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Effects of Three Different Lighting Programs on Live Weight Change of Bronze Turkeys under Semi-Intensive Conditions

Abstract

A study was conducted to evaluate the influence of three lighting programs (23L: 1D), (18L: 6D), and (12L: 12D) on live weight changes of American Bronze turkeys by Profile analysis technique. The F-statistics and Wilk's Lamba statistics for testing group-response interaction or similar profiles suggested that there was a significant interaction effect ($p<0.01$). The effects of the three lighting programs on live weight gain appeared to be different throughout the study except for the last 6 weeks. On the other hand, the results of the present study suggested that the effect of the three lighting programs on live weight gain followed a similar trend or three lighting programs had similar physiological effect on live weight gain from 10^{th} week on wards.

Key Words: American Bronze turkey, live weight, lighting regime, profile analysis, repeated measurement

Zusammenfassung

Titel der Arbeit: **Einfluss von drei unterschiedlichen Beleuchtungsprogrammen auf die Lebendgewichtsveränderung von Bronzeputen unter semi-intensiven Bedingungen**

Die vorliegende Arbeit wurde mit Hilfe des Profilanalyseverfahrens durchgeführt, um den Einfluss von 3 unterschiedlichen Beleuchtungsprogrammen (23L:1D, 18L:6D und 12L:12D) auf das Lebendgewicht amerikanischer Bronzeputen zu bewerten. Die Ergebnisse der F-Statistik und der Wilk's Lamba Statistik zeigen eine signifikante Gruppen-Effekt-Interaktion ($p<0,01$). Die Effekte der unterschiedlichen Lichtprogramme auf die Zunahme des Lebendgewichts zeigten, mit Ausnahme der letzten 6 Wochen, unterschiedliche Einflüsse. Allerdings muss hervorgehoben werden, dass die Lebendgewichtszunahme ab der 10. Woche unter allen Lichtprogrammen einer ähnlichen Tendenz folgte bzw. die physiologischen Einflüsse während dieser Phase der Aufzucht offensichtlich sehr ähnlich sind.

Schlüsselwörter: Amerikanische Bronzeputen, Lebendgewicht, Beleuchtungsprogramme, Profileanalyse, wiederholte Messung

Introduction

Lighting is one of the most crucial environmental factors which affects poultry performance. An increase in lighting period also increases time for feeding. Therefore, continuous lighting is applied in fattening. On the other hand any reduction in lighting period leads to slow growth. Continuous or intermittent lighting in fattening affects 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).

Live weight gain is one of the most important performance criteria, so determination of effects of lighting programs and periods is of particular importance in poultry production (NOLL et al., 1991; HERSTAD, 1992; MORRIS and BUTLER, 1995). Comparison of effect of different lighting programs on weight gain is a crucial step in deciding the best management system which will provide maximum economic benefit to the producer. Proper lighting program should be determined since the live weight of

turkey varies according to the lighting program applied. Many studies have been carried out to determine the effect of different lighting systems on live weight gain and growth performance in poultry production (BUCKLAND et al., 1976; SIOPES et al., 1986; CECIL, 1986; HESTER et al., 1987; KOVACHISHKI et al., 1987; LEWIS and PERRY, 1990; AL-MAHROUS, 1997; YAHAV et al., 2000). However, convincing results have not been always obtained from these studies due to the aim of the study or the choice of the statistical methods in the evaluation of the data. The aim of this study was to investigate the effects of three different lighting programs on weekly body weight gain of bronze turkeys by Profile analysis, which is an extension of the repeated measurement and provides rather specific information in comparison to repeated measurement and growth curve models (GRIBSKO, 1987; MORRISON, 1995; RENCHER, 1995; DING, 2001; SUMMERS et al., 2001), to obtain more detailed information.

Materials and Methods

In this study, 15 week old 60 male American Bronze turkeys were used. The study was carried out at the Research Unit of Çanakkale Onsekiz Mart University.

