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Changes of Poultry Meat Chemical Composition, in Relationship with Lighting Schedule

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Abstract**—**The paper is included within the framework of a complex research program, which was initiated from the hypothesis arguing on the existence of a correlation between pineal indolic and peptide hormones and the somatic development rhythm, including thus the epithalamium-epiphysis complex involvement. At birds, pineal gland contains a circadian oscillator, playing a main role in the temporal organization of the cerebral functions. The secretion of pineal indolic hormones is characterized by a high endogenous rhythmic alternation, modulated by the light/darkness (L/D) succession and by temperature as well. The research has been carried out using 100 chicken broilers - "Ross" commercial hybrid, randomly allocated in two experimental batches: L_c batch, reared under a 12L/12D lighting schedule and L_{exp} batch, which was photic pinealectomised through continuous exposition to light (150 lux, 24 hours, 56 days). Chemical and physical features of the meat issued from breast fillet and thighs muscles have been studied, determining the dry matter, proteins, fat, collagen, salt content and pH value, as well. Besides the variations of meat chemical composition in relation with lighting schedule, other parameters have been studied: live weight dynamics, feed intake and somatic development degree. The achieved results became significant since chickens have 7 days of age, some variations of the studied parameters being registered, revealing that the pineal gland physiologic activity, in relation with the lighting schedule, could be interpreted through the monitoring of the somatic development technological parameters, usually studied within the chicken broilers rearing aviculture practice.

Keywords**—**lighting schedule, physic-chemical characteristics of meat, pineal gland at birds.

I. Introduction

SEVERAL experimental trials revealed the main structural, metabolic and functional unbalances given by the surgical ablation of the pineal gland in certain laboratory animal species [1, 7]. The consequences of the photic pinealectomy have been poorer investigated in poultry, as compared to those generated by the surgical pinealectomy [4, 5].

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The maintenance of the poultry population within continuous light conditions, starting just from hatching [2, 3] induces the functional inhibition of the pineal gland [6]. During the research, that team carried out, the photic pinealectomy effects have been debated considering the variable values of the studied parameters.

II. Material and Method

The research had been carried out using 100 "Ross" chicken broilers, randomly allocated in two experimental batches:

- L_c batch - 12L/12D lighting schedule;
- L_{exp} batch – pinealectomized chickens through continuous photic exposition (24L schedule).

Several parameters have been assessed during our research: body weight dynamics, meat quality and qualitative production.

Weight gain dynamics has been established through individual weightings, weekly run on each batch, starting from the first experimental day, each morning and prior to feeding.

Meat quality and qualitative production have been assessed on 56 days old chickens, several indexes being calculated: slaughtering efficiency, internal organs weight, trenching parts participation in the whole carcass.

The physic-chemical features of the meat have been measured using a Food–Check analyzer, result several data concerning the contents of dry matter, water, proteins, and lipids, minerals in meat and pH value as well.

III. Results and Discussions

The achieved results (table I) revealed that the average weight during the first day of life had values of 40.87±0.33 g at control batch (L_c) and 41.6±0.32 g at the experimental batch (L_{exp}), not statistical significance being observed for the 0.73 g difference. Starting from the 7th day, certain differences occurred between the average body weight of the chickens in the studied batches, the experimental one being in advantage; thus, the measured values reached 114.74±0.77 g at the control batch and 122.26±0.9 g at the pinealectomized chickens. Live weights at 28 days of age were of 652.83±2.77 g at control batch of chickens (L_c) and 753.36±1.85 g at the photic pinealectomized chickens (L_{exp}), the differences occurred between averages being highly significant. The average body weight at 56 days reached 1756±18.01 g at control batch, as compared to 1954±8.32 g at experimental batch, meaning a highly statistic significant difference. The average daily gain, as body weight dynamics index, has been

calculated for each age period. Thus, during the first week of life, it reached 10.55 g/chicken/day at the control batch and 11.52 g/chicken/day at the experimental one. During the next period (8-28 days), chickens from control batch proved an average gain of 25.62 g/chicken/day, as compared to 30.05 g/chicken/day, value calculated for the pinealectomized batch.

Between 29 and 56 days, the daily average gain was calculated at 39.4 g/chicken/day (batch L_c), respectively at 42.88 g/chicken/day (L_{exp}).

