

EFFECT OF LIGHT PROGRAMME AND BIRD STRAIN UPON CARCASE AND MEAT QUALITY IN BROILER CHICKENS

Ewa Gornowicz, Lidia Lewko

National Research Institute of Animal Production, Department of Animal Genetic Resources Conservation, Zakrzewo, Poland

Key words: chicken, meat, carcase, quality, light, strain

The purpose of this study was to evaluate the effect of the kind of light programme on slaughter and meat yield, as well as on physicochemical and sensory traits of breast and leg muscles in Ross 308 and Hybro G commercial hybrids of broiler chickens. The results of study indicated that the intermittent light programme 4L:2D or 3L:1D used in growing broiler chickens significantly affected the following traits in the examined strains of broilers: increased slaughter yield by circa 2.0%; higher yield of breast muscles by about 1.29%; of leg muscles by about 1.44% and lower amount of peritoneal fat tissue in the carcase by about 1.39%. The applied light system also improved the physicochemical characteristics of meat, *i.e.* pH_{15'}, pH₂₄ and water holding capacity and decreased the intramuscular fat content. The kind of light programme affected the quality traits of carcase and meat both in Ross 308 and Hybro G strains of broiler chicken.

INTRODUCTION

In the commercial production of poultry meat more and more attention has been paid to profitability increase. However, the economic result of that production is dependent not only on the performance traits of birds but also on numerous factors which determine broiler meat quality [Wężyk, 1999]. Nowadays in the time of developing further processing of poultry meat and growing consumer requirements it seems inevitable to carry out studies to know to which extent the diversified environmental conditions can influence the muscle quality in broiler chickens [Barbut 1997; Woelfel *et al.*, 2002; Richardson, 2004]. The studies by Ristic [1991], Świerczewska *et al.* [2000] and others have shown that besides genetic factors, the chemical composition of muscles is affected by the, broadly understood, environment *i.e.* feeding programme and nutritive value of the diet, hygienic conditions and others. The production of good quality and wholesome poultry meat products requires improvements and innovations in the management of birds [Herbut & Wężyk, 2000]. Among them, new light programmes have been applied which, in the comparison with the traditional light system 23 h light and 1 h darkness, are more effective and recommended in the instructions by Ross, Cobb and Hubbard Companies.

Due to a considerable diversity of the breeding material followed by the introduction of new commercial hybrids of broiler chicken the effect of bird genotype on the quality of carcase and meat was reported by Moran [1997] and Szalkowska & Meller [1997].

Little knowledge has been available on the effect of the light programme on the carcase meat yield as well as on the

physicochemical and sensory characteristics of breast and leg muscles in broiler chickens. That issue has been important in the case of Ross 308 and Hybro G broiler chickens which predominate in the commercial production of broiler meat in Poland.

The purpose of this study was to evaluate the effect of the kind of light programme on slaughter and meat yield, as well as on physicochemical and sensory traits of breast and leg muscles in Ross 308 and Hybro G commercial hybrids of broiler chickens.

MATERIAL AND METHODS

From the 1st to 3rd day of life of the experimental birds a 24 h 10 lx light intensity programme was used. From the 4th day of age in two groups of birds an intermittent 5 lx light was applied *i.e.* 4 h of light and 2 h of darkness (4L:2D), while third group of broilers was grown under 23 h light programme (23L:1D). The other management factors during bird growth were the same in all experimental groups.

Broilers were fed *ad libitum* on the same compound feed. After 42 days of growing period ten males and ten females from each group of broilers of the weight range from 1900 to 2300 g were taken for post mortem examination. Meat yield was examined acc. to Ziolecki & Doruchowski [1989]. The pH value of muscles was determined with the use of mobile Inlab 427 pH meter with calomel electrode, while the water holding capacity by the modified Grau & Hamm method. Muscle samples from the right breast of carcase (*m. superficialis* and *m. profundus*) and from the right leg were taken for the chemical analysis. The chemical composition of muscles was

determined by standard methods [PN-75/A-04018; PN-ISO 1444:2000; PN-ISO 1442:2000; PN-ISO 936:2000]. Sensory evaluation of the raw and cooked muscles from the left half of carcasses was conducted acc. Ziotecki [1988]. The experimental results were subjected to one factorial analysis of variance and correlations were calculated between the kind of light programme and selected physicochemical traits of muscles

RESULTS AND DISCUSSION

The slaughter and meat yield was higher in broilers grown under intermittent light programme (Figure 1), i.e. higher by 1.20 to 2.55% and by 1.84 to 3.67%, respectively. The noted differences were found statistically significant at $p \leq 0.05$ both in Ross 308 and Hybro G broilers. Also Renden *et al.* [1993] reported the effect of various high programmes on the performance traits and slaughter yield in broilers.

