Biotechnology in Animal Husbandry 36 (4), 447-462 , 2020
Publisher: Institute for Animal Husbandry, Belgrade-Zemun
ISSN 1450-9156
UDC 575.22:636.034'65
https://doi.org/10.2298/BAH2004447L

GENOTYPE AND BREEDER FLOCK AGE IMPACT ON BROILER PERFORMANCE IN SUBOPTIMAL CONDITIONS

Miloš Lukić[1], Veselin Petričević[1], Zdenka Škrbić[1], Nikola Delić[1], Nataša Tolimir[2], Vladimir Dosković[3], Simeon Rakonjac[3]

[1]Institute for Animal Husbandry, Autoput 16, 11080 Belgrade-Zemun, Serbia
[2]Institute for Science Application in Agriculture, Bul. Despota Stefana 68b, 11000, Belgrade, Serbia
[3]Faculty of Agronomy, University of Kragujevac, Cara Dušana 34, 32102 Čačak, Serbia
Corresponding author: Miloš Lukić, miloslukic.izs@gmail.com
Original scientific paper

Abstract: A comparative study of production traits was performed between COBB 500 broilers from a 52-week-old breeder flock and a ROSS 308 from two breeder flocks of different ages (52 weeks and molted flock 79-week-old) in equal, relatively suboptimal ambiental (temperature oscillations) and nutritional conditions (market feed of average quality). The experiment was performed on a total of 720 day-old chicks of both sexes in 4 experimental groups (Cobb; Ross 52; Ross 79; Ross mix - a mixture of Ross broilers from two breeder ages), with 6 replications per group and 30 chickens in each replication. Mortality, body weight (days 0, 7, 21 and 42), weight gain, feed conversion and production index (EPEF) were monitored in 42 days of fattening. It was determined that heavier day-old chickens ($p<0.01$) with better gain in the first week of production, were obtained from the older breeder flock. Except in the first week, Cobb generally had the highest ($p<0.05$) body weights and gains in the experiment, aside from in mid and the end of the test, where did not differ significantly from the body weight of the Ross 79 and Ross mix group of broilers, respectively. Results also indicate that genetics (used hybrid) may have a greater influence on the final body weight and daily gain in suboptimal test conditions than the breeder age. Cobb 500 broilers also had significantly higher mortality under test conditions ($p<0.05$). Feed conversion and the achieved EPEF production index did not vary significantly in the test in chickens of different genotypes or parents. In general, suboptimal conditions in our research constrained realisation of the genetic production potential, with a suppressive effect on both hybrids, higher on the growth in Ross 308, and on the resistance measured by mortality in Cobb 500 hybrids.

Key words: broiler strain, breeder age, suboptimal conditions, production

Introduction

The two most popular breeds of fast-growing chickens in Serbia (and probably worldwide) are Cobb 500 and Ross 308, for a reason, because behind these two brands are genetic companies with almost hundred-year tradition and investment in improving the genetics of their products. According to the manufacturer, the current genetic potential allows in optimal conditions of six-week fattening of both sexes to reach an average body weight of 2952 g, with a feed conversion of 1.61 (*Cobb-Vantress, 2018b*), or 2918 g in Ross 308 hybrids, also with consumption of 1.61 kg of feed per kilogram of gain (*Aviagen, 2019b*). The success of the farm depends on the value of these two parameters, together with low mortality, because the price of feed and live weight of broilers depending on the market, on which the primary producer has no influence but must adjust to.

With long genetic selection focus on the growth rate, meat yield, and feed efficiency, modern fast-growing broilers approaching close to the biological limit and become very vulnerable, especially their immune, musculoskeletal, and cardiovascular systems (*Tixier-Boichard, 2020; Hartcher and Lum, 2020*), resulting in the need for very sophisticated nutrition and care, and often the so-called yield gap on farms. The achievement of the genetic potential of broilers on the farms themselves is limited by a number of factors, among which the quality of delivered day-old chicks and feed as well as the environment and health status of the farm have the greatest impact. Hence, in practice, every farm, and even every facility and flock within the farm, can have different production results, because during fattening, many things can deviate from optimal conditions for a longer or shorter time, more or less. Despite the constant yearly improvement of the genetic potential of these hybrids, the average final weight of chickens delivered to slaughterhouses in Serbia in the previous three years was the same and amounted to 2.4 kg (*Statistical Office of the Republic of Serbia, 2020*). In the US, chickens have been delivered on average after 47 days of fattening in the previous three years, with weights growing steadily (from 2.81 kg in 2017 to 2.87 kg in 2019), but also with an increase in farm mortality (from 4.5 to 5%) in the observed three-year period (*National Chicken Council, 2020*).

The production technologies of these two hybrids differ somewhat, especially in terms of feeding programs, which producers often neglect when using standard feeding strategy for broiler production. Also, adapting to market and constantly optimizing broiler production often requires suboptimal solutions to make feed cheaper. On the other hand, research has found that, due to the application of different selection goals, Ross 308 and Cobb 500 hybrids respond differently to the suboptimal diet (*Sterling et al., 2006; Gous, 2007; Tallentire et al. 2016).*

A raising problem is maintaining optimal ambient conditions on farms, due to increasingly extreme weather conditions caused by climate change, as well as

increasing the final broiler weights of broilers, which require lower optimal ambient temperatures while emitting more heat and gases. New, more efficient environmental control technologies require significant investments, so it is not uncommon for farms with older technologies in use and poorer conditions in the facility, which, despite poorer results, negatively assess the feasibility of new investments and loans (*Gillespie et al., 2017; El-Tahawy et al., 2017).*

