RESEARCH ON THE INFLUENCE OF DENSITY ON THE WELFARE CONDITION AND PERFORMANCE OF CHICKEN BROILERS

C.D. Curea[1], R.M. Radu-Rusu[1], R.N. Rațu[1], A. Usturoi[1], M.G. Usturoi[1*]

[1]Iasi University of Live Sciences, Romania

Abstract

The research aimed at studying the productive response of the chicken broiler to European welfare standards and was carried out on a herd of 61.880 Ross-308 chickens divided into three batches of experience differentiated by the density applied to the popular: group Lm (19 heads/m^2 - minimum welfare conditions); Lexp-1 lot (17 heads/m^2 - average welfare conditions); Lexp-2 lot (16 heads/m^2- superior welfare conditions). The data obtained showed that puppies benefiting from higher welfare conditions (Lexp-2 group) had the highest body weight at slaughter (2.69% higher than those in the Lexp-1 group and 3,97% compared to those in the Lm group), the most convenient average daily consumption of compound feeds (5.77% lower than the chickens in the Lexp-1 group and 14.84% compared to the chickens in the Lm group) and feed conversion (8.77% lower than the Lexp-1 batch and 19.67% lower than the Lm batch), as well as the lowest mortality rate (0.19% lower than the Lexp-1 batch) and by 0.40% compared to Lm). The study concluded that the use of a population density of 16 head/m^2, corresponding to higher welfare conditions under measure 14, allows the achievement of superior product performance, materialized in a better growth rate, a lower mortality rate, and lower mortality rate feed consumption combined.

Key words: well-being, density, chicken broiler, growth, performance

INTRODUCTION

In the context of Romania's accession to the European Union, the set of regulations adopted by this intergovernmental organization was also reflected at the national level, influencing many areas of society, including animal husbandry.

At the European level, the concept of "animal welfare" has been adopted, which aims to respect the five fundamental freedoms in animal husbandry [4, 11].

Given the preference of European consumers for poultry meat, it was considered necessary to identify those technological factors that influence the quality of poultry products to ensure the food security of the population [1, 7].

From this point of view, the concept of bird welfare implies strict observance of standards regarding the density applied to the people and to ensure an optimal microclimate in shelters [3, 12].

In the case of chicken broilers, in addition to other factors that influence the productive level [2, 5, 6, 8, 10], the number of individuals introduced per unit area affects the concentration of pollutants in the halls, which have negative effects on the health of birds. The quality of the meat obtained [5, 9].

The aim of our study was to evaluate on a scientific basis the effects of the application of welfare rules on chicken broilers, in order to provide farmers with clear data on the opportunity to access the annual program financed by the European Agricultural Fund for Rural Development, namely, Measure 14 [13].

MATERIAL AND METHOD

The biological material used in this research was the commercial chicken-meat hybrid Ross-308.

The investigations were carried out on a total number of 61,880 Ross-308 chickens, divided into three groups, namely: group Lm

*Corresponding author: umg@uaiasi.ro
The manuscript was received: 15.10.2021
Accepted for publication: 21.03.2022

(22610 chap.), Group Lexp-1 (20230 chap.) and group Lexp-2 (19040 chap.).

The differentiation between the lots was ensured by the density practiced in the popular and which was correlated with the European norms regarding the welfare, respectively: 19 had/m^2 in the lot Lm (minimum welfare conditions); 17 had/m^2 for the Lexp-1 lot (average welfare conditions); 16 head / m^2 in the Lexp-2 lot (superior welfare conditions).

The breeding of the studied chicks was carried out in production conditions, according to the technology of maintenance on permanent bedding, the three lots being distributed in three equal halls as a usable area (1198 m^2) and with identical facilities.

The feeding of the chicks from the three groups of experience was done identically, with combined feeds obtained according to the specific recipes of this category of birds, respectively: Starter (administered within 1-14 days), Growth (period 14-21 days) and Finishing (during 21-35 days).