The yield of breast and leg muscles in the carcass of birds grown under intermittent light programme (Figure 2) was

found higher by 0.71 to 1.04% in Ross 308 broilers whereas by 1.71 to 1.86 in Hybro G broilers. The observed differences were statistically significant at $p \leq 0.05$ in the groups of birds of the same origin. Similar relationship was observed in the yield of leg muscles in two groups of the examined birds.

Significantly less (at $p \leq 0.05$) peritoneal fat tissue by 1.21 to 1.41% in Ross 308 broilers and by 1.40 to 1.53% in Hybro G broilers was noted in groups grown under intermittent light programme.

Herbut & Wężyk [2000] examined the effect of light programme in the cycle of 3hD:1hL and reported a lower fatness of carcasses by 30%. In our study by the application of both intermittent light programmes, the fatness of carcasses was reduced by nearly 50%.

The acidification of breast and leg muscles immediately after slaughter (pH_{15}) was found relatively high and diversified (Table 1 and 2). In birds kept under intermittent light programme a significantly ($p \leq 0.05$) higher acidification was observed in the breast and leg muscles. Thus it demonstrat-

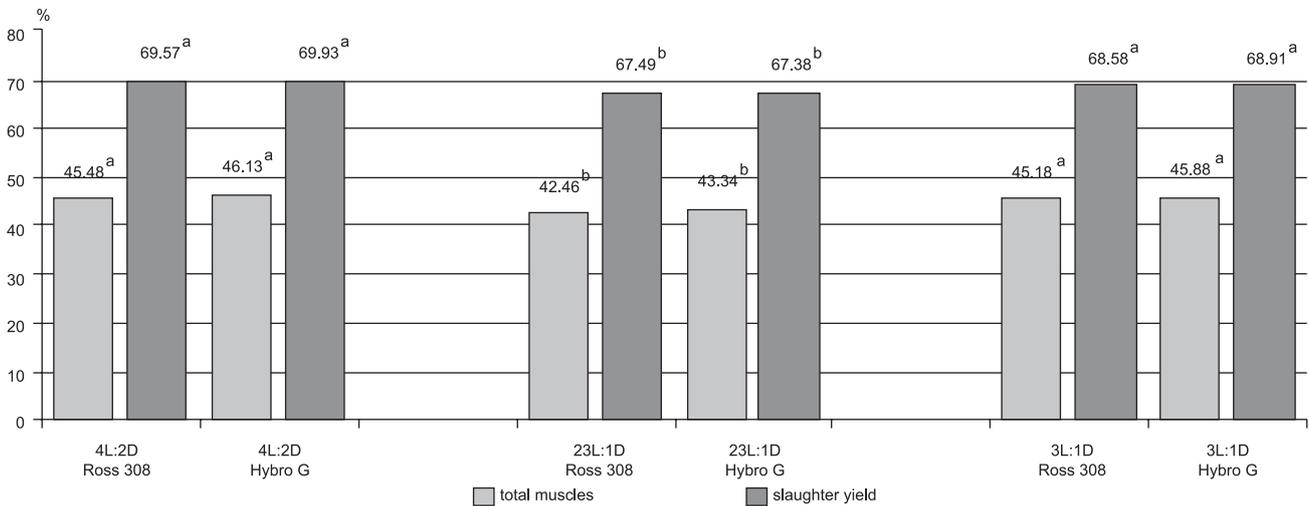


FIGURE 1. Slaughter yield in % and percentage total muscle yield in the carcass with neck in Ross 308 and Hybro G broilers grown under various light programmes.