TABLE I
BODY WEIGHT DYNAMICS AND STATISTIC SIGNIFICANCE

Age	Batch	$\bar{X} \pm s_{\bar{X}}$ (g)	s	V%	Statistic significance
1 day	L_c	40.87±0.334	1.670	4.08	L_c vs L_{exp} - $\hat{F}$ = 2,57 < F5%(1.48) = 4,04 n.s
	L_{exp}	41.6±0.319	1.594	3.83	
7 days	L_c	114.74±0.768	3.840	3.34	L_c vs L_{exp} - $\hat{F}$ = 40.4 > F0.1% = 12.60 ***
	L_{exp}	122.26±0.900	4.503	3.68	
14 days	L_c	253.1±2.087	0.436	4.12	L_c vs L_{exp} - $\hat{F}$ = 59.5 > F0.1% = 12.60 ***
	L_{exp}	273.37±1.595	7.977	2.92	
21 days	L_c	424.69±1.728	8.469	1.99	L_c vs L_{exp} - $\hat{F}$ = 60.2 > F0.1% = 12.60 ***
	L_{exp}	487.77±2.865	14.326	2.93	
28 days	L_c	652.83±2.775	13.598	2.08	L_c vs L_{exp} - $\hat{F}$ = 90.1 > F0.1% = 12.60 ***
	L_{exp}	753.36±1.854	9.273	1.23	
35 days	L_c	905.0±1.825	8.944	0.98	L_c vs L_{exp} - $\hat{F}$ = 107.5 < F0.1% = 12.60 ***
	L_{exp}	1032.0±1.992	9.962	0.96	
42 days	L_c	1173.0±9.461	46.351	3.95	L_c vs L_{exp} - $\hat{F}$ =115.9 > F0.1% = 12.60 ***
	L_{exp}	1320.0±9.820	49.101	3.72	
49 days	L_c	1457.54±12.324	60.379	4.14	L_c vs L_{exp} - $\hat{F}$ = 151.5 > F0.1% = 12.60 ***
	L_{exp}	1630.92±7.107	35.538	2.17	
56 days	L_c	1756.0±18.011	88.235	5.02	L_c vs L_{exp} - $\hat{F}$ = 102.26 > F0.1% = 12.60 ***
	L_{exp}	1954.0±8.324	41.621	2.13	

The overall analysis of the structural alterations related to muscles fibres structure reveals the influence of the epiphysis physiological ablation on the metabolism. Therefore they turned toward anabolism and led to structural changes of the analyzed elements.

The assessments dealt with the calculation of the slaughtering efficiency, with participation of the trenched parts in the whole carcass, the weight of internal organs and the main sensorial, physical and chemical features of the meat. Slaughtering efficiency was higher at chickens from L_{exp} batch, compared to those in L_c batch, either as whole batch and either between genders. Thus, in control batch, the average value of the slaughtering efficiency reached 71.1±0.04% (71.2±0.07% at males and 71.0±0.02% at females) respectively 72.1±0.1% at L_{exp} batch (72.3±0.1% at males and 72.1±0.12% at females) (table II).

TABLE II
SLAUGHTERING EFFICIENCY AND THE SIGNIFICANCE OF DIFFERENCES

Studied parameter	Gender	Nr.	Batch	Statistical indexes			
				$\bar{X} \pm s_{\bar{X}}$	s	V%	Stat. sign
Live weight prior to slaughter (g)	M	5	L_c	1860.2±12.1	27.2	1.4	L_c vs $L_{exp:}$ $\hat{F}$ = 76,6 > F0,1% = 25,4 ***
			L_{exp}	2015.6±2.1	4.6	0.2	
	F	5	L_c	1694.8±28.5	63.8	3.7	
			L_{exp}	1968.2±12.6	28.3	1.4	
	M+F	10	L_c	1777.5±31.2	98.6	5.5	L_c vs $L_{exp:}$ $\hat{F}$ = 42,4 > F0,1% = 15,4 ***
			L_{exp}	1991.9±9.9	31.5	1.6	
Carcass + internal organs weight (g)	M	5	L_c	1324.6±8.4	18.8	1.4	L_c vs $L_{exp:}$ $\hat{F}$ = 239,9 > F0,1% = 25,4 ***
			L_{exp}	1457.0±1.4	3.2	0.2	
	F	5	L_c	1204.0±20.2	44.7	3.7	L_c vs $L_{exp:}$ $\hat{F}$ = 91,5 > F0,1% = 25,4 ***
			L_{exp}	1416.4±9.5	21.4	1.5	
	M+F	10	L_c	1264.3±22.6	71.3	5.6	L_c vs $L_{exp:}$ $\hat{F}$ = 51,6 > F0,1% = 15,4 ***
			L_{exp}	1436.7±8.2	25.8	1.8	
Slaughter efficiency (%)	M	5	L_c	71.2±0.07	0.1	0.2	L_c vs $L_{exp:}$ $\hat{F}$ = 242,0 > F0,1% = 25,4 ***
			L_{exp}	72.3	0	0	
	F	5	L_c	71.0±0.02	0.05	0.07	L_c vs