The animals were raised under intensive condition with a lighting program of 23D:1D in the first 55 days of the study. They were then allowed to go onto the pasture till the end of the study. Three different artificial lighting programs in addition to day light were applied 16^{th} week onwards. Therefore, 16^{th} week was taken as the first week of the study for three different lighting programs. I. group (control), II. group and III. group involved lighting programs of 23L:1D, 18L:6D and 12L:12D, respectively. Each group had 20 turkeys. The live weight gains of turkeys in all groups were determined by weighing and the animals were slaughtered at 31^{st} week of the study.

The starter and growth diets of the animals included 28% crude protein, 2900-3000 kcal/ME and 22% crude protein, 2800-2900 kcal/ME, respectively under intensive condition. Wheat and water were offered *ad libitum* to the turkeys when they returned back from the pasture under semi-intensive condition.

Statistical Method

In this study, k-sample profile analysis was adapted to compare live body weights of groups of American Bronze turkeys. This allowed for the assigment of a level of statistical significant differences and the shapes of the centroids of three lighting programs. Profile analysis is a method of comparison of groups that are experimental units to the same set of p measurements by examining the p-1 slopes between adjacent coordinate values for mean vectors of the groups. Profile analysis is an extension of the repeated measurement.

The basic of profile analysis is a sequence comparison method for finding and aligning distantly related sequences.

Let $\mu_i=(\mu_{i1,}\ \mu_{i2,...,}\ \mu_{ip})$ be the mean vector for group i and the subjects of this vector representing the avarage responses to the p measurements. It is known that the test for no treatment effect is equivalent to $H_0 : \mu_1 = ... = \mu_j$. Rather than testing the hypothesis that $H_0 : \mu_1 = ... = \mu_j$, we wish to be more specific in comparing the profiles obtained by connecting the points (i, μj_i), (i,μj_i),..., (i,μj_i), i=1,2,...,p and j=1,2,...,k.

There are three different hypotheses of interest in comparing the profiles of two or more samples as follows:
a) The population mean profiles are parallel or there is no treatment x repeated factor interaction effect.
b) If the first hypothesis is true (the population profiles are parallel), are they also at the same level? That is, k profiles are all at the same level or there is no treatment effect.
c) Again assuming parallelism, are the population means of the tests different? That is, the means of all p variables in each group are the same.
The first hypothesis refers to the hypothesis of no response by group interaction, while the second hypothesis refers to the hypothesis of equal group effect and the third hypothesis refers to the hypothesis of repeated factor effect or response effect. The tests for equal levels and response effects have no meaning If a group-response interaction is present. The parallelisim hypothesis can be defined with respect to the slopes. The profiles are parallel if the two slopes for each segment are the same. Therefore, if the profiles are parallel or there is no interaction effect, the increments for each segment are the same and it is not necessary to use actual slopes to express the hypothesis, since we simply compare the increase from one point to the next. This is one of the superiority of profile analysis to other methods such as repeated measurements and growth curve (SRIVASTAVA and CARTER, 1983; MORRISON, 1995).
The hypothesis of parallelism can be expressed as

$$H_0 : C\mu_1 = C\mu_2 = ... = C\mu_k \qquad (3)$$

The hypothesis (3) is equivalent to the null hypothesis $H_0 : \mu_{z1} = \mu_{z2} ... = \mu_{zk}$ in a one-way MANOVA on transformed variables $z_{ij} = Cy_{ij}$.

z_{ij} is distributed as $N_{p-1}(C\mu_1, C\Sigma C')$. Since C has p-1 rows, Cy_{ij} is (p-1) x 1, $C\mu_i$ is (p-1) x 1, and $C\Sigma C'$ is (p-1) x (p-1).

Where C is a (p-1) x p matrix of contrast C=
$$\begin{bmatrix} 1 & -1 & 0 & . & . & . & 0 \\ 0 & 1 & -1 & . & . & . & 0 \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ 0 & 0 & 0 & . & . & . & -1 \end{bmatrix}$$

The hypothesis and error matrices for testing $H_0 : C\mu_1 = C\mu_2 = ... = C\mu_k$ in (3) are $H_z = CHC'$ and $E_z = CEC'$. We thus have

$$\Lambda = \frac{|CEC|'}{|CEC + CHC'|} \qquad (4)$$

which is distributed as $\Lambda_{p-1}, \nu_H, \nu_E$.

