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EFFECTS OF LIGHT DURATION AND DIET DENSITY ON BROILERS' GROWTH PERFORMANCE

SUMMARY

The experiment was conducted on Cobb 500 hybrid chickens for the period of up to 42 days. The setting had 4 treatments with 4 replications involving 80 chicks per treatment. In the Group A the lighting program was: I wk – 23L:1D and then onwards 18L:6D – standard; Group B lighting program: I wk – 23L:1D; II wk – 12L:12D; III wk – 14L:10D; IV wk – 16L:8D; V wk – 18L:6D; VI wk – 20L:4D.

Group "a" feed with standard protein and energy contents chicks were fed with the starter mixture containing 21.22% CP and 12.3 MJ/kg ME to 14 days of age, grower with 20.2 CP and 15.5 MJ/kg ME to 35 days and finished with 18.6% CP and 12.7 MJ/kg ME until the end of the fattening period.

Group "b" feed with increased protein and energy contents. Oil and soybean meal was added to the existing meal content in order to increase the protein and energy content in the starter mixture to 22.04 % CP, energy value of the meal to 12.78 MJ ME/kg, grower to 35 days 20.98 CP and 13.0 MJ ME/kg and finisher up to 42 days 19.39% CP and 13.24 MJ ME/kg. The ratio of energy and protein in the setting "a" and in the setting "b" was the same and amounted to 138 for the starter, 147 for the grower and 162 for the finisher.

The tests show that the lighting program has a significant effect on body weight gain in all weeks of life. As the daylight duration grew in the second fattening period (3-6 weeks) the effect of light was annulled and it did not have an effect on average daily yield. The second parameter tested – diet density – had the opposite effect on body weight and daily yield.

The treatments tested in this trial did not show a significant effect on mortality; feed efficiency, which is justified with a high intra-group variability and a small number of replications.

The highest production index was determined in chicks grown under the lighting program 18L:6D, and with Axb interaction.

Keywords: broilers, lighting, stocking density, performance

INTRODUCTION

A large number of studies have been conducted in order to test various lighting programs in broilers fattening. The experiments have mainly shown that light duration has an effect on final body weight, food conversion, vitality and welfare of chicken. Lighting programs applied so far have mainly included

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continuous lighting throughout 24 hours or with 23 hours of light and 1 hour of darkness (23L: 1D). There have also been other experiments with intermittent and ahemeral light (Supić *et al*., 1990; Lien, *et al*., 2007, Škrbić *et al*., 2009a; Škrbić *et al*., 2012) and a wide spectrum of light intensities (Lien *et al*., 2007; Blatchford. *et al*, 2009). Broilers have usually been kept on long continuous lighting periods in order to maximize the feed intake and achieve yield, which is a result of the fact that they are hungry all the time and take food only under light (Campo and Davila, 2002). Undesirable effects of long lighting program include increased fat deposition in broiler carcasses, higher incidence of metabolic diseases, skeletal deformities and leg weakness in particular (Kristensen, *et al*., 2006; Olanrewaju *et al*., 2006, Škrbić *et al*., 2009b). Some researchers indicate that the photoperiod treatments have no significant effect on growth performance of broilers (Archer *et al*., 2009; Onbasilar *et al*., 2007).

The composition of meals as a factor is also important for majority of production parameters. Broilers have to be fed a meal with optimal share of protein and energy in order to achieve maximum production and good quality of meat. High content of protein and energy in meal can increase feed cost (Brickett *et al*.,2007; Kamran *et al*., 2008; Huang *et al*., 2009), nitrogen excretion (Bregendahl *et al*.,2002), fat deposition as well as the incidence of metabolic disorders (Nahashon *et al*., 2005). Most research found that feeding a high protein and energy content diet increases body weight, but decreases FCR (Campo and Davila, 2002; Nahashon *et al*., 2005; Archer *et al*., 2009. Some researchers state that low density diet results in lower FCR (Wu *et al*., 2007; Fanatico *et al*., 2008), but has no effect on the carcass yield, breast meat yield, thigh yield and abdominal fat (Kamran *et al*., 2008). A small number of researches focused on the interaction of lighting program and energy levels of diet on growth performance and carcass quality in broilers (Buys *et al*. 1998).

The studies on effects of lighting schedule and stocking density have also become interesting from the viewpoint of poultry welfare measures prescribed by the EU and countries that follow their recommendations (Council Directive 2007/43/CE, 2007) stating that broiler chickens need to be provided light intensity of min. 20 lux, the continuous light duration of 18L and 6 hours of dark and stocking density not exceeding 35 kg per m^2 of floor area.

The research was conducted in order to establish the effect of the duration of periods of light and diet density of broiler chickens on their final body weight, food conversion, mortality and production index.

