Scientific Papers. Series D. Animal Science. Vol. LXVI, No. 1, 2023
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

EFFICIENCY OF GROWING OF CHICKEN BROILERS UNDER CONDITIONS OF COMPLIANCE WITH EU RULES OF WELFARE

Cornelia Daniela CUREA[1], Marius Giorgi USTUROI[1], Ioan CUSTURĂ[2], Răzvan Mihail RADU-RUSU[1], Roxana Nicoleta RAȚU[1], Marian PRISĂCARU[1], Alexandru USTUROI[1]

[1]University of Life Science Iași, 3 Mihail Sadoveanu Alley, Iasi, Romania
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Bucharest, Romania

Corresponding author email: austuroi@uaiasi.com

Abstract

The research focused on the effect of the application of the EU welfare rules on the technical-economic results achieved in a chicken broiler breeding farm. In this sense, three rearing halls identical in the usable area and technical equipment were studied, which were populated with day-old chicks Ross-308 following the densities imposed by the annual European funding program, as follows: batch Lm = 19 chickens/m^2 (mandatory minimum requirements); batch Lexp-1 = 17 chickens/m^2 (density reduced by 10% compared to the minimum requirements); batch Lexp-2 = 16 chickens/m^2 (density reduced by 15% compared to the minimum requirements). The level of production indicators was directly influenced by the density ensured, an aspect highlighted by the values calculated for the European Production Efficiency Factor and, respectively, for the European Broiler Index, which was much higher in the lot with only 16 chickens/m^2 (Lexp-2). The conclusion of the study was that the economic efficiency of chicken meat production farms affiliated with the annual European funding program strictly depends on the allocations received, as there are no price differences compared to farms that do not comply with welfare norms.

Key words: *broiler hen, welfare, performance, profitability.*

INTRODUCTION

Estimates of global food consumption indicate increases of 50-60% by 2050 (Falcon et al., 2022) and especially for poultry meat, a food product appreciated for its moderate energy intake and high protein, vitamin, and mineral contents (Vukasovic, 2010). In the European Union, the demand for poultry meat has exceeded that of beef or mutton, even in countries where these meats are traditionally consumed (Devine, 2003; Marangoni et al., 2015); the exception is the USA, where although the consumption of poultry meat has increased, red meat still predominates, representing about 58% of the total meat consumption (Daniel et al., 2015).
In most countries, poultry meat is obtained within industrial production systems (Kryeziu et al., 2016; Usturoi et al., 2020), but with large differences in terms of the level of production achieved and especially economic efficiency, gaps printed by numerous factors with direct action they are indirect, starting from cultural/religious considerations (Devi et al., 2014) and ending with the economic situation of the respective country (Szollosi & Szucs, 2014; Tudorache et al., 2012). For example, the cost of production in EU countries is higher by approx. 45%/kg of chicken meat than that in Brazil, a phenomenon that can be compensated by diversification of production, orientation towards the products demanded by the current consumer market, and especially by qualitative differentiation (Magdelaine, 2003).
However, the industrial production of meat has also generated negative reactions from those interested in the welfare of birds, being accused of the lack of sustainability of the current production systems (Chodova et al., 2021; Poltowicz & Doktor, 2012), the too high density per surface unit and the deprivation of birds from access to the external environment (Curea et al., 2022; Eleroglu et al., 2015), the increasing incidence of specific diseases, but also the loss of some quality characteristics of the meat (Arrazola & Torrey, 2021; Custură et al., 2019; Wilhelmsson et al., 2019).

Against the background of these social problems, Directive 43/EC was adopted in 2007, which provides for the maximum stocking density for broiler chickens (Directive 2007/43/EC), which was also adopted by the legislation in our country; in essence, these legislative provisions limit the density of broilers to 33-42 kg/m^2, to ensure the welfare of the birds, but also to protect the environment by reducing the level of harmful gases produced by this category of farm animals (Applicant's Guide to Measure 14, 2021).

Starting from these considerations, our research focused on the degree of influence of the conditions imposed by the FEADR program measure 14, Subpackage 1b and 2b (reducing the density of birds by 10% and, respectively, by 15% compared to the density resulting from the application of the mandatory minimum requirements regarding the surface minimum allocated), on the technical-economic results achieved within a holding specialized in raising broiler chickens.