The analysis of the productive performances of the studied puppies was made through the prism of specific indicators of this type of activity, calculated in accordance with the methodology agreed in the poultry research:

- the bodyweight of the chicks in the control groups was weighed individually (in the morning, before the feeding) at the age of one day and then every 7 days, the last weighing being performed on the 35th day of life;
- weight gain was calculated by weeks of life and total period, as a ratio between the difference in weight of the chicks at the end of the period and that at the beginning of the period and the number of days of the period;
- daily herds-mortality was cumulated for each week of the chicks' life and was reported to the initial herd of the week in question;
- the causes of the departures from the herd were established by anatomopathological examination, the cases being related to the number of deaths in the respective week;
- feed consumption - was calculated for each of the three periods of administration of the combined feed, as well as for the total period, establishing: total consumption (kg nc / batch / period), individual consumption (g nc/head/period) and average daily consumption (g nc/head/day);
- the food conversion index was calculated as the ratio between individual food consumption and individual weight gain (kg n.c./kg increase).

RESULTS AND DISCUSSIONS

Bodyweight dynamics. At the time of breeding population, the weight of the chicks in the three groups was substantially equal, with limits between 40.13 ± 0.20 g as in those in the Lexp-1 group and 40.21 ± 0.21 g in those from the lot Lm.

The first differences between the groups were found right from the 7th day of the chicks' life, when their weight was 174.39±1.23 g for those in the Lexp-2 group (superior welfare conditions), of 172.84±2.23g in the Lexp-1 group (average welfare conditions) and only 170.33±3.06 g in the Lm group (minimum welfare conditions).

These differences between batches were maintained at the following control stages so that at the end of the production cycle (35 days old chicks), the recorded body weights were 1994.42±27.90 g in the Lexp-2 batch (density of 16 heads/m^2), compared to 1940.66±39.17 g as it was for the chicks in the Lexp-1 group (17 heads/m^2) and especially of 1915.08±52.22 g as was the weight of the chicks from group Lm (19 head/m^2).

The density provided to the population also influenced the variability of the bodyweight of the individuals in the composition of the experience groups, starting with the 7th day of life.

Thus, the values of the coefficient of variation calculated for the chicks from the Lm group (V=12.69-19.28%) indicated a medium to high variability, those for the chicks from the Lexp-1 group (V=9.11-14.27%) showed a small to medium variability, while in the Lexp-2 group the values of the coefficient of variation (V = 4.97-9.89%) showed a much better homogeneity at the group level (tab. 1).

Table 1 Bodyweight dynamics of the studied chicken

The age of the chicks (days)	Statistical estimators	Bodyweight (N=50)		
		Lm	Lexp-1	Lexp-2
1	$\bar{X} \pm s_{\bar{x}}$ (g)	40.21±0.21	40.13±0.20	40.20±0.21
	V%	3.74	3.51	3.65
	Minimum (g)	39.45	39.58	39.52
	Maximum (g)	41.02	40.95	40.99
7	$\bar{X} \pm s_{\bar{x}}$ (g)	170.33±3.06	172.84±2.23	174.39±1.23
	V%	12.69	9.11	4.97
	Minimum (g)	157.6	160.2	168.9
	Maximum (g)	185.9	189.6	200.3
14	$\bar{X} \pm s_{\bar{x}}$ (g)	456.68±9.33	470.79±6.33	482.54±3.47
	V%	14.44	9.51	5.08
	Minimum (g)	414.4	425.9	458.7
	Maximum (g)	488.6	493.1	514.6
21	$\bar{X} \pm s_{\bar{x}}$ (g)	874.56±20.27	890.78±12.62	910.87±6.92
	V%	16.39	10.02	5.37
	Minimum (g)	836.2	845.8	903.3
	Maximum (g)	910.5	921.3	1000.4
28	$\bar{X} \pm s_{\bar{x}}$ (g)	1410.48±34.64	1430.60±24.22	1480.43±13.00
	V%	17.36	11.97	6.21
	Minimum (g)	1311.1	1340.9	1399.5
	Maximum (g)	1620.7	1682.5	1700.2
35	$\bar{X} \pm s_{\bar{x}}$ (g)	1915.08±52.22	1940.66±39.17	1994.42±27.90
	V%	19.28	14.27	9.89
	Minimum (g)	1605.5	1708.6	1954.9
	Maximum (g)	1980.8	2000.6	2220.3

Weight gain. Naturally, the best average weight gain of 55.83 g / head / day was in chickens in the Lexp-2 group (superior welfare conditions); the limits for this indicator were between 19.17 g / head / day as it was achieved in the period 1-7 days and 78.14 g / head / day in the period 28-35 days.