MATERIAL AND METHODS

The experiment was conducted on Cobb 500 hybrid chicken in floor system production. The experiment was conducted as a two-by-two factorial design (2x2) with 4 replications per treatment with 20 chickens in each replication. The experimental design overview is given below.

The data obtained in monitoring of production performance – body weight per week of age, number of dead chickens, duration of fattening and feed

consumption – were used to calculate the final body weight, average daily yield, mortality at the treatment level, feed efficiency and production index.

Table 1. Treatments and factor levels

Treatment	Factor level
Lighting program: I wk 23L:1D i do kraj 18L : 6D – standard	A
Lighting program: I wk 23L:1D; II wk 12L:12D; III wk 14L:10D; IV wk 16L:8D; V wk 18L:6D; VI wk 20L:4D;	B
Feed with standard protein and energy contents	a
Feed with increased protein and energy contents	b

The data were processed using the computer programme STATISTICA 12. Means and variability measures were determined. Variance analysis was done (ANOVA), while Duncan test (Duncan Multiple Range Test) was used where statistical significance was shown in the variance analysis at the $p \leq 0.05$ probability level.

RESULTS AND DISCUSSION

Body weight of chickens per week and final weight at the end of the experiment (Table 2) show that the lighting program had effect on body weight, but not in all weeks. The difference in body weight as a result of effect of the lighting program were noted in the second, the third, the fourth, the fifth and the sixth week, and the difference was statistically significant ($P<0.05$). In the first week, all chickens were grown under the light schedule of 23L and 1D, so differences were not possible. The reference materials state positive as well as negative effects of lighting duration, depending on the light program. The light programs with longer hours of dark mainly had either no effect or a negative effect on the final body weight of the chickens, which is explained with shorter periods of time available for feed intake (Lien *et al*., 2007; Blatchford. *et al*, 2009; Škrbić *et al*., 2009a).

The increased level of proteins and energy in the meal of the group „b“ was also statistically very significant ($P<0.05$) for all weeks of the experiment, except the third week. The results obtained are in line with those of many other researches (Onbasilar *et al*., 2007, 2008; Lien *et al*., 2007; Blatchford. *et al*, 2009; Archer *et al*., 2009; Škrbić *et al*., 2010, 2012). The continuous lighting programme and a diet with increased contents of protein and energy in group (Axb) showed higher values of body weight in all weeks of the experiment, and the differences are statistically significant ($P<0.05$) for almost all weeks of the experiment. Such relationship from the reference material available has not been confirmed, but has not been denied, either.

Analysis of the daily yields per week and per three-week periods, but also for the entire period under observation (Table 3) has shown certain characteristic

differences among the groups tested. The lighting program has a significant influence on daily yields in the second week.

Table 2. Body weight (g)

Treatment*	N	week						
		0	1	2	3	4	5	6
Total	309	38,9	149,16	358,85	698,35	102,27	1691,01	2265,11
A	156	38,8	149,69	366,86a	715,67a	1207,7a	1730,2a	2311,41a
		3,17	15,92	48,72	93,19	157,57	205,25	281,74
B	153	39,0	148,63	350,6b	680,6b	1122,5b	1651,0b	2217,91b
		3,09	19,08	46,91	108,24	179,16	232,86	291,07
A	155	38,9	145,6b	347,1b	689,19	1138,7b	1648,2b	2206,87b
		3,07	15,81	40,14	96,43	180,53	222,45	272,68
B	154	38,9	152,6a	370,68a	707,56	1192,5a	1734,0a	2323,73a
		3,20	18,51	53,11	107,36	162,61	214,90	295,39
Axa	78	38,9	146,2a	353 ab	700 ab	1184 a	1692 a	2221 a
		3,11	15,36	38,17	89,14	176,83	228,32	278,76
Axb	78	38,8	153,1b	380,45c	730 ac	1231 ab	1768 ab	2401,73b
		3,24	15,81	54,29	95,32	132,66	172,52	256,02
Bxa	77	39	145,0a	340,8b	677,4b	1092,6c	1603,5c	2192,47a
		3,04	16,33	41,35	102,54	173,41	208,43	267,43
Bxb	76	39	152,4b	360,66a	683,9b	1152,8a	1699,1a	2243,8a
		3,16	21,01	50,27	114,32	180,91	247,41	312,88

[a,b,c] Different letters indicate significant difference between means columns ($P<0.05$)

*A Lighting program: I wk 23L:1D and onwards 18L : 6D – standard

B Lighting program: I wk 23L:1D; II wk 12L:12D; III wk 14L:10D; IV wk 16L:8D; V wk 18L:6D; VI wk 20L:4D;

a Feed with standard protein and energy content

b Feed with increased protein and energy content.

It is particularly notable as chickens grow intensively in that period and the duration of light was only 12 hours, which points to the fact that chickens need more light in order to be able to take feed more often (Lien *et al*., 2007; Blatchford. *et al*, 2009). When observing the first three-week period it is clearly confirmed, since in this period light duration was shortened to 12 hours at one point.