MATERIALS AND METHODS

To achieve the proposed goal, three batches of experience were created, differentiated by the number of chickens introduced per surface unit at the time of population, departing from the maximum norm of 42 kg/m^2 allowed in farms that access the annual European funding program, as follows: batch Lm = 19 chickens/m^2 (minimum welfare conditions); batch Lexp-1 = 17 chicks/m^2 (10% density reduction compared to the mandatory minimum requirements); batch Lexp-2 = 16 chickens/m^2 (15% reduction in density compared to the mandatory minimum requirements).

The biological material was represented by 61880 chickens belonging to the Ross-308 commercial hybrid (they came from the same hatching, from a hatchery located near the work unit), which were distributed in three rearing halls, according to the specified densities previously, respectively: lot Lm = 22610 heads; lot Lexp-1 = 20230 heads; lot Lexp-2 = 19040 heads.

The breeding of chicks was carried out following the principles of the intensive system (on permanent bedding), in halls identical in terms of useful surface (1198 m^2) and technical equipment, in which the same level of micro-climate factors was ensured (according to the provisions of the technological guide of the hybrid used); and the feeding of the chickens in the three batches was uniform, being given combined feeds with the following nutritional characteristics: the Starter recipe with 23.0% P.B. and 3000.5 kcal/kg E.M. (in the period 1-14 days), the recipe for Growth with 21.5% P.B. and 3100.7 kcal/kg E.M. (period 15-21 days) and the recipe for Finishing with 19.5% P.B. and 3200.5 kcal/kg E.M. (period 22-35 days).

The technical and economic analysis of the growth and utilization of broiler chickens in compliance with the EU welfare norms was made through the lens of specific indicators for this type of activity, calculated following the agreed methodology in poultry research:

- body weight = the chickens from the control pens were weighed individually, on the morning of the day they were delivered to the slaughterhouse (at the age of 35 days);
- increase in weight gain = the ratio between the weight difference of the chickens at the end of the period and that at the beginning of the period and the number of days of the period (g/head/day);
- herd losses = weekly mortalities were related to the initial herd of the week in question and accumulated over the entire growth period (%);
- feed conversion index = the ratio between the individual consumption of combined feed and the individual increase in weight gain (kg n.c./kg gain);
- European Efficiency Factor of Production (FEEP) = was calculated with the relationship:

$$\text{FEEP} = \frac{\text{Viability (\%) x live weight (kg)}}{\text{Age (days) x Feed conversion index (kg n.c./kg gain)}} \text{ x 100}$$

- European Broiler Index (IEB) = calculated according to the formula:

$$\text{IEB} = \frac{\text{Viability (\%) x Average daily gain (g/chicken/day)}}{\text{Feed conversion index (kg n.c./kg gain) x 10}}$$

- economic efficiency = represented the difference between total production expenses and total realized revenues. In the calculation of the revenues, the financial allocations granted per U.V.M. (large cattle unit) were taken into account, with a coefficient of 0.03 for birds and which are granted for reducing the density in the hall (by 10% and 15%, respectively, compared to a mandatory minimum), to reduce the level of noxes (by 30%) and for fuel excise. The main data obtained were statistically processed, calculating:the arithmetic mean ($\overline{\mathbf{x}}$), the standard error of the mean (± sx) and the coefficient of variation (V%).

RESULTS AND DISCUSSIONS

Productive indicators. At the age of slaughter (day 35), body weight recorded average values of 1915.08 g in the case of chickens to which the highest population density was applied (group Lm), of 1940.66 g in chickens where the density was reduced by 10% (group Lexp-1) and 1994.42 g in chickens where the reduction in density was 15% (group Lexp-2). Percentage-wise, the weight differences between the batches were 1.32% between Lm vs. Lexp-1 and, respectively, 3.98% between the same control batch vs. Lexp-2; even between the two experimental groups there were differences in body weight, of 2.69% (Table 1).

Table 1. Productive indicators achieved by the chickens studied (n = 50)

Productive indicator	Statistics	Treatment		
		Lm	Lexp-1	Lexp-2
Body weight	Mean ± SEM (g)	1915.08 ± 52.22	1940.66 ± 39.17	1994.42 ± 27.90
	Variability (%)	19.28	14.27	9.89
Increased weight gain	Mean ± SEM (g/cap/zi)	53.57 ± 1.43	54.30 ± 1.08	55.83 ± 0.69
	Variability (%)	18.98	14.01	8.72
Livestock losses	Mean ± SEM (%)	1.85 ± 0,05	1.66 ± 0,03	1.45 ± 0,02
	Variability (%)	18.56	14.57	7.77
Feed conversion index	Mean ± SEM (kg n.c./kg spor)	2.129 ± 0.05	1.935 ± 0.04	1.779 ± 0.01
	Variability (%)	17.76	13.28	5.13

The increase in weight calculated for the entire studied period (1-35 days) was only 53.57 g/head/day in chickens from the control group (19 head/m^2), compared to 54.30 g/head/day in those from the Lexp-1 batch (17 heads/m^2) and of 55.83 g/head/day in the chickens from the Lexp-2 batch (16 heads/m^2), the difference between the Lm batch and the other two batches being 1.34% and respectively, of 4.05%; between the experimental groups there was a difference of 2.74%.