			L_{exp}	72.1±0.12	0.4	0.5	L_{exp}: $\hat{F}$ = 18,3 > F0,1% = 11,5 ***
			L_c	71.1±0.04	0.1	0.2	L_c vs L_{exp}:
	M+F	10	L_{exp}	72.1±0.1	0.4	0.5	$\hat{F}$ = 66,8 > F0,1% = 15,4 ***

The statistical comparisons, concerning the weight of internal organs (table III), revealed the occurrence of the highly significant differences between batches, for all possible combinations. Very well uniformity was noticed in almost all studied characters, excepting for the gizzard weight at males from L_c batch, whose variation coefficient was calculated toward middle range (V = 10.9%).

TABLE III
THE WEIGHT OF INTERNAL ORGANS AND THE STATISTIC SIGNIFICANCE BETWEEN AVERAGES

Studied parameter	Gender	Nr	Batch	Statistical indexes $\overline{X} \pm s_{\overline{X}}$	s	V%	Stat sign
Heart weight (g)	M	5	L_c	10.2±0.06	0.1	1.5	L_c vs L_{exp}: $\hat{F}$ = 120.9 > F0.1% = 25.4 ***
			L_{exp}	10.9±0.05	0.1	1.0	
	F	5	L_c	9.2±0.1	0.3	3.5	L_c vs L_{exp}: $\hat{F}$ = 85.9 > F0.1% = 25.4 ***
			L_{exp}	10.6±0.1	0.1	1.6	
	M+F	10	L_c	9.6±0.2	0.5	5.3	L_c vs L_{exp}: $\hat{F}$ = 48.6> F0.1% = 15.4 ***
			L_{exp}	10.8±0.1	0.2	1.8	
Lung weight (g)	M	5	L_c	13.9±0.1	0.1	0.7	L_c vs L_{exp}: $\hat{F}$ = 128.5 > F0.1% = 25.4 ***
			L_{exp}	15.1±0.1	0.2	1.5	
	F	5	L_c	12.7±0.2	0.2	1.3	L_c vs L_{exp}: $\hat{F}$ = 76.2 > F0.1% = 25.4 ***
			L_{exp}	14.7±0.1	0.5	3.8	
	M+F	10	L_c	13.3±0.2	0.3	1.8	L_c vs L_{exp}: $\hat{F}$ = 41.2 > F0.1% = 15.4 ***
			L_{exp}	14.9±0.08	0.7	5.6	
Liver weight (g)	M	5	L_c	46.5±0.3	0.6	1.4	L_c vs L_{exp}: $\hat{F}$ = 166.4 > F0.1% = 25.4 ***
			L_{exp}	50.6±0.1	0.3	0.5	
	F	5	L_c	42.4±0.7	1.6	3.8	L_c vs L_{exp}: $\hat{F}$ = 76.85 > F0.1% = 25.4 ***
			L_{exp}	49.2±0.3	0.7	1.4	
	M+F	10	L_c	44.4±0.8	2.5	5.5	L_c vs L_{exp}: $\hat{F}$ = 43.5 > F0.1% = 15.4 ***
			L_{exp}	49.9±0.3	0.9	1.8	
Gizzard weight (g)	M	5	L_c	37.3±1.8	4.0	10.9	L_c vs L_{exp}: $\hat{F}$ = 38.3 > F0.1% = 25.4 ***
			L_{exp}	48.6±0.1	0.2	0.5	
	F	5	L_c	32.8±1.0	2.3	6.9	L_c vs L_{exp}: $\hat{F}$ = 192.9 > F0.1% = 25.4 ***
			L_{exp}	47.1±0.2	0.5	1.1	
	M+F	10	L_c	35.0±1.2	3.9	11.2	L_c vs L_{exp}: $\hat{F}$ = 102.5 > F0.1% = 15.4 ***
			L_{exp}	47.9±0.2	0.9	1.8	