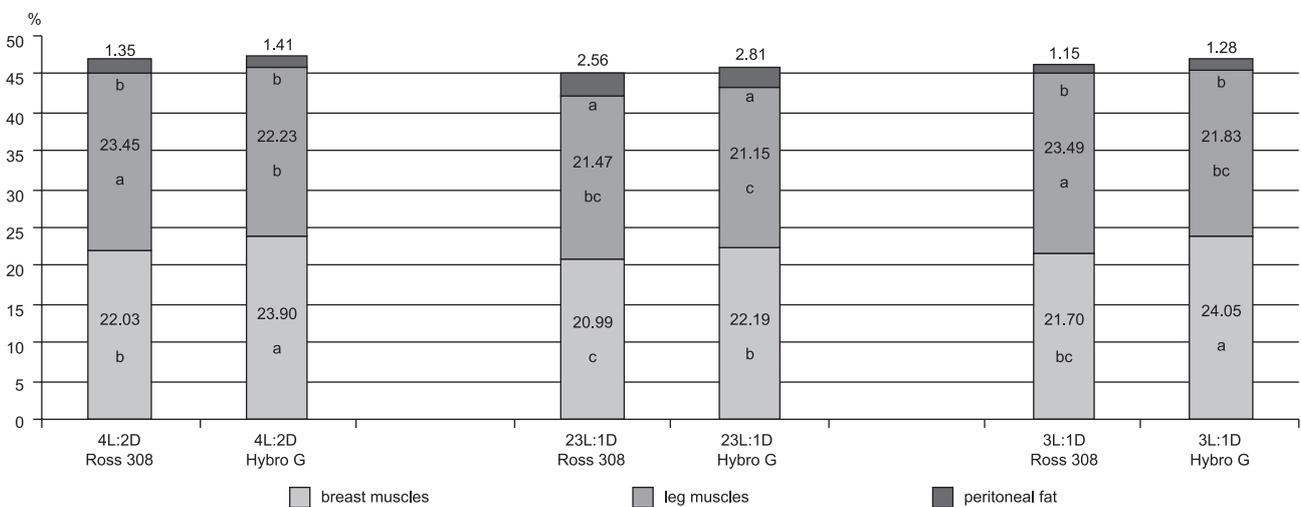


FIGURE 2. Percentage yield of breast muscles, leg muscles and peritoneal fat tissue in the carcass with neck in Ross 308 and Hybro G broilers grown under various light programmes.

TABLE 1. Physicochemical traits of breast muscles in broilers.

Trait	4 L: 2 D		23 L: 1 D		3 L: 1 D	
	Ross 308	Hybro G	Ross 308	Hybro G	Ross 308	Hybro G
pH ₁₅	6.04 ^c	6.07 ^c	6.26 ^a	6.21 ^{ab}	6.12 ^{bc}	6.16 ^{ab}
pH ₂₄	5.86 ^c	5.94 ^{bc}	6.17 ^a	6.13 ^a	6.00 ^{ab}	6.04 ^{ab}
WHC (mg%)	32.18 ^b	29.36 ^c	34.67 ^a	32.45 ^b	32.67 ^b	30.19 ^c
Protein (%)	22.16	22.66	22.41	22.45	22.52	22.34
Fat (%)	1.82 ^b	1.87 ^b	2.35 ^a	2.39 ^a	1.87 ^b	1.90 ^{ab}
Water (%)	71.38	71.33	72.77	72.94	71.31	71.41
Ash (%)	2.77	2.88	2.71	2.80	2.67	2.60

^{ab} - different superscripts in the row denote statistically significant difference at $p \leq 0.05$

TABLE 2. Physicochemical traits of leg muscles in broilers.

Trait	4 L: 2 D		23 L: 1 D		3 L: 1 D	
	Ross 308	Hybro G	Ross 308	Hybro G	Ross 308	Hybro G
pH ₁₅	6.29 ^b	6.30 ^b	6.49 ^a	6.47 ^a	6.35 ^b	6.30 ^b
pH ₂₄	6.13 ^c	6.19 ^{bc}	6.27 ^{ab}	6.31 ^a	6.17 ^{bc}	6.22 ^{ab}
WHC (mg%)	34.23 ^b	34.61 ^b	36.48 ^a	36.74 ^a	33.95 ^b	34.00 ^b
Protein (%)	18.91	19.05	18.52	18.83	18.87	18.98
Fat (%)	6.99 ^b	7.20 ^b	8.01 ^a	8.02 ^a	7.17 ^b	7.27 ^b
Water (%)	72.40	72.13	71.65	71.46	72.37	72.01
Ash (%)	1.71	1.62	1.69	1.70	1.60	1.75