The lowest mortality rate, of only 1.45%, was in chickens with the lowest density per surface unit (group Lexp-2), followed by specimens from group Lexp-1 (-10% compared to the mandatory density) with 1.66% mortality and of chickens from the Lm group (minimum mandatory density) where the mortality was 1.85%. The differences between the batches were 0.19% (Lm vs. Lexp-1), 0.40% (Lm vs. Lexp-2) and 0.21% (Lexp-1 vs. Lexp-2), respectively.

The chickens from the Lexp-2 batch (16 heads/m^2) achieved the most favorable feed conversion index, of only 1,779 kg n.c./kg gain, followed by those from the Lexp-1 batch (17 heads/m^2) with 1,935 kg n.c./kg gain and of chickens from the Lm batch (19 head/m^2) with 2,129 kg n.c./kg gain.

The experimental factors also influenced the homogeneity of the studied characteristics, the coefficients of variation calculated for the Lm (V% = 17.76-19.28) and Lexp-1 (V% = 13.28-14.27) groups indicating a medium and even high variability, while in the Lexp-1 group production performances were much more uniform (V% = 5.13-9.89).

Production efficiency indicators. In the specialized literature it is stated that the production of meat obtained by broiler chickens is profitable only when the European Efficiency Factor of Production (FEEP) is at least 300 points.

The value of the European Production Efficiency Factor correlated with the level of productive parameters achieved by the chickens studied and which were influenced by the welfare conditions ensured, respectively by the density applied to the flocks (Table 2).

From this point of view, it turned out that the group of chickens where the mandatory minimum density of 19 heads/m^2 was applied (group Lm) achieved the worst performance during growth, hence the lowest EPEF, of only 252.24 points. In the next position were the chickens where the stocking was done with 17 head/m^2 (Lexp-1 group), with an EPEF of 281.77 points, while in the group with only 16 head/m^2 (Lexp-2) it was recorded the best level for EPEF, of 315.64 points.

Expressed as a percentage, the differences between the batches were 10.52% (Lm vs. Lexp-1), 20.12% (Lm vs. Lexp-2) and, respectively, 10.73% (Lexp-1 vs. Lexp-2); statistically, the differences between the groups were very significant, in each of the three comparisons performed (p < 0.001).

Table 2. European Production Efficiency Factor

Traits	Statistics	Treatment		
		Lm	Lexp-1	Lexp-2
Liveability (%)		98.15	98.34	98.55
Live weight (kg)		1.91508	1.94066	1.99442
Age at slaughter (days)		35	35	35
FCR (kg feed/kg gain)		2.129	1.935	1.779
EPEF (European Production Efficiency Factor)	Mean ± SEM	252.24 ± 5.81	281.77 ± 5.33	315.64 ± 4.15
	Variability (%)	16.28	13.38	9.29
	ANOVA p values	***Lm vs. Lexp-1: $p = 7.6 \times 10^{-14}$ ***Lm vs. Lexp-2: $p = 7.6 \times 10^{-14}$ ***Lexp-1 vs. Lexp-2: $p = 7.6 \times 10^{-14}$		

SEM - standard error of mean. ***highly significant differences between means for *p < 0,001*.

The European Broiler Index, although it is less used, this indicator allows the comparison of technical results from a poultry unit, but, like the EPEF, it does not highlight the economic aspect of meat production; so for example, if a very low stocking density is used, the gain in weight and implicitly the EBI, will register higher values, but the profit per unit of area will be correspondingly reduced, at the expense of the economic efficiency of the unit.

In the situation analyzed by us, the values resulting from the calculation for the EBI were at a level of only 246.96 points for the Lm lot (minimum welfare conditions), 275.96 for the Lexp-1 lot (density reduced by 10% compared to the minimum requirements mandatory) and of 309.28 points to the Lexp-2 batch (density reduced by 15% compared to the minimum mandatory requirements) (Table 3).