The chickens from the Lexp-1 group (average welfare conditions) followed, in which the weight gain increased between 18.96 g / head/day (period 1-7 days) and 75.72 g / head/day (period 28-35 days), with an average over the entire studied period of 54.30 g / head/day.

On the last position were the chicks from group Lm (minimum welfare conditions) in which the increase in weight gain ranged between 18.59 g / head/day (period 1-7 days) and 74.96 g / head/day (period 28-35), the average weight gain for the period 1-35 days being 53.57 g / head/day (table 2).

Outflows and their causes. They were slightly higher in the first week of the life of the chicks, but with differences between the batches printed by the popular density (0.71% for the Lm batch, 0.55% for the Lexp-1 batch, and only 0.32 % in the Lexp-2 group), after which they stabilized at levels of 0.25-0.31% / week.

Throughout the study period (1-35 days), the mortality rate was 1.85% in the case of chicks that formed the Lm group, 1.66% in chickens in the Lexp-1 group, and only 1.45% in those that formed the Lexp-2 batch (tab. 3)

Table 2 Average daily weight gain of the studied chiken

The age of the chicks (days)	Batch	Average body weight (g)		Average daily increase (g/head/day)
		at the beginning of the week	on the weekend	
1-7	Lm	40.21	170.33	18.59
	Lexp-1	40.13	172.84	18.96
	Lexp-2	40.20	174.39	19.17
7-14	Lm	170.33	456.68	40.91
	Lexp-1	172.84	470.79	42.56
	Lexp-2	174.39	482.54	44.02
14-21	Lm	456.68	874.56	59.70
	Lexp-1	470.79	890.78	60.01
	Lexp-2	482.54	910.87	61.19
21-28	Lm	874.56	1390.48	73.70
	Lexp-1	890.78	1410.60	74.26
	Lexp-2	910.87	1447.43	76.65
28-35	Lm	1390.48	1915.08	74.96
	Lexp-1	1410.60	1940.66	75.72
	Lexp-2	1447.43	1994.42	78.14
TOTAL 1-35	Lm	40.21	1915.08	53.57
	Lexp-1	40.13	1940.66	54.30
	Lexp-2	40.20	1994.42	55.83

Table 3 Outflows from the pups studied

The age of the chicks (days)	Batch	Effective:		Mortality:			
		at the beginning of the week (head)	on the weekend (head)	weekly		cumulative	
				head	%	head	%
1-7	Lm	22610	22449	161	0.71	161	0.71
	Lexp-1	20230	20119	111	0.55	111	0.55
	Lexp-2	19040	18979	61	0.32	61	0.32
8-14	Lm	22449	22379	70	0.31	231	1.02
	Lexp-1	20119	20062	57	0.28	168	0.83
	Lex-2	18979	18931	48	0.25	109	0.57
15-21	Lm	22379	22316	63	0.28	294	1.30
	Lexp-1	20062	20007	55	0.27	223	1.10
	Lexp-2	18931	18882	49	0.26	158	0.83
22-28	Lm	22316	22251	65	0.29	359	1.59
	Lexp-1	20007	19953	54	0.27	277	1.37
	Lexp-2	18882	18823	59	0.31	217	1.14
29-35	Lm	22251	22192	59	0.26	418	1.85
	Lexp-1	19953	19894	59	0.29	336	1.66
	Lexp-2	18823	18764	59	0.31	276	1.45

The data regarding the causes of outflows from the herd showed that, for the lot Lm out of a total of 418 chapters, 106 chapters. had colibacillosis (25.36%), 124 heads suffered various mechanical accidents (29.67%), and the difference of 188 heads they died of other causes (44.98%).

In the Lexp-1 batch, there were a total of 336 dead chicks, of which 110 were due to colibacillosis (32.74%), 118 chap. due to mechanical accidents (35.12%) and 108 chap. from other causes (32.14%).