^{ab} - different superscripts in the row denote statistically significant difference at $p \leq 0.05$

ed that the course of glycolysis in the muscles occurred in those birds at a faster rate. The higher pH₁₅ level in broilers grown under continuous light programme (23L:1D) demonstrated a higher glycogen content in the muscles. That can be explained by a lower influence of stress in those birds during growing time due to an extended time after switching on light. Sante [1997] reported that glycolysis rate affects the quality of poultry meat. A rapid initiation and completion of *rigor mortis* in the breast muscles results in the occurrence of the typical status of PSE meat, which is watery, pale and soft and demonstrates low water holding capacity.

Over 24 h from slaughter, the concentration of hydrogen ions in the muscles of birds grown under intermittent light decreased at a higher rate than in the other examined groups of broilers. In the breast muscles of birds kept under continuous light programme the pH value was lower by 0.08 units on average during 24 h, whereas in those grown under intermittent light those values decreased by 0.12 to 0.18 units. The observed rate of pH changes confirms the previously expressed supposition about the lower glycogen content in the muscles of broilers subjected to the intermittent light programme during growing period. The noted differences were statistically significant at $p \leq 0.05$ but only in the case of the intermittent light programme 4L: 2D.

The results of the determination of water holding capacity in the breast and leg muscles revealed that those values were also dependent upon the applied light programme as in the case of muscle pH level.

Higher water holding capacity values were noted in the muscles of birds kept under continuous light programme, *i.e.* they amounted to 34.67 mg% in Ross 308 and to 32.42 mg% in Hybro G broilers. Połtowicz [2000] in her study reported differences in the water holding capacity of breast muscles and in the glycolysis rate after slaughter which were similar to those in our experiments. On the other hand, the WHC values in our study were by *ca.* 2 mg% lower, regardless of the genotype of birds grown under intermittent light programme. Similar differences in the values of water holding capacity as affected by the used light programme were also observed in broiler leg muscles. Those differences were found to be statistically significant at $p \leq 0.05$ both in the breast and leg muscles. The muscles of birds grown under intermittent light programme demonstrated better water holding capacity, *i.e.* water binding ability. According to Kortz [2001], that is one of the most important traits of meat proteins in the raw material used in the manufacture of further processed meat products.

Among the analysed chemical constituents of broiler muscles (Table 1 and 2) only in the fat content significant differences at $p \leq 0.05$ were noted. In the muscles of birds grown under continuous light programme a higher by 0.50% fat content in Ross 308 and Hybro G breast muscles and by 0.93% in Ross 308 and by 0.79% in Hybro G leg muscles was determined.

The results of the sensory analysis of raw muscles (Figure 3 and 4) ranged from 4.02 to 4.50 in breast muscles and from 3.89 to 4.34 in the leg muscles. In both examined commer-

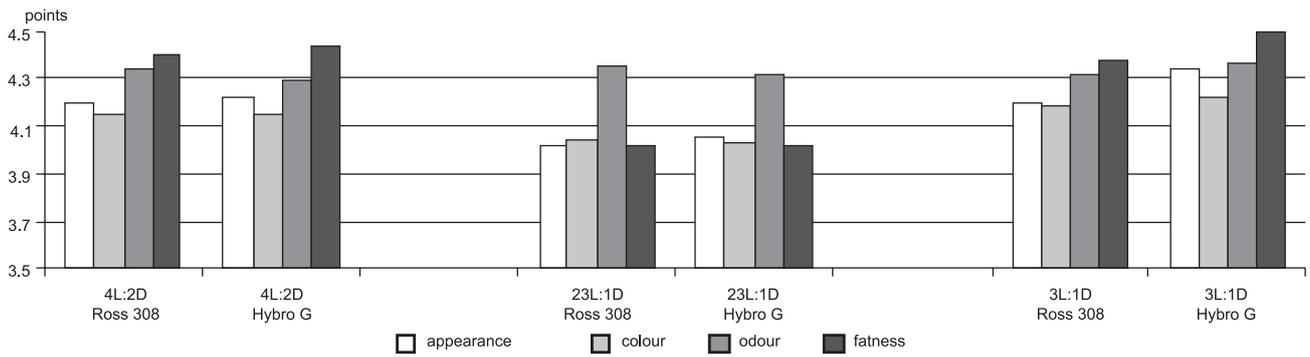


FIGURE 3. Results of the sensory evaluation of raw breast muscles tissue in broilers.