Table 3. European Broiler Index

Traits	Statistics	Treatment		
		Lm	Lexp-1	Lexp-2
Liveability (%)		98.15	98.34	98.55
Saily weight gain (g/day)		53.57	54.30	55.83
FCR (kg feed/kg gain)		2.129	1.935	1.779
EBI (European Broiler Index)	Mean ± SEM	246.96 ± 5.58	275.96 ± 5.08	309.28 ± 4.16
	Variability (%)	15.98	13.01	9.50
	ANOVA p values	***Lm vs. Lexp-1: $p = 7.5 \times 10^{-14}$ ***Lm vs. Lexp-2: $p = 7.5 \times 10^{-14}$ ***Lexp-1 vs. Lexp-2: $p = 7.5 \times 10^{-14}$		

SEM - standard error of mean. ***highly significant differences between means for *p < 0,001*.

From a statistical point of view, the differences between the groups were very significant (p < 0.001), highlighting also in this case the influence of the experimental factor tested by us (population density); expressed as a percentage, the differences between the batches were even greater than in the case of EPEF, the resulting levels being 11.74% (Lm vs. Lexp-1), 25.23% (Lm vs. Lexp-1) and 12.74% (Lexp-1 vs. Lexp-2).

The economic balance of meat production was calculated on the basis of the data obtained from the unit where our investigations took place and concerned the total production expenses and the income from the sale of chickens to a specialized slaughterhouse to which were added the subsidies from affiliation of the farm to the annual European funding program.

In the batch where only the mandatory minimum density was ensured (Lm with 19 heads/m^2), the highest production expenses were recorded (51403.74 Euro/series), due to the higher number of chickens; the expenses from the mentioned lot were higher by 13.96% compared to those related to the lot where the density was 17 heads/m^2 (Lexp-1) and by 21.34% compared to the lot where the density was only 16 heads/m^2 (batch Lexp-2) (Table 4).

The income came from the sale of chickens at the slaughterhouse and the excise duty on diesel (both valid for all lots), from compliance with the noxes level (1.46 Euro/UVM for the Lexp-1 lot; 1.42 Euro/UVM for the Lexp-2 lot) and from compliance with the rules of density (3.19 Euro/UVM for the Lexp-1 lot; 4.79 Euro/UVM for the Lexp-2 lot). The revenues achieved on a growth series were 47648.82 Euro for the control batch, 46441.49 Euro for the Lexp-1 batch and 45161.95 Euro for the Lexp-2 batch.

Table 4. Economic balance of meat production

Specification		Treatment		
		Lm	Lexp-1	Lexp-2
Costs	Workforce	1502.87	1451.57	1425.93
	Sheet	737.38	737.38	737.38
	Hall preparation	82.06	82.06	82.06
	Hall heating	2618.38	2618.38	2618.38
	Electricity	923.26	923.26	923.26
	One day old chicks	8605.45	7844.62	7383.25
	Combined feed	36062.37	29745.79	26497.33
	Drugs	871.97	823.22	767.74
	Total	51403.74	44226.28	40435.33
Income	Chicks delivered live	39498.25	35882.17	34774.68
	Subpackage 2b (density) 3.19 Euro/UVM=10% discount 4.79 Euro/UVM=15% discount	-	1903.85	2696.38
	Subpackage 3b (noxe) 1.46 Euro/UVM=10% discount 1.42 euro/UVM=15% discount	-	871.35	799.34
	Diesel excise duty (Euro/litre/UVM)	8150.57	7784.12	6891.55
	Total	47648.82	46441.49	45161.95
Benefits		- 3754.94	+ 2215.21	+ 4726.62

Under these conditions, the highest net benefit (4726.62 Euro/house/series) was achieved by the chickens in which the stocking density was reduced by 15% compared to the mandatory minimum (batch Lexp-2), followed by the chickens where the density was 10% lower than the minimum (lot Lexp-1) with a benefit of 2215.21 Euro/hall/series; the batch of chickens where the minimum mandatory density was ensured for the chickens (batch Lm) ended the series with a negative balance, having losses of 3754.94 Euro/house

CONCLUSIONS

From the data regarding the production indicators of the production of Ross-308 chickens in compliance with the EU welfare standards, it turned out that the best results were in the batch where the stocking density was reduced by 15% compared to the mandatory minimum requirements (Lexp-2), and the weakest in the batch where the density was at the mandatory minimum level (Lm).

This state of affairs is also attested by the values obtained for the European Production Efficiency Factor (the score of the Lexp-2 batch was higher by 10.73-20.12% than the other variants tested) and especially by the values established for the European Broiler Index (the differences between the batch previously highlighted and the other lots were even higher, 12.74-25.23%).