Duration of light was increased in the second three-week period, so that chickens had more time to take feed. The difference in the duration of lighting between the standard program and the program with increasing light in the final weeks was reduced, so light as an environmental factor had no significant effect on daily yields.

Better daily yields in chickens with increased diet density in group „b“ were established in the first and the second week and the differences are statistically significant ($P<0.05$). When observing three-week periods, statistically significant differences were noted in the second three-week period ($P<0.05$). However, in the period from the beginning till the end of the fattening,

chicken in the group "b" achieved better results, but the differences were not statistically significant.

In chicken grown under the light duration of 18L:6 D and with increased contents of protein and energy interaction (Axb) better daily yields were noted in the first and the second three-week period as well as during the entire fattening compared to chickens in interactions (Bxa), (Bxb) and (Axa), these differences were statistically significant ($P<0.05$), for the second three-week period and for the period from the beginning till the end of the fattening.

Table 3. Daily yield (g)

Treatment	Week									
		1	2	3	4	5	6	0-3	3-6	0-6
Total	320	15.6	29.34	47.3	65.22	72.5	79.5	30.76	72.1	51.2
A	160	15,6	30,3a	48,8	69 a	72,7	80,9	31 a	73.9	52 a
		±2,8	±8,16	16,3	±27,5	±36	±47	±6.22	±18	±10
B	160	15,6	28,3b	45.9	61,1b	72,2	78,1	29.9b	70.4	49 b
		±2,8	±8,60	±17	±29,6	±42	±48	±6.50	±19	±12
A	160	15 b	28,2b	48,0	63,75	70,5	77,3	30.48	69.a	50
		±2,2	±7,52	±15	±28,9	±41	±47	±5.66	±18	±11
B	160	16 a	30,4a	46,7	66,69	74,5	81.7	31.04	74.b	52.3
		±3,2	±9,14	±17	±28,8	±38	±48	±7.08	±19	±12
Axa	80	15ab	29 a	48,8	68,8a	70,7	73,6	31 ab	70 a	50 a
		±2,2	±6,74	±15	±29,3	±41	±48	±5.51	±19	±10
Axb	80	15ab	31,6b	48,7	69,7a	74,7	88,2	32.1a	77b	54b
		±3,4	±9,23	±17	±25,7	±31	±45	±6.84	±18	±10
Bxa	80	15 b	27,3a	47,1	58,6b	70,2	80,9	29.9b	69a	49a
		±2,3	±8,17	±16	±27,8	±41	±45	±5.78	±18	±11
Bxb	80	16a	29ab	44,8	63ab	74,3	75,2	29.9b	71a	49a
		±3,1	±8,95	±18	±31,4	±43	±51	±7.18	±20	±13

[a,b] Different letters indicate significant difference between means columns ($P<0.05$)

The consumption of feed per yield unit per week is shown in the Table 3. The data on feed conversion show that there were no statistical differences between the light duration factors (A&B). Furthermore, as far as the diet density is concerned, there was no statistically significant difference except in the week I, where better feed conversion was noted in chickens that were fed increased protein and energy content "b". In difference to our results (Kamran *et al*.,2008) noted statistically significant differences when it comes to feed conversion in chickens fed with increased protein and energy content, particularly in the second half of the fattening period.

The interaction of light duration and diet density had an effect in the first weeks, but did not have that effect int eh final three-week period.

Many researchers conducted show that the duration of light and the diet density have a significant influence on feed efficiency (Puron *et al*., 1995; Feddes

et al.,2002; Onbasilar *et al*., 2008; Škrbić *et al*., 2010), which was not the case in this experiment.

Table 4. Food conversion (kg/kg)

Treatment	N	Week					
		1	2	3	4	5	6
Total	320						
A	160	1.417	1.399	1.832	2.386	2.047	2.126
		0.77	0.05	0.10	0.15	0.11	0.21
B	160	1.421	1.468	1.830	2.582	2.058	2.287
		0.10	0.09	0.19	0.24	0.13	0.28
A	160	1.474a	1.444	1.777	2.443	2.093	2.154
		0.05	0.10	0.12	0.25	0.14	0.13
B	160	1.364b	1.423	1.884	2.525	2.013	2.258
		0.08	0.06	0.16	0.19	0.07	0.34
Axa	80	1.467ab	1.359a	1.844ab	2.338	2.090	2.149
		0.06	0.04	0.07	0.14	0.14	0.12
Axb	80	1.366ab	1.440ab	1.819ab	2.434	2.005	2.102
		0.06	0.03	0.14	0.16	0.07	0.29
Bxa	80	1.481b	1.529b	1.710b	2.549	2.095	2.159
		0.05	0.08	0.14	0.31	0.17	0.17
Bxb	80	1.361a	1.407a	1.950a	2.617	2.021	2.414
		0.11	0.08	0.16	0.19	0.08	0.34