Where ν_H =(k-1) and ν_E =k(n-1). These calculations were based on those of RENCHER (1995).

Results

Descriptive statistics, test of fixed effects, and results of Scheffe multiple comparisons are given in Table 1, Table 2 and Table 3, respectively. The effect of lighting programs on live weight gain in the first 10 weeks of the study was found significant ($p<0.05$). However, lighting programs had no significant effect on live weight gain at the end of the 16 week study ($p=0.11$). The F-statistics and Wilk's Lamba statistics for testing group-response interaction or similar profiles, have the value of 4.36 and 0.21374, respectively. Hence one concludes that there is a significant interaction effect ($p<0.01$, Table 2). In other words, the difference in mean live weights of the turkeys between weeks depends on lighting program (profiles are not parallel). Figure 1 and Figure 2 tend to support this conclusion. When the effect of lighting programs on total feed intake was evaluated, it was found that there was no difference between 23L:1D and 18L:6D lighting programs, but these two programs differed significantly from the 12L:12D lighting program ($p<0.01$).

Table 1
Descriptive statistics by groups (g) (Beschreibende Statistik der Gruppen (g))

Weeks	Group-I (23L:1D) Mean ±SE	Group-II (18L:6D) Mean ±SE	Group-III (12L:12D) Mean ±SE
1	3466.3 ± 63.5	3472.8 ± 83.4	3359.3 ± 86.0
2	3712.0 ± 77.4	3688.0 ± 90.8	3498.3 ± 89.6
3	3884.0 ± 79.5	3897.0 ± 92.7	3680.5 ± 88.9
4	4188.0 ± 83.0	4146.0 ± 106	3858.4 ± 97.4
5	4419.3 ± 79.6	4459.0 ± 108	4090.8 ± 97.7
6	4528.5 ± 93.4	4648.0 ± 122	4279.0 ± 104
7	4861.0 ± 96.7	4953.0 ± 130	4440.0 ± 112
8	5148.8 ± 95.0	5214.0 ± 131	4739.0 ± 128
9	5447.0 ± 106	5452.0 ± 137	5018.0 ± 133
10	5688.0 ± 111	5801.0 ± 142	5294.0 ± 140
11	6048.0 ± 123	6236.0 ± 148	5701.0 ± 145
12	6324.0 ± 138	6463.0 ± 169	6022.0 ± 155
13	6535.0 ± 166	6695.0 ± 167	6340.0 ± 169
14	6958.0 ± 171	7102.0 ± 188	6782.0 ± 174
15	7301.0 ± 198	7421.0 ± 218	7145.0 ± 193
16	7654.0 ± 211	7828.0 ± 255	7547.0 ± 219

Table 2
Tests of Fixed effects (Testergebnisse der fixen Effekte)

	Type 3 Tests of Fixed Effects		
Effect	F Value	Wilks' Lambda	P
Group	2.30	0.10550	0.11
Week	259.33	0.01394	0.00
Group*Week	4.36	0.21374	0.00

A profile plot of these means is given in Figure 1. There is a high degree of parallesim in the three profiles. The effects of these three lighting programs on live weight gain appeared to be different throughout the study except for the last 6 weeks. In other word, as the age of turkey increased, the difference in mean live weights decreased (Figures 1 and 2). The results of the Scheffe multiple comparison test support this finding statistically and so does Figure 2 visually.

When three lighting programs were compared in terms of the difference between consecutive weeks or profile segments (regression slopes), a significant difference at least between two lighting programs was found from the difference between live weigh means of 1-2, 3-4, 4-5, 5-6, 6-7, and 9-10 weeks. In fact, the effect of these

three lighting programs on live weight gain was not at the same level. On the other hand, from 10th week on wards, it can be said that the effect of the three lighting programs on live weight gain followed a similar trend. This can be seen from Figure 1 and 2. The differences between live weight means in consecutive weeks after 10th week were parallel in three lighting programs (Table 3, Figures 1 and 2).

