHICKEN BROILERS

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Light is an important aspect of an animal's environment. Avian as well as mammalian species respond to light energy in a variety of ways. Recent research has indicated that light source may affect body weight, immune response, livability and health status. Broiler behavior is strongly affected by light sources. So the present project was designed to study the effect of light sources on the production performance of broilers. For this purpose, 500 day-old broilers purchased from the local market were reared for three days (adaptation period) in one group. Then these were randomly divided into five experimental groups each comprising of 100 birds. Group A was given 25.incandescent light (INC), Group B was given fluorescent light (FC), Group C was given metal halide light (MH), Group D was given high pressure sodium light (HPS) and Group E was given no light source (control). Performance trial in terms of measurement of weekly body weight, weekly feed consumption, feed conversion ratio (FCR), daily water consumption and mortality were checked. Among various lighting sources, MH proved the best light source regarding main parameters of production performance.
Keywords: Metal halide, incandescent, fluorescent, high pressure sodium, light source, broilers

INTRODUCTION

Commercial chicken broilers have been selected for fast growth rate which convert raw ingredients and agriculture byproducts into high quality nutrients for human consumption. Poultry has helped in filling the animal protein gap in most of the developed and developing countries. In Pakistan annual per capital availability of meat is 20 kg (Govt. of Pak. Economic Survey, 2003-04 and 2006-07) which is approximately five times less than per capita availability of meat in developed countries (Kieu, 1999). According to World Agricultural Supply, Demand Estimates and Supporting Materials Report, per capita availability of meat in USA is 100.59 Kg/annum (www.ers.usda.gov).

Production performance of broilers is influenced by their genetic make up, feed, environment and light (Morris, 2004). Light is an important aspect of an animal's environment. Growth and reproductive performance of avian and mammalian species respond to light energy in a variety of ways. Light plays a pivotal role regarding sight, stimulation of internal organs and initiation of hormone release (Scheideler, 1990). The spectral sensitivity of chickens, or their ability to see different colored light, differs from that of humans (Nnboer *et al*, 1992)**.** Chickens are less sensitive than humans in the blue-green color range and much more sensitive to orange-red (Prayitno *et al.*, 1993 & 1997)**.**

Light imparts many effects on the glandular system, thyroid and pineal glands and on the hypothalamus control in birds. Even for proper working of thyroid gland it needs to be stimulated by normal photoperiods (Blair *et al.*, 2000). Lighting is a crucial environmental factor which affects poultry performance. Source and regimens of light affect not only growth rate and performance of poultry but also carcass quality (Classen *et al.*, 1991; Lilburn *et al.*, 1992; Clarke *et al.*, 1993; Hamilton and Kennie, 1997).

In the light of above mentioned facts and our own geonetical conditions the present project was designed to see the impact of various lighting sources on the production performance of broilers.

MATERIALS AND METHODS

To check the impact of various lighting sources on production performance of broilers, birds (equal number of mail and female in pens of 10x10 feet) were reared and kept in shed of Parasitology Department, University of Agriculture, Faisalabad, Pakistan. Five hundred day-old broilers were purchased from the local market and reared for three days (adaptation period) in a single group. On 4th day these were randomly divided into five experimental groups, comprising of 100 birds each. During day time all the birds in five groups were exposed to daylight while at night they were given light

by various lighting sources as mentioned above. The weekly parameters were recorded at the end of experimental week not the age. The experimental barn was cleaned thoroughly and kept under similar housing and management conditions like floor space, temperature, ventilation, humidity, *ad-libitum* feed and fresh water except sources of light. Performance trial in terms of measurement of weekly body weight, weekly feed consumption, feed conversion ratio (FCR), daily water consumption, mortality and humoral immune response were checked.

Average body weight was calculated by weighing randomly ten birds of each experimental group at the end of each experimental week.

A weighed quantity of Ani feed (pellet) was offered *ad-libitum* to each group. Residual feed present in feeder was collected and weighed to calculate the feed consumption.

Weekly feed conversion ratio (FCR) was calculated

The birds in each group were offered a measured quantity of water in the morning and evening. Daily water consumption was recorded to calculate weekly water consumption per group.