[a,b] Different letters indicate significant difference between means columns (P<0.05)

Table 5. Mortality rate and production index

	N	PI	Mortality,%
Total	16	259.81	3.437
A	8	271.97a	2.50
		26.23	3,77
B	8	247.64b	4.375
		11.32	4,17
A	8	255.14	3.125
		16.78	2,58
B	8	264.47	3.75
		28.69	5,17
Axa	4	257.60a	2.50
		23.31	2,88
Axb	4	286.34b	2.50
		22.41	5,00
Bxa	4	252.68a	3.75
		9.42	2,50
Bxb	4	242.59a	5.00
		11.93	5,77

[a,b] Different letters indicate significant difference between means columns (P<0.05)

In order to provide a full overview of growth performance of broiler chickens depending on the treatments analysed, the Table 5 below presents the values of the production index and mortality. Higher production index (271.97) was noted in Treatment A compared to the Treatment B 247.64 and the differences are statistically significant ($P<0.05$). The diet density had no effect on production index, while in interaction (Axb) the difference noted was statistically significant ($P<0.05$) compared to other combinations.

The mortality of chickens as an important factor of success in fattening should be taken with a reserve in this experiment, considering that the number of chickens per replication was only 20, and 80 chickens in total per treatment, so the variability within the groups was high, which could not have resulted in a more significant difference among the groups. Most of authors state in their papers that the duration of lighting has a minimum effect on chickens' vitality. On the other hand, increased stocking density can result in reduced immunity and increased mortality (Puron *et al*., 1995; Feddes *et al*., 2002; Dozier III, *et al*., 2005).

CONCLUSIONS

Generally, in short, the conclusion is that the duration of light in broilers has a significant effect on body weight in all weeks of age. With the increase in light periods in the second part of the fattening period (3-6 weeks) the effect of light was annulled and had no effect on average daily yields. The second parameter tested – diet density – had an opposite effect on body weight and daily yields.

The treatments analysed in this experiment have not shown a significant effect on mortality, feed efficiency, which is justified with a high intra-group variability and a small number of replications, which was not the case in experiments conducted by other authors.

The highest production index was determined in chickens grown under the lighting program 18L:6D, and interaction Axb.

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UTICAJ DUŽINE SVIJETLA I GUSTINE OBROKA NA PROIZVODNE OSOBINE BROJLERA

SAŽETAK

Ispitivanja su izvedena na pilićima Cobb 500 hibrida u trajanju do 42 dana. Postavka je bila 4 tretmana sa 4 ponavljanja po 80 pilića po tretmanu. U grupi A Program osvetljenja: I ned. 23S:1M i do kraj 18S : 6M – standardno ; grupa B Program osvetljenja: I ned. 23S:1M; II ned. 12S:12M; III ned. 14S:10M; IV ned. 16S:8M; V ned. 18S:6M; VI ned. 20S:4M.

Grupa "a" Hrana sa standardnim sadržajem proteina i energije pilići su hranjeni starter smešom sa 21,22% SP i 12.3 MJ/kg ME do 14 dana starosti, groverom sa 20,2 SP i 15,5 MJ/kg ME do 35 dana i finišerom sa 18,6% SP i 12,7 MJ/kg ME do kraja tova.

Grupa "b" Hrana sa povećanim sadržajem proteina i energij. Na postojeći sadržaj obroka dodavano je ulje i sojina sačma da bi se povećao sadržaj proteina i energije u starter smješi na 22,04, % SP, energetska vrednost obroka na 12.78 MJ ME/kg, grover do 35 dan 20.98 SP i 13.0MJ ME/kg i finišerom do 42 dana 19.39% SP i 13,24 MJ ME/kg. Odnos energije i protein u postavci "a" i u postavci "b" bio je isti i iznosio je je za starter 138, grover 147 i finišer 162.

Ispitivanja su pokazala da svetlosni program ima značajnog uticaja na telesne mase u svim nedeljama života. Sa povećanjem dužine dana u drugom periodu tova (3-6 nedelja) efekat svetla je anuliran i nije uticao presečane dnevne prirase. Drugi ispitivani parametar gustina obrokai imao je suprotan efekat na telesne mase i dnevne priraste..

Ispitivani tretmani u ovom ogledu nisu pokazali značajnijeg uticaja na mortalitet, efikasnost krišćenja hrane što se pravda visokom unutar grupnom varijabilnošću i malim brojem ponavljanja.

Najveći proizvodni indeks utvđen kod pilića gajeni pri svjetlosnom program 18S:6M, I pri interakciji Axb.

Ključne riječi: brojleri, svijetlo, gustina naseljenosti, osobine