Table 3.
Differences among the groups for different weeks (g) (Differenzen zwischen den Gruppen während verschiedener Wochen)

Sequential week difference	Group1 (23L:1D)	Group2 (18L: 6D)	Group3 (12L:12D)	Conclusion
1-2	245.7[a]	215.2[a]	139[b]	significant
2-3	172a[b]	209[a]	182.2[ab]	non-significant
3-4	304[a]	249[b]	177.9[c]	significant
4-5	231.3[b]	313[a]	232.4[b]	significant
5-6	109.2[b]	189[a]	188.2[a]	significant
6-7	332.5[a]	305[a]	161[b]	significant
7-8	287.8[a]	261[a]	299[a]	non-significant
8-9	298.2[a]	238[a]	279[a]	non-significant
9-10	241[b]	349[a]	276[b]	significant
10-11	360[a]	435[a]	407[a]	non-significant
11-12	276[a]	227[a]	321[a]	non-significant
12-13	211[a]	232[a]	318[a]	non-significant
13-14	423[a]	407[a]	442[a]	non-significant
14-15	343[a]	319[a]	363[a]	non-significant
15-16	353[a]	407[a]	402[a]	non-significant
Grand mean ± SE	279.2 ± 20.8[a]	290.2 ± 20.5[a]	279.2 ± 25.1[a]	non-significant

[a,b,c] Rows that do not share the same letters differ significantly (P<0.01)
L: light, **D:** dark

Table 4
Total live weight gains of turkeys of three lighting programs in the first 10 weeks and in the last 6 weeks of the study (g) (Totale Lebensgewichtszunahmen der Puten bei drei Lichtprogrammen in den ersten 10 Wochen und in den letzen 6 Wochen)

Lighting Programs	Total live weight in the first 10 weeks	Total live weight in the last 6 weeks
23L:1D	45342.8	40820.0
18L:6D	45730.8	41745.0
12L:12D	42257.3	39537.0

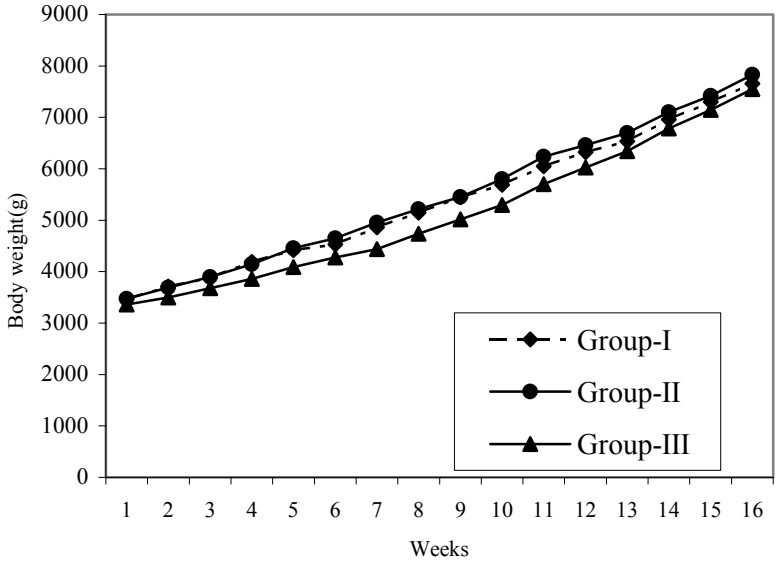

Fig. 1: Groups Profiles (Gruppenprofile)