The physic-chemical analyses (table IV) run onto samples (10 g each) gathered from the chickens of both genders from control batch (L_c) revealed a water content of 6.82±0.049 g in breast muscles and 6.94±0.048 g in thigh muscles, while proteins content reached 2.02±0.031 g within pectoral muscles and 2.19±0.034 g in thigh muscles. The most obvious differences were observed for the lipids content, meaning values of 1.03±0.016 g in pectoral muscles and just 0.75±0.011 g in thighs muscles, the values being in accordance with the scientific references. Minerals content was slightly similar between the studied muscles, reaching 0.11±0.001 g within the breast muscles and 0.11±0.002 g within the thighs ones. The assessments carried on the samples issued from the experimental batch gave close results to the former ones.

Thus, water content reached 6.78±0.051 g within pectoral muscles and 6.84±0.048 g within thigh ones, while the protein levels were measured at 2.09±0.032 g in the pectoral muscles and 2.20±0.050 g in the thighs musculature.

TABLE IV
PHYSICAL AND CHEMICAL FEATURES OF THE MEAT AND STATISTIC SIGNIFICANCE BETWEEN AVERAGES
Sample weight = 10 g

Note		Sex	Batch	Nr.	$\overline{X} \pm s_{\overline{X}}$	s	V%	Statistic significance
WATER (g)	Breast muscles	M	L_c	5	6.82±0.074	0.166	2.44	L_c vs L_{exp}: $\hat{F}$= 0.14 < F5% = 5.320 n.s.
			L_{exp}	5	6.78±0.076	0.169	2.49	
		F	L_c	5	6.83±0.072	0.162	2.37	L_c vs L_{exp}: $\hat{F}$= 0.15 < F5% = 5.320 n.s.
			L_{exp}	5	6.79±0.078	0.175	2.57	
	Thigh muscles	M	L_c	5	6.93±0.071	0.159	2.30	L_c vs L_{exp}: $\hat{F}$= 0.85 < F5% = 5.320 n.s.
			L_{exp}	5	6.84±0.073	0.163	2.39	
		F	L_c	5	6.94±0.072	0.161	2.32	L_c vs L_{exp}: $\hat{F}$= 0.97 < F5% = 5.320 n.s.
			L_{exp}	5	6.84±0.071	0.159	2.33	
PROTEINS (g)	Breast muscles	M	L_c	5	2.03±0.047	0.105	5.16	L_c vs L_{exp}: $\hat{F}$= 0.84 < F5% = 5.320 n.s.
			L_{exp}	5	2.09±0.048	0.108	5.19	
		F	L_c	5	2.02±0.047	0.105	5.19	L_c vs L_{exp}: $\hat{F}$= 0.84 < F5% = 5.320 n.s.
			L_{exp}	5	2.08±0.049	0.109	5.26	
	Thigh muscles	M	L_c	5	2.20±0.050	0.113	5.14	L_c vs L_{exp}: $\hat{F}$= 0.02 < F5% = 5.320 n.s.
			L_{exp}	5	2.20±0.050	0.113	5.12	
		F	L_c	5	2.19±0.052	0.117	5.33	L_c vs L_{exp}: $\hat{F}$= 0.05 < F5% = 5.320 n.s.
			L_{exp}	5	2.20±0.050	0.113	5.14	
LIPIDS (g)	Breast muscles	M	L_c	5	1.03±0.025	0.056	5.48	L_c vs L_{exp}: $\hat{F}$= 0.21 < F5% = 5.320 n.s.
			L_{exp}	5	1.02±0.023	0.052	5.14	
		F	L_c	5	1.03±0.023	0.052	5.09	L_c vs L_{exp}: $\hat{F}$= 0.21 < F5% = 5.320 n.s.
			L_{exp}	5	1.01±0.025	0.057	5.65	
	Thigh muscles	M	L_c	5	0.75±0.017	0.038	5.01	L_c vs L_{exp}: $\hat{F}$= 3.77 < F5% = 5.320 n.s.
			L_{exp}	5	0.84±0.019	0.044	5.27	
		F	L_c	5	0.74±0.016	0.035	4.95	L_c vs L_{exp}: $\hat{F}$= 3.92 < F5% = 5.320 n.s.
			L_{exp}	5	0.83±0.018	0.040	4.83	
MINERALS (g)	Breast muscles	M	L_c	5	0.11±0.002	0.005	4.80	L_c vs L_{exp}: $\hat{F}$= 1.80 < F5% = 5.320 n.s.