In the case of the Lexp-2 group, the total exits from the herd were 276 heads. Of which 71 chap. due to colibacillosis (25.72%), 105 chap. due to mechanical accidents (38.04%) and 100 chap. from other causes (36.23%) (tab. 4).

Table 4 Causes of outbreaks in the puppies studied

Age period (days)	Batch	Cash outflows (head/ period)	Cause					
			Colibacillosis		Accidents		Other causes	
			head	%	head	%	head	%
1-7	Lm	161	49	30.43	45	27.95	67	41.61
	Lexp-1	111	45	40.54	30	27.03	36	32.43
	Lexp-2	61	21	34.43	16	26.23	24	39.34
8-14	Lm	70	14	20.00	21	30.00	35	50.00
	Lexp-1	57	12	21.05	29	50.88	16	28.07
	Lexp-2	48	9	18.75	25	52.08	14	29.17
15-21	Lm	63	14	22.22	19	30.16	30	47.62
	Lexp-1	55	23	41.82	17	30.91	15	27.27
	Lexp-2	49	10	20.41	18	36.73	21	42.86
22-28	Lm	65	8	12.31	24	36.92	33	50.77
	Lexp-1	54	11	20.37	19	35.19	24	44.44
	Lexp-2	59	17	28.81	20	33.90	22	37.29
29-35	Lm	59	21	35.59	15	25.42	23	38.98
	Lexp-1	59	19	32.20	23	38.98	17	28.81
	Lex-2	59	14	23.73	26	44.07	19	32.20
Total 1-35	Lm	418	106	25.36	124	29.67	188	44.98
	Lexp-1	336	110	32.74	118	35.12	108	32.14
	Lexp-2	276	71	25.72	105	38.04	100	36.23

Consumption of compound feeds. During the period of 1-14 days, the average daily consumption of compound feeds was 47.37 g nc /head/day for chickens from the Lm group, 43.61 g n.c. / head / day for those from the Lexp-1 group and 41.19 g n.c. / head / day in chickens from the Lexp-2 group. The next period was 14-21 days, when there was an average daily consumption of 110.27 g n.c. /head/day in the Lm group, 101.50 g n.c. /head/day in the Lexp-1 group, and 95.81 g n.c./head/day in the Lexp-2 batch.

In the last period taken into account (21-35 days, the average daily consumption was at levels of 183.77 g n.c. / head/day for the chicks of the Lm group, of 169.09 g n.c./head/day for those in the Lexp-1 group and 159.68 g n.c. / head/day in the chicks of the Lexp-2 group.

Throughout the study period (1-35 days), the lowest average daily consumption of 99.32 g n.c. / head / day was in the chickens of the Lexp-2 group (total consumption = 65708 kg n.c. / lot; average herd = 18902 chap.), followed by chickens from group Lexp-1 with 105.05 g n.c. / head / day (total consumption = 73763 kg nc / lot; average herd = 20062 chap.) and chickens from group Lm with 114.06 g n.c. / head / day (total consumption = 89426 kg n.c. / lot; average number = 22401 head) (tab. 5).

Table 5 Consumption of compound feeds

Age period (days)	Average cash (head/ period)			Total consumption (kg n.c./batch)			Individual consumption (g n.c./head)			Average daily consumption (g n.c./head/day)		
	Lm	Lexp-1	Lexp-2	Lm	Lexp-1	Lexp-2	Lm	Lexp-1	Lexp-2	Lm	Lexp-1	Lexp-2
1-14	22494.5	20146.0	18985.5	14920	12301	10948	663.27	610.59	576.65	47.37	43.61	41.19
14-21	22347.5	20034.5	18906.5	17250	14234	12680	771.90	710.47	670.67	110.27	101.50	95.81
21-35	22254.0	19950.5	18823.0	57256	47228	42080	2572.84	2367.26	2235.56	183.77	169.09	159.68
1-35	22401.0	20062.0	18902.0	89426	73763	65708	3992.05	3676.75	3476.25	114.06	105.05	99.32

Food conversion index. In the case of chicks from the Lm group, the feed conversion index was 1.592 kg n.c. / kg increase in the 1-14 day lifespan, 1.847 kg n.c. / kg increase in the 14-21 day period and 2.473 kg n.c. / kg increase in the period 21-

35 days, resulting in an average value for the entire growth period (1-35 days) of 2,129 kg n.c. / kg increase (individual consumption = 3992.05 g n.c. / head / period; increase in growth = 1874,87 g / head / period).