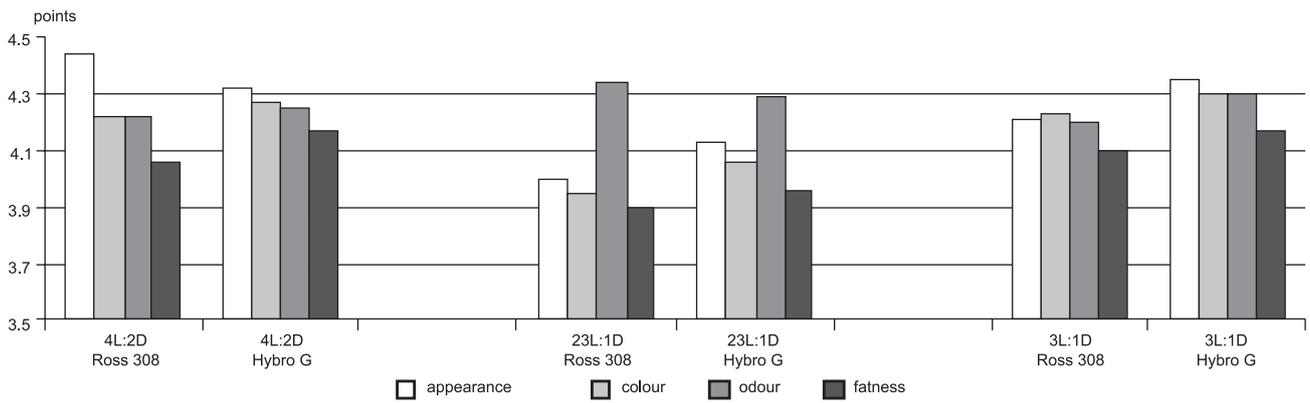


FIGURE 4. Results of the sensory evaluation of raw leg muscles in broilers.

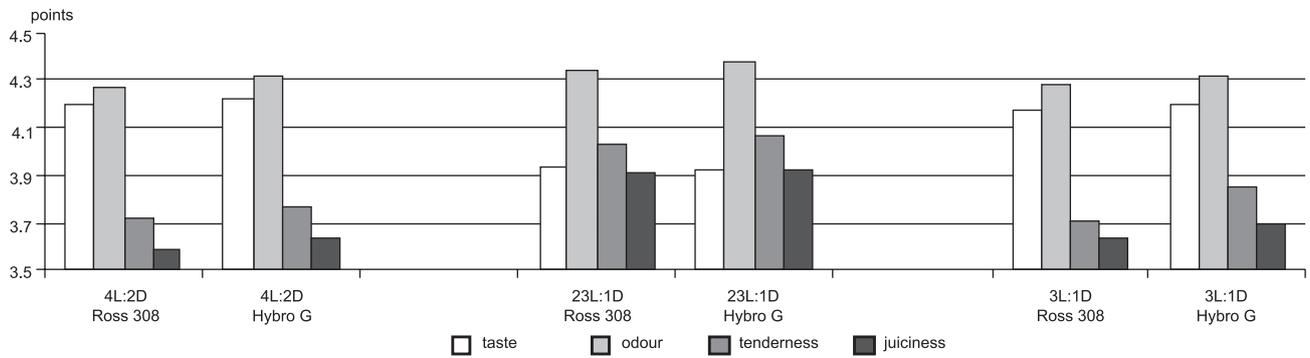


FIGURE 5. Results of the evaluation of cooked breast muscles in broilers.