A complete record of mortality in each group was maintained throughout the experimental period.

important aspect (Buckland *et al.*, 1976; Siopes *et al.*, 1986; Cecil, 1986; Hester *et al.*, 1987; Kovachishki *et al.*, 1987; Lewis and Perry, 1990; Noll *et al.*, 1991; Herstad, 1992; Morris and Butler, 1995; Yahav *et al.,* 2000).

Comparison of means of body weight with respect to different light sources indicated that metal halide (MH) group exhibited significantly higher body weight than others and next to MH group was high pressure sodium (HPS) group. The difference between incandescent (INC) and fluorescent (FC) groups was non-significant while No light group was at lowest level. In terms of interaction between weeks and groups, there was no significant difference in first two weeks. The body weight of MH group was the maximum in 4^{th}, 5^{th} and 6^{th} week of experiment. During 2^{nd} week, the INC group showed better results and during 3^{rd} week, HPS group showed highest body weight. Body weight of control group was lesser than all the others (Table-1).

Energy-efficient light sources varying in wavelength emission may affect broiler growth performance (Zimmermann, 1988). The spectral sensitivity of chick or their ability to see different colors of light differs from that of humans (Nnboer *et al.*, 1992**)**. Chickens are less sensitive than humans in the blue-green

Table 1. Comparison of means for body weight (g) of broilers under different light sources

Group	Mean weight	1^{st} week	2^{nd} week	3^{rd} week	4^{th} week	5^{th} week	6^{th} week
INC	1044 ± 82 BC	218 ± 90 K	465 ± 15 J	760 ± 29 I	1180 ± 25 F	1800 ± 64 BCD	1840 ± 50 BCD
FC	1052 ± 85 BC	207 ± 70 K	430 ± 80 J	855 ± 30 HI	1080 ± 33 FG	1820 ± 61 BCD	1920 ± 61 AB
MH	1118 ± 89 A	245 ± 80 K	450 ± 90 J	760 ± 69 I	1400 ± 63 E	1854 ± 31 BCD	2000 ± 37 A
HPS	1068 ± 82 AB	232 ± 10 K	430 ± 80 J	880 ± 23 H	1180 ± 61 F	1804 ± 23 BCD	1880 ± 23 BC
No light	994 ± 79 C	210 ± 40 K	405 ± 13 J	790 ± 32 HI	1060 ± 27 G	1740 ± 54 D	1760 ± 59 CD
Mean		222 ± 40 F	436 ± 60 E	809 ± 19 D	1180 ± 26 C	1804 ± 22 B	1880 ± 24 A

INC = Incandescent light. FC = Fluorescent light. MH = Metal Halide light.
HPS = High Pressure Sodium light.
Means sharing similar letters in a cell are statistically non-significant.

Statistical analysis

The data so obtained was statistically analyzed by analysis of variance (ANOVA) technique using Completely Randomized Design with 2 x 2 factorial arrangements of treatments (Steel *et al.,* 1997). The differences in means of the treatments were compared by Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Live body weight is one of the most important performance parameter, so determination of effects of light sources on body weight is of particular importance that's why many studies have been conducted on this

wavelengths and much more sensitive to orange-red wavelengths, in addition, they can see ultraviolet light, which humans cannot detect. Light color affects behavior of birds, being less active in blue and green light than in red or white light and choose to spend more time in blue and green light Prayitno *et al.*, 1993 & 1997**).** Blue (435-500 nm), green (500-565 nm) and yellow (500-600nm) wavelengths have positive, orange (600-630 nm) and red (630-700 nm) wavelengths have negative effects on broiler performance (Hakan and Ali, 2005). Green light stimulates growth at early age and blue light at market age (Rozenboim *et al.*, 1999).

Light spectra promote growth in broilers and it is also observed that green and blue light significantly

increase the body weight (Stoianov *et al.,* 1978, Knisley, 1990; Tarihi; 1996, Rozenboim *et al.*, 1999; Rozenboim *et al.*, 2004). As satellite cells are the only source of additional nuclei in skeletal muscles of chickens and various studies suggested that the higher muscle weight found in the green and blue light groups may be due to increased satellite cell proliferation during the first days of age (Halevy *et al.*, 1998). MH is the best type of light lamp that produces blue, green, aqua to be used as a primary light source if no or little natural sunlight is available.