			L_{exp}	5	0.10±0.003	0.008	7.75	
		F	L_c	5	0.11±0.002	0.005	4.80	L_c vs L_{exp}: $\hat{F}$= 1.80 < F5% = 5.320 n.s.
			L_{exp}	5	0.10±0.003	0.008	7.74	
	Thigh muscles	M	L_c	5	0.11±0.004	0.009	7.71	L_c vs L_{exp}: $\hat{F}$= 1.38 < F5% = 5.320 n.s.
			L_{exp}	5	0.11±0.003	0.007	6.43	
		F	L_c	5	0.11±0.004	0.008	7.71	L_c vs L_{exp}: $\hat{F}$= 1.38 < F5% = 5.320 n.s.
			L_{exp}	5	0.11±0.003	0.007	6.43	
pH	Breast muscles	M	L_c	5	7.10±0.025	0.057	0.80	L_c vs L_{exp}: $\hat{F}$= 0.31 < F5% = 5.320 n.s.
			L_{exp}	5	7.08±0.025	0.057	0.80	
		F	L_c	5	7.08±0.025	0.057	0.80	L_c vs L_{exp}: $\hat{F}$= 0.00 < F5% = 5.320 n.s.
			L_{exp}	5	7.08±0.025	0.057	0.80	
	Thigh muscles	M	L_c	5	7.14±0.025	0.057	0.79	L_c vs L_{exp}: $\hat{F}$= 0.31 < F5% = 5.320 n.s.
			L_{exp}	5	7.12±0.025	0.057	0.80	
		F	L_c	5	7.13±0.026	0.058	0.82	L_c vs L_{exp}: $\hat{F}$= 0.21 < F5% = 5.320 n.s.
			L_{exp}	5	7.12±0.023	0.052	0.74	

Lipids content was higher in pectoral muscles (1.01±0.016 g) as compared to the thighs ones (0.83±0.012 g), while minerals content proved to be almost identical (0.10±0.002 g in breast muscles and 0.11±0.002 g in thighs muscles).

The high influence of genetic determinism onto the meat chemical composition induced close values between both batches. Therefore, no statistical significance occurred.

The pH assessments run just after slaughtering, revealed higher acidity in pectoral muscles than in the thighs ones. Thus, the mean pH value in the breast samples reached 7.09±0.017 at control batch (L_c) and 7.08±0.017 at L_{exp} batch; within the thighs muscles, the measured values were of 7.14±0.017 pH at batch L_c and 7.12±0.016 at L_{exp} batch.

No significant statistical differences occurred between the means of the compared batches, while the variation coefficient values were calculated under the 10% limit.

IV. Conclusions

1. The average weight of the internal organs (heart, lungs, liver, gizzard) was higher at chickens belonging to experimental batch, as compared to those from control one, assessed either for the whole batch, either for each gender. These data could be explained through a higher intense metabolic activity at the photic pinealectomized chickens.
2. The comparisons of the physical and chemical meat features revealed that the values provided by the samples from both studied batches were close enough to prevent the occurrence of any statistical difference between the used lighting schedules, being meantime in accordance with the scientific references values:

67.5% water; 19.8% proteins; 11.5% lipids; 1.2% minerals.

3. The lighting schedule with continuous light exposure leaded to the intensification of the metabolic processes of anabolic kind, given by the activity of the epithalamiums-epiphysis complex, correlated with the pineal peptide hormones involvement.

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