In the chicks that formed the Lexp-1 group, the feed conversion index was at levels of 1.418 kg n.c. / kg increase in 1-14 days, 1.692 kg n.c. / kg increase in 14-21 days and 2.255 kg n.c. / kg increase in the period 21-35 days; for the entire analyzed period (1-35 days) a conversion index of 1.935 kg n.c. / kg increase resulted (individual consumption = 3676.75 g n.c. / head / period; growth increase = 1900.53 g / head / period).

Calculations for chickens in the Lexp-2 batch showed a feed conversion rate of 1,304 kg n.c. / kg increase in 1-14 days, 1,566 kg n.c. / kg increase in 14-21 days and 2,063 kg n.c. / kg increase in the period 21-35 days, resulting in an average food conversion index of 1.779 kg n.c. / kg increase (individual consumption = 3476.25 g n.c./head/period; growth increase = 1954.22 g/head/period) (tab. 6).

Table 6 Food conversion index

Age period (days)	Growth increase (g / head / period)			Food consumption (g n.c./head/period)			Food conversion rate (kg n.c./kg increase)		
	Lm	Lexp-1	Lexp-2	Lm	Lexp-1	Lexp-2	Lm	Lexp-1	Lexp-2
1-14	416.47	430.66	442.34	663.27	610.59	576.65	1.592	1.418	1.304
14-21	417.88	419.99	428.33	771.90	710.47	670.67	1.847	1.692	1.566
21-35	1040.52	1049.88	1083.55	2572.84	2367.26	2235.56	2.473	2.255	2.063
1-35	1874.87	1900.53	1954.22	3992.05	3676.75	3476.25	2.129	1.935	1.779

CONCLUSIONS

From the general analysis of the production indicators for the chicken broiler raised to different densities, in accordance with the European welfare rules, a number of aspects emerged, as follows.

The experimental factor showed its influence on the weight of the studied puppies, although, at the time of population, there were no differences between groups.

Thus, the best average body weights were obtained by chicks housed at a density of 16 head / m^2 (Lexp-2 batch), both at the age of 7 days (174.39 g) and at 14 days (482,54 g), at 21 days (910.87 g), at 28 days (1480.43 g) and at 35 days (1994.42 g). The mentioned weights were higher by 0.89-3.38% than those made by chickens accommodated at a density of 17 cap./m^2 (Lexp-1 batch) and, respectively, higher by 2.33-5.36% compared with the average weights of the chicks to which the density of 19 head / m^2 was applied (batch Lm).

The best average daily weight gain of 55.83 g / head/day was recorded in the Lexp-2 group, with chickens raised in superior welfare conditions and which was 2.74% higher than those from group Lexp-1 (average welfare conditions) and by 4.05% compared to chickens from group Lm (minimum welfare conditions).

The lower density at which the chicks from the Lexp-2 group were accommodated (16 heads/m^2) ensured better growth conditions, materialized in a rate of outflows of only 1.45%, compared to 1.66 % as it was for the chicks from the Lex-1 group (17 heads / m^2) and 1.85% for those from the Lm group (19 heads / m^2).

The causes of the outflows were due to an episode of colibacillosis (with limits between 25.36% in the Lm group and 32.74% in the Lexp-1 group), mechanical accidents (between 29.67% in the Lm group and 38.04% in the Lexp-2 group), but also for other causes (between 32.14% in the Lexp-1 group and 44.98% in the Lm group).

Data on the average daily consumption of compound feeds indicated that the best results were in chickens from the Lexp-2 group (superior welfare conditions), both in periods of growth (41.19 g n.c. / head / day in period 1 - 14 days; 95.81 g n.c. / head / day in the period 14 - 21 days; 159.68 g n.c. / head / day in the period 21-35 days), as well as for the total period studied (99.32 g n.c. / head / day).