The results of current study are well justified because metal halide light is blue-green orientated in the spectrum. Results are contradictory with the findings of Hulan and Proudfoot (1987), Lewis and Morris (1998), Rodenburg and Middelkoop (2003) and Kristensen (2006) who reported that light source has no significant effect on body weight; the most probable reason may be that they tested only INC and FC light sources and did not study the affects of MH light.

Based on the results of the present study and available literature it may be inferred that Metal Halide (MH) is the best source of light for growth and the performance of broilers.

Average feed consumption indicates that differences between INC, FC, MH and No light group was non-significant but they all showed significant difference with HPS group (Table-2). Over all MH group consumed less feed. Results are in line with the findings of Jones *et al.,* (1982) who stated that feed consumption was maximum for hens subjected to red light and Stoianov *et al.,* (1978) who stated that feed consumption was minimum for broilers subjected to green light. More over Robbins *et al.,* (1984) reported that males grown under the 16L: 8D photoperiod consumed less feed and grew less rapidly than males under constant light. The slower rate of growth in their studies may be most probably due to less feed consumption, which is similar to our No light group.

Statistical analysis of the data revealed that light sources have significant effect on the feed conversion ratio with respect to age of broilers and with respect to different groups (Table-2). Results of the present study are in accordance with the finding of Tarihi (1996) and Siopes (1984) who observed best feed efficiency in the green color light group, followed by red or white color light groups. In the present study differences of FCR values was significant and over all birds kept under MH light used their feed more efficiently, HPS group showed poor response. However, the results are not well supported by the findings of Hulan and Proudfoot (1987), Leighton *et al.*, (1989), Rodenburg and Middelkoop (2003). They reported that light source and intensity has no significant effect on feed conversion ratio probably they used other sources and intensities.

Comparison of means for water consumption indicates that difference between INC, FC, MH and No light group is non-significant but these all have significant difference with HPS group (Table-2). Average water consumption was less in MH group than all other groups. These results are in accordance with Daghir (1995) and others who reported that less feed consumption, results into lower metabolic waste; requires less water for thermoregulation and removal of body wastes.

Table 2. Comparison of means for feed consumed, feed consumption ratio and water consumption under different light sources

Week	Feed consumed	FCR	Water consumption
1st	243.10 ± 11.26 E	1.09 ± 0.048 D	315 ± 14.75 E
2nd	416.26 ± 08.18 D	1.51 ± 0.032 C	1384 ± 27.15 D
3rd	591.22 ± 23.25 C	1.55 ± 0.049 C	2661 ± 104.62 C
4th	860.88 ± 32.06 B	1.80 ± 0.097 B	3116 ± 134.40 B
5th	995.46 ± 37.44 A	1.72 ± 0.056 B	4404 ± 165.40 A
6th	999.20 ± 37.54 A	2.10 ± 0.089 A	4084 ± 153 A
Group			
INC	669.70 ± 119.67 B	1.67 ± 0.133 AB	874 ± 156 B
FC	667.50 ± 129.24 B	1.62 ± 0.138 BC	873 ± 169 B
MH	643.50 ± 114.88 B	1.50 ± 0.128 C	843 ± 151 B
HPS	767.50 ± 152.65 A	1.78 ± 0.180 A	1002 ± 200 A
No light	673.50 ± 131.79 B	1.67 ± 0.184 AB	879 ± 172 B

INC = Incandescent light. FC = Fluorescent light. MH = Metal Halide light.
HPS = High Pressure Sodium light.
Means sharing similar letters in a cell are statistically non-significant.