From an economic point of view, the variant where the population density was reduced by 15% (lot Lexp-2) registered a double benefit compared to the solution with a 10% reduction in density (Lexp-1), while the lot with the minimum mandatory density (Lm) posted losses on the growth streak.

In conclusion, it can be stated that the economic efficiency of chicken meat production in the case of farms affiliated with the annual European funding program depends on the subsidies granted, the size of which correlates with the self-imposed reductions for density and noxes. This situation can endanger the existence of poultry establishments since there are no incentive price differences between meat obtained under welfare conditions and where such rules are not respected.

REFERENCES

Arrazola, A., & Torrey, S. (2021). Welfare and performance of slower growing broiler breeders during rearing. *Poultry science*, 100 (11), 101434.

Chodova, D., Tumova, E., Ketta, M., & Skrivanova, V. (2021). Breast meat quality in males and females of fast-, medium- and slow-growing chickens fed diets of 2 protein levels. *Poultry Science*, 100(4), 100997.

Curea, C.D., Radu-Rusu, R.M., Rațu, R.N., Usturoi, A., & Usturoi, M.G. (2022). Research on the influence of density on the welfare condition and performance of chicken broilers. *Animal & Food Sciences Journal,* 77(1), 211-217.

Custură, I., Tudorache, M., Van, I., Marin, M.P., Marmandiu, A., & Pană, E.S. (2019). Researches about influence of pro-biotics on broiler production performances. *Scientific Papers: Series D, Animal Science,* 62(2), 135-139.

Daniel, C.R., Cross, A.J., & Sinha, R. (2011). Trends in meat consumption in the USA. *Public Health Nutrition, 14*(4), 575-583.

Devi, S.M., Balachandar, V., & Kim, I.H. (2014). An Outline of Meat Consumption in the Indian Population - A Pilot Review. *Korean Journal for Food Science of Animal Resources*, 34(4), 507-515.

Devine, R. (2003). Meat consumption trends in the world and the European Union. *Productions Animales*, *16*(5), 325-327.

Eleroglu, H., Yildirim, A., Duman, M., & Sekeroglu, A. (2015). The welfare of slow growing broiler genotypes reared in organic system. *Emirates Journal of Food and Agriculture*, 27(5), 454-459.

Falcon, W.P., Naylor, R.L., & Shankar, N.D. (2022). Rethinking Global Food Demand for 2050. *Population and Development Review*, WOS:000837462200001.

Kryeziu, A.J., Mestani, N., Berisha, S., & Kamberi, M.A. (2018). The European performance indicators of broiler chickens as influenced by stocking density and sex. *Agronomy Research*, *16*(2), 483-491.

Magdelaine, P. (2003). Economy and prospects of the egg, poultry and rabbit meat sectors in France and European Union. *Productions Animales*, *16*(5), 349-356.

Marangoni, F, Corsello, G, & Poli, A. (2015). Role of poultry meat in a balanced diet aimed at maintaining health and wellbeing: an Italian consensus document. *Food & Nutrition Research*, 59.

Poltowicz, K., & Doktor, J. (2012). Effect of slaughter age on performance and meat quality of slow-growing broiler chickens. *Annals of Animal Science*, *12*(4), 621-631.

Szollosi, L., & Szucs, I. (2014). An economic approach to broiler production. A case study from Hungary. *Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu*, *16*(3), 275-281.

Tudorache, M., Van, I., Custură, I., Popescu-Micloșan, E., & Popa, A. (2012). Study on unit cost of certificate-type broilers. *Scientific papers Series D Animal science*, LV, 250-255.

Usturoi, M.G., Rațu, R.N., & Usturoi, A. (2020). Studies on the factors which influence the chemical composition of meat from the chicken broiler. USAMV București, *Scientific Papers-Series D-Animal Science, 63*(1), 422-427.

Vukasovic, T. (2010). Buying decision-making process for poultry meat. *British Food Journal*, *112*(2-3), 125-139.

Wilhelmsson, S., Yngvesson, J., Jonsson, L., Gunnarsson, S., & Wallenbeck, A. (2019). Welfare Quality (R) assessment of a fast-growing and a slower-growing broiler hybrid, reared until 10 weeks and fed a low-protein, high-protein or mussel-meal diet. *Livestock Science*, 219, 71-79.

*** Council Directive 2007/43/EC of 28 June 2007 establishing minimum standards for the protection of chickens intended for meat production.

*** Applicant's guide for Measure 14 - Animal welfare - package b) Payments in favor of bird welfare. Fourth Edition, 2021. Cod: DPD – SZ M14 – GSB.