The average daily consumption of chickens in the Lexp-1 group (average welfare conditions) was higher than in the group previously highlighted both during life

periods (by 5.87% in the period 1-14 days; by 5.94% in period 14-21 days and by 5.89% in the period 21-35 days), as well as for the total period (by 5.77%), a phenomenon also valid for the chicks of the Lm group (minimum welfare conditions) for which they have registered the highest daily consumption, both by periods of growth (higher by 15.0%, by 15.09%, and by 15.08%, respectively) and by total period (by 14.84%).

Regarding the feed conversion index, the most convenient levels were achieved by the chicks of the Lexp-2 group in each of the 3 growth periods (1,304 kg n.c. / kg increase; 1,566 kg n.c. / kg increase; 2,063 kg n.c. / kg increase) and for the entire breeding period of the studied chicks (1,779 kg n.c. / kg increase), these being lower by 8.05-9.31% (for the life span of the chicks) and by 8.77% (total period) than the chicks in the Lexp-1 group and 17.94-22.08% respectively (during breeding periods) and 19.67% lower than.

In conclusion, it can be stated that compliance with European welfare rules for chicken broilers ensures a better survival rate, a higher body weight when delivered to the slaughterhouse, and lower feed consumption, benefits which, together with the level of subsidy granted, can compensate. economically, the deficit generated by the application of lower population densities than those recommended for the chicken hybrid used in this study.

REFERENCES

[1] Beaumont C., Lenihan-Duval E., Mignon-Grasteau S., and Leterrier C., 2010-*The European experience in poultry welfare-a decade ahead.* Poultry Science, Vol. 89, Issue 4, pg. 825-831.

[2] Buijs S., Keeling L., Rettenbacher S., Van Poucke E. and Tuyttens F.A.M., 2009-*Stocking density effects on broiler welfare: identifying sensitive ranges for different indicators.* Poultry Science, no. 88(8), pg. 1536-1543.

[3] Dawkins M.S., Donnelly C.A. and Jones T.A., 2004-*Chicken welfare is influenced more by housing conditions than by stocking density.* Nature, no. 427(6972), pg. 342–344.

[4] Duncan I.J., 2002-*Poultry welfare: science or subjectivity?* British Poultry Science, no. 43(5), pg. 643-652.

[5] Elson H.A, 2015-*Poultry welfare in intensive and extensive production systems*. World's Poultry Science Journal, vol. 71:3, pg. 449-460.

[6] Hall A.L., 2001-*The effect of stocking density on the welfare and behavior of broiler chickens reared commercially*. Animal Welfare, no. 10(1), pg. 23-40.

[7] Kryeziu A.J., Mestani N., Berisha Sh. and Kamberi M.A., 2018-*The European performance indicators of broiler chickens as influenced by stocking density and sex*. Agronomy Research, no. 16(2), pg. 483-491

[8] Usturoi M.G., 2015-*Study of certain factors influencing meat production in Ross-308 chicken hybrid.* Lucrări Ştiinţifice, Seria Zootehnie, Vol. 64 (20), pg. 223-226. Editura „Ion Ionescu de la Brad", Iaşi. ISSN: 2284-6964. ISSN L: 1454-7368.

[9] Zuidhof M.J., 2010, *Stocking density – Finding a balance between effects on the broiler value chain.* Canadian Poultry, April, pg. 18-36.

[10] Zuowei S., Yan L., Yuan L., Jiao H., Song Z., Guo Y. and Lin H., 2011-*Stocking density affects the growth performance of broilers in a sex-dependent fashion.* Poultry Science, Vol. 90, Issue 7, pg. 1406-1415.

[11] ***Animal Welfare, https://www.oie.int/en/what-we-do/animal-health-and-welfare/animal-welfare/

[12] ***Directiva 2007/43/CE a Consiliului din 28 iunie 2007 de stabilire a normelor minime de protecţie a puilor destinaţi producţiei de carne.

[13] ***Ghidul solicitantului pentru Măsura 14 - Bunăstarea animalelor-pachetul b) Plăţi în favoarea bunăstării păsărilor. Ediţia a IV-a, 2021.Cod: DPD – SZ M14 – GSB.