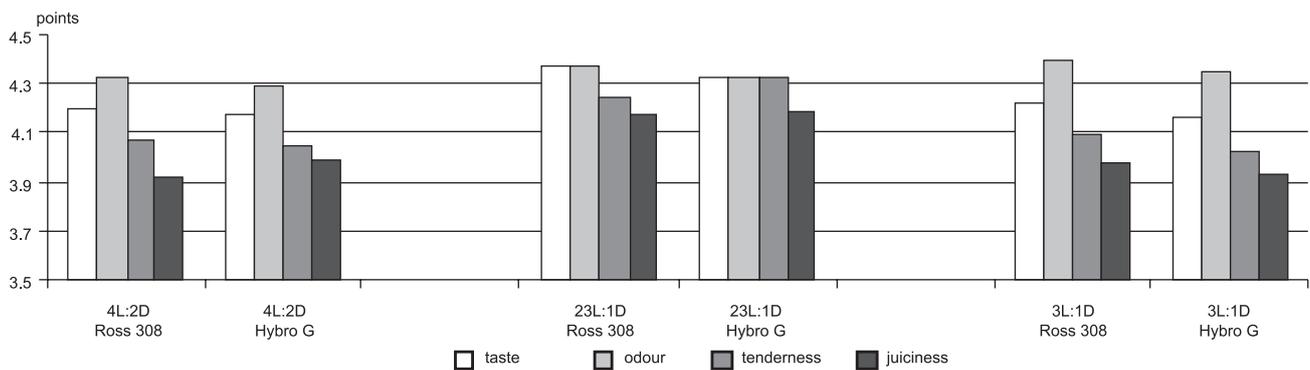


FIGURE 6. Results of the sensory evaluation of cooked leg muscles in broilers.

cial strains of broilers the sensory scores specified above were similar whereas slightly higher ones were given for muscles of broilers kept under intermittent light programme. Muscle tissue colour was the only sensory trait which obtained scores on the same or higher level in birds grown under continuous light programme.

The results of sensory evaluation of the cooked muscle samples were found different (Figure 5 and 6). The scores for taste, odour, tenderness and juiciness in the groups of broilers kept under continuous light programme 23L: 1D were slightly higher than in the two other groups. The differences were around 0.27 point for taste; 0.07 for odour; 0.31 for tenderness and 0.27 for juiciness.

The observed differences in the scores for the organoleptic traits in the raw and cooked muscles were statistically non significant at $p \leq 0.05$ and at a similar level in the breast and leg muscles regardless of the examined commercial broiler strain.

Correlations calculated between the used light programmes and the carcass traits: slaughter weight, the yield of breast and leg muscles, and peritoneal fat tissue; pH_{15} and pH_{24} value; water holding capacity and intramuscular fat content ranged from 0.389 to 0.428 and were found statistically significant.

CONCLUSIONS

The results of study indicated that the intermittent light programme 4L:2D or 3L:1D used in growing broiler chickens significantly affected the following traits in the examined strains of broilers: increased slaughter yield by *ca.* 2.0%; higher yield of breast muscles by about 1.29%; of leg muscles by about 1.44% and lower amount of peritoneal fat tissue in the carcass by about 1.39%.

The applied light system also improved the physicochemical characteristics of meat, *i.e.* pH_{15} , pH_{24} and water holding capacity and decreased the intramuscular fat content. The kind of light programme affected the quality traits of carcass and meat both in Ross 308 and Hybro G strains of broiler chicken.

The observed differences in the quality and physicochemical traits of meat were dependent upon the studied light programmes and thus important for the further processing of poultry meat as well as from the point of view of consumer requirements.