During the research period, mortality record was maintained for each group and updated on daily basis. The mortality was the maximum in HPS (14%) followed by No light group (4 %) INC and FC groups showed 2% mortality being at number third. The MH group was best regarding resistance and showed only 1% mortality (Figure-1). Postmortem finding showed that the chicks died mostly due to ascities and hydro pericardium syndrome. On the other hand blue, green and yellow wavelengths have positive while orange and red wavelengths have negative effects on broiler performance (Hakan and Ali, 2005). Spectrum of HPS light being yellow-orange oriented may be the main cause of maximum mortality in this group. Current

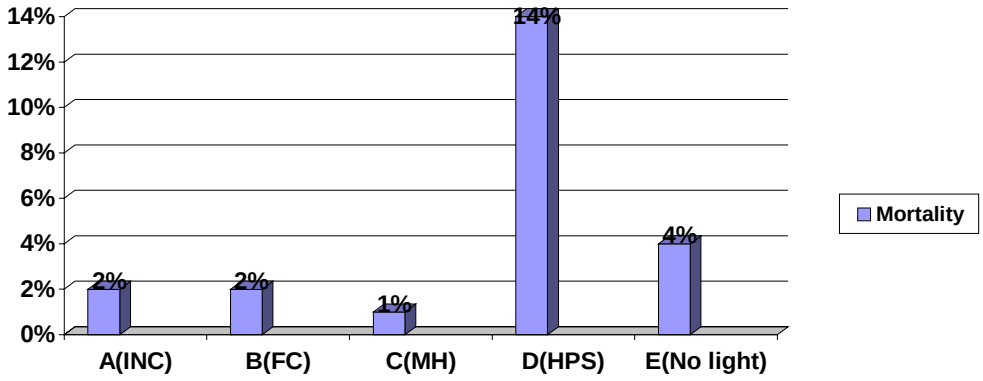

Fig. 1. Percentage mortality of different treatment groups

Table 3. Economics of broilers kept under different light sources

Parameters /Group	INC	FC	MH	HPS	No light
Chick (cost in Rupees)	21	21	21	21	21
Housing	1	1	1	1	1
Labor	1	1	1	1	1
Medication	1	1	1	1	1
Electricity	1.68	0.56	0.34	0.34	0
Cost of light source*	0.3	0.065	0.12	0.12	0
Automation**	0.12	0.12	0.12	0.12	0
Feed Consumed (kg)	4.018	4.005	3.861	4.065	4.041
Feed cost***	52.63	52.46	50.51	53.25	52.93
Miscellaneous	2	2	2	2	2
Expenditure	**80.73**	**79.205**	**77.09**	**79.83**	**78.93**
Mortality %	2	2	1	14	4
Mortality loss****	1.61	1.58	0.77	11.18	3.15
Net Expenditure	**82.34**	**80.785**	**77.86**	**91.01**	**82.08**
Live weight	1.84	1.92	2	1.88	1.76
Live weight cost	54	54	54	54	54
Income/bird	**99.36**	**103.68**	**108**	**101.52**	**95.04**
Profit/bird	**17.02**	**22.895**	**30.14**	**10.51**	**12.96**

$$* \text{ Cost of light source} = \frac{\text{Actual cost} \times 42 \text{ days} \times 10 \text{ hour}}{\text{Total life of the source}}$$

Cost of system for phase-1 = 30000 for 10000 birds
Total No. of birds per year = 10000 * 5 = 50000
Deprecation of equipment/year @ 20% = 30000 * 20/100 = 6000 Rs.
**Cost of system per bird = 6000/50000 = 0.12 Rs.
***Feed price = 13.10 Rs. /kg

$$**** \text{Mortality loss} = \frac{\text{No. of mortalities} * \text{Expenditure on one bird}}{\text{Total No. of birds in the group}}$$

findings are similar to that of Leighton *et al.*, (1989) who also observed greater mortality in birds under fluorescent light. Though some other scientists have observed that light source has no significant effect on mortality (Hulan and Proudfoot, 1987; Rodenburg and Middelkoop, 2003; Kristensen, 2006; MacDonald and Gibb, 2002). However they do not compared the MH light source with others.

The economic aspect of different lighting sources was also evaluated during study for the production performance of broiler chick (Table-3). MH proved as the best source of light on the basis of profit also. Maximum profit (30.14 Rs/bird) was found under MH light and next to it was FC group with profit of Rs.22.895 followed by INC, No light and HPS groups having profit Rs. 17.02, Rs. 12.96 and Rs. 10.51 respectively.

The light source that is more energy efficient and longer life should be used to replace incandescent lighting in poultry houses (Lewis and Morris, 1998). Metal halide fulfills these qualities and potentials, so based on the present study it is the recommended source.

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