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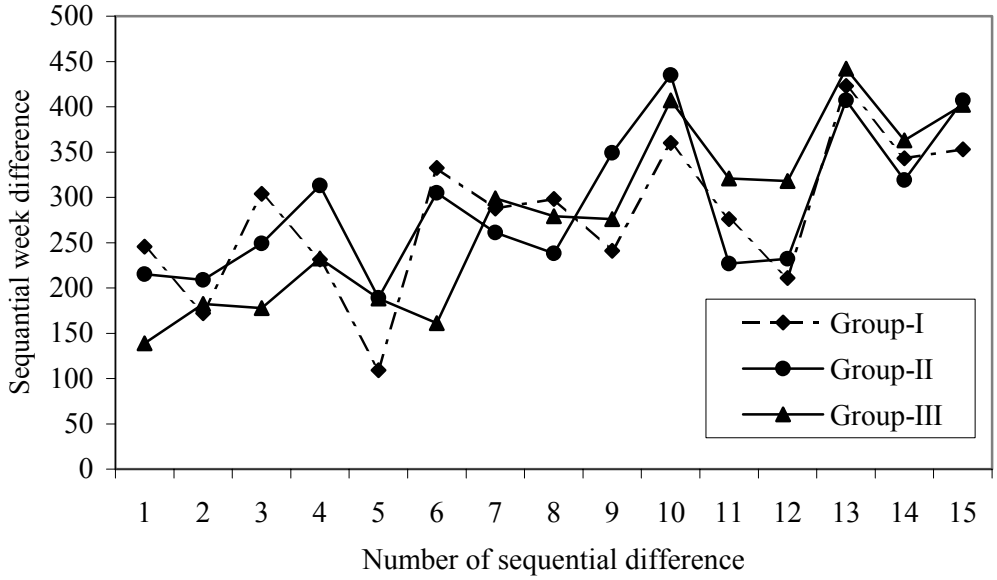

Fig. 2: Sequential week difference by groups (Verlauf der Differenzen der sequentiellen Wochen der Gruppen)

Discussion

The results of the present study indicated that differences in live weight gain and feed intake parameters among the three lighting programs were more apparent especially in the first 10 weeks of the study. The live weight gain and total feed intake of turkeys who were exposed to 23L:1D or 18L:6D were significantly higher in the first 10 weeks of the study as compared to the turkeys received a lighting program of 12L:12D. However, live weight gain and feed intake values of all the treatment groups tended to get similar after the 10^{th} week. In other words, from 10^{th} week onwards, the live weight gain and feed intake of turkeys increased as the feeding period increased. Total live weight of turkeys exposed to a lighting program for 23L:1D was 45342.6 g, and were 45730 g and 42257.3 g for 18L:6D and 12L:12D at the end of 10 weeks. On the other hand, the same parameter was found to be 40820 g, 41745 g and 39537 g for 23L:1D, 18L:6D and 12L:12D groups, respectively in the last 6 weeks of the present study (Table 4). It is important to note that the highest weight gain occurred in the 18L:6D group, whereas the lowest weight gain was observed in the 12L:12D group in both the first 10 and the last 6 weeks of the study. The results of the feed intake of turkeys are similar to those of other studies in the literature (HALVORSOR et al., 1991; NOLL et al., 1991; CLARKE et al., 1993; SENGUL et al., 2000). On the other hand, maximum live weight difference among three lighting programs throughout first 10 weeks (3473.5 g) was notably higher than the weight gain (2208 g) observed throughout last 6 weeks. This suggests that the effects of lighting systems on weight gain and feed intake were rather similar to each other in the last 6 weeks of the present study. The feed intake of turkeys exposed to a lighting program of 12L:12D seemed to follow a compensatory pattern in which they increased their feed intake resulting in increased weight gain as compared to that of turkeys receiving a lighting program of 23L:1D and 18L:6D.

Though this finding is consistent with the results of HERSTAD (1992), NEWBERRY (1992), HULET et al. (1993), CLASSEN et al. (1994), HEMILTON and KENNIE

(1997), SENGUL et al. (2000), and YAHAV et al. (2000), it provides other implications. In this regard, in addition to the trial conditions, the aim of studies and the use of statistical models for the evaluation of the results of such studies can have significant influence on the outcome of such studies. For example, SENGUL et al., (2000) investigated the effect of three different lighting programs on growth performance and carcass quality in American Bronze turkeys. They analyzed their data in a 3 x 2 factorial design and found a significant interaction between three lighting programs and live weight, but not between lighting program and week. In fact, the evaluation of the data of consecutive weeks can lead to disappearance of the effect between weeks and of the carry-over effect between consecutive weeks throughout the study. Therefore, the results of similar studies can be variable due to the use of various statistical models for data evaluation.

This finding indicates that the effect of lighting programs is rather crucial on the physiology of turkeys in the first 10 weeks. We can suggest that a lighting program of 18L:6D is more preferable than the other programs. However, it should be born in mind that the suitability of lighting program may depend on poultry species and other husbandry factors.

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