REFERENCES

1. Barbut S., Problem of pale soft exudative meat in broiler chickens. *Brit. Poultry Sci.*, 1997, 38, 355-358.
2. Herbut E., Wężyk S., Pro-ecological and energy-saving management system of broiler chickens. 2000, *in: Proc. Polish-German Conf., Animal and environment friendly management of pigs and poultry*, Balice, Poland, 2000, pp. 71-79 (in Polish).
3. Kortz J., Evaluation of post-slaughter raw materials. 2001, Wydawnictwo AR, Szczecin, pp. 135-145 (in Polish).
4. Moran E., Quality of poultry meat as affected by genetic and management factors. 1997, *in: Proc. XIII European Symposium, Poultry meat quality*, Poznań, Poland, 1997, pp. 31-36.
5. PN-75/A-04018/Az3: 2002, 1975. Agricultural food products – Determination of nitrogen by the Kjeldahl method and expressing as protein (in Polish).
6. PN-ISO 936:2000. Meat and meat products – Determination of total ash (in Polish).
7. PN-ISO 1442:2000. Meat and meat products – Determination of moisture content. Reference method (in Polish).
8. PN-ISO 1444:2000. Determination of free fat content (in Polish).
9. Połtowicz K., Effect of initial pH value in breast muscles on selected quality traits in broiler chickens of three genotypes. *Rocz. Nauk. Zoot., Supl.*, 2000, 8, 161-165 (in Polish).
10. Renden J.A., Bilgili S.F., Kinacid S.A., Comparison of restricted and increasing light programs for male broiler performance and carcass yield. *Poultry Sci.*, 1993, 72, 378-382.
11. Richardson R.I., Some factors affecting poultry meat quality. 2004, *in: Proc. Intern. Conference, Pig and poultry meat quality – genetic and non-genetic factors*, British Society of Animal Science, Kraków, Poland, 2004, pp. 22-25.
12. Ristic M., Influence of age and sex on carcass value and meat quality in broilers. *Fleischwirtsch.*, 1991, 71, 443-446.
13. Sante V.S., Symptoms and causes of muscular abnormalities in poultry. P1997, *in: Proc. XIII WPSA European Symposium, Poultry meat quality*, Poznań, Poland, 1997, pp. 292-297.
14. Szałkowska H., Meller Z., The influence of age and genotype on the quality and technological suitability of meat from chicken broilers. 1997, *in: Proc. XIII WPSA European Symposium, Poultry meat quality*, Poznań, Poland, 1997, pp. 108-111.
15. Świerczewska E., Niemiec J., Mroczek J., Siennicka A., Grzybowska A., Grochalska D., Performance traits, composition of carcass and chemical composition of meat as affected by feeding broiler chickens on diets of various protein content. *Zeszyty Naukowe PTZ*, 2000, 49, 365-375 (in Polish).
16. Wężyk S., Polish poultry in the European Union and that from the E.U. in Poland. 1999, *in: Materials of the Agricultural Forum, Advances in animal breeding and production*, Kraków, Poland, 1999, pp. 4-13 (in Polish).
17. Woelfel R.L., Owens C.M., Hirschler E.M., Martinez-Dawson R., Sams A.R., The characterization and incidence of pale, soft and exudative broiler meat in a commercial processing plant. *Poultry Sc.*, 2002, 81, 579-584.
18. Ziolecki J., Guidelines on the sensory examination of poultry carcasses. COBRD.1988, 1-22 (in Polish).
19. Ziolecki J., Doruchowski W., Method of slaughter value evaluation in poultry. COBRD, 1989, 1-32 (in Polish).

WPLYW PROGRAMU ŚWIETLNEGO ORAZ POCHODZENIA KURCZĄT BROJLERÓW NA JAKOŚĆ TUSZKI I MIĘSA

Ewa Gornowicz, Lidia Lewko

Instytut Zootechniki – Państwowy Instytut Badawczy, Dział Ochrony Zasobów Genetycznych Zwierząt, Zakrzewo

Celem pracy było określenie wpływu rodzaju programu świetlnego na wydajność rzeźną, dysekcijną oraz na fizykochemiczne, organoleptyczne cechy jakości mięśni piersiowych i nóg, porównawczo dla dwóch mieszańców towarowych kur mięsnych Ross 308 i Hybro G.

Wyniki przeprowadzonego doświadczenia, pozwalają stwierdzić, że stosowanie przerywanego programu świetlnego (4S:2C) lub (3S:1C) w odchowie kurcząt brojlerów w sposób istotny $p \leq 0,05$ wpłynęło na następujące cechy jakości tuszek: zwiększenie wydajności rzeźnej (o ok. 2,0%), wzrost zawartości mięśni piersiowych (o ok. 1,29%) i nóg (o ok. 1,44%) w tuszce, zmniejszenie ilości tłuszczu sadelkowego (o ok. 1,39%).

Ten system oświetlenia także poprawił kształtowanie się cech fizycznych mięsa (pH_{15} , pH_{24} , wodochłonność) oraz wpłynął na obniżenie zawartości tłuszczu śródmięśniowego. Spośród analizowanych cech chemicznych mięśni istotnie $p < 0,05$ różna była tylko zawartość tłuszczu.

Stwierdzone różnice w wartościach wyróżników ocen organoleptycznych mięśni w stanie surowym oraz po obróbce termicznej nie były istotne $p \leq 0,05$. Kształtowały się podobnie zarówno dla mięśni piersiowych, jak i mięśni nóg.

Rodzaj stosowanego programu świetlnego wpływał na kształtowanie się cech jakości tuszek i mięsa, w takim samym stopniu dla kurcząt brojlerów Ross 308, jak i Hybro G.