Therefore, it is necessary to check both the resistance and the ability to adapt the latest genotypes of hybrid broilers by measuring productivity in suboptimal breeding and feeding conditions. It is usually up to the broiler producer to choose or test which genotype best suits his production conditions and available feed, especially since in recent literature, comparative testing of these two hybrids are relatively rare, especially independent research carried out in conditions that are not completely optimal for any of the tested hybrids. Also, different strain, sex, stocking density, environmental and health conditions, feeding levels, and programs, among others, interact and define the response of birds, and consequently make difficult the comparison and interpretation of results in different tests. In addition to *in vivo* tests, software programs for modelling broiler growth and optimization of nutrition and production are increasingly in use, which mainly take into account and can predict the impact of the above (input) parameters of fattening *in silico*. For them, the success of prediction depends on the availability and accuracy of the input data, as well as the sophistication of the model itself (*Gous, 2007*). However, they also do not take into account or interpolate the differences between the latest genotypes of hybrids, resulting from the application of different selection targets and selection pressures in different genetics companies, which is why biological tests are still irreplaceable.

On farms, the problem can be not only the choice of a suitable hybrid for fattening, but also the availability of a sufficient number of chicks from the same breeding flock or from parents of similar age, so mixing chickens is often inevitable. That is why we wanted to compare chickens of the same genotype from breeding flocks of different ages, reared separately and together.

The aim of the experiment is to evaluate the production performance of broiler chickens of different hybrids (Cobb 500 and Ross 308) and the same hybrid (Ross 308) from two breeding flocks of different ages in equal, relatively suboptimal production conditions.

Materials and Methods

Experimental design and used birds

Comparative testing of production traits was performed on broilers of COBB 500 (from a 52-week-old breeding flock) and ROSS 308 proveniences from two breeding flocks of different ages (52^{nd} and 79^{th} week of age, with the older flock molted and in the second laying cycle). All chickens were procured from the

same local producer, incubated in the same machine by the same procedure, hatched and delivered to the experimental farm on the same day.

The trial was performed on a total of 720 one-day-old broiler chicks of both sexes in 4 experimental groups (**Cobb** - Cobb 500 broilers from the breeding flock aged 52 weeks; **Ross 52** - Ross 308 broilers from the 52-week-old parent flock; **Ross 79** - chickens of Ross 308 hibrid from 79-week-old breeding flock; **Ross mix** - a mixture of an equal number of Ross chicks from breeding flocks of different ages), with 6 replications per group and 30 chickens in each replication (180 chickens of both sexes in each group).

At the beginning of the trial, an individual initial visual inspection and weighing of the chickens were performed. All used birds in the trial were vital and in good condition. During the trial, the usual legally prescribed and technologically recommended preventive health care measures were performed.

Testing was performed at the Institute of Animal Husbandry, Belgrade - Zemun, Serbia, at the Experimental Broiler Farm in the period August/September 2020. The experiment and experimental procedures were evaluated and approved by the Ethics Committee of the Institute of Animal Husbandry Belgrade - Zemun.

Housing, rearing and feeding conditions

The chickens were kept in a floor system, in one room with group boxes for 30 broilers (stocking density 10 birds/m^2), on a litter of chopped straw. Food and water were given to the broilers ad libitum from one automatic bell drinker and two standard round feeders per box.

The lighting program during the first 10 days and the last three days of fattening was 23 hours of light (L) and 1 hour of darkness (D), and from the 11th to the 38th day in 24 hours 16L/4D/2L/2D.

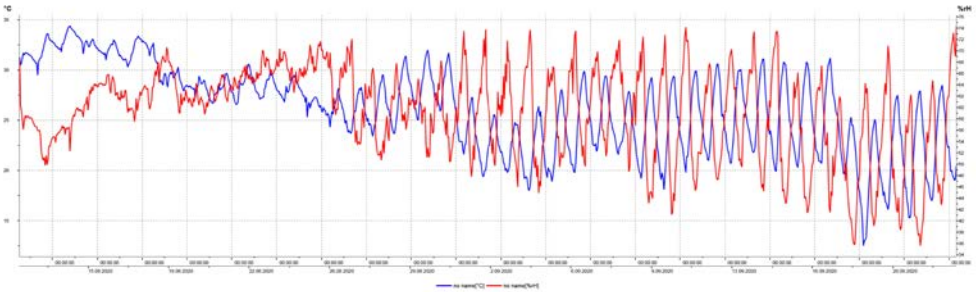
Ventilation and temperature in the facility are regulated by automatic switching on of heating (set temperature) and ventilation (by setting a timer, without the possibility of cooling the inlet air) according to the recommendations of the manufacturer of the used hybrids. Measurement of temperature and humidity data (Testo 174H, Testo SE & Co. KGaA, Germany) at the level of chickens was performed every hour. The ambient gases (Dräger X-am 7000, Drägerwerk AG & Co. KGaA, Germany), and air flow (Testo 410-2, Testo SE & Co. KGaA, Germany) were measured once daily in 5 different points in the facility, at the chickens level.

The average measured values of the indicators of ambient conditions during the experiment are shown in Table 1 and Graph 1.

Table 1. Weekly averages of ambient temperature (T), relative humidity (RH), air flow and concentration of individual ambient gases during the broiler test

Trial week	T Mean±SD (^{0}C)	T Min/Max (^{0}C)	RH Mean±SD (%)	RH Min/Max (%)	Air steam (m/s)	CO_2 (%)	NH_3 (ppm)
I	32±2	27/34	61±4	50/71	0-0.1	0.04	3
II	28±2	24/30	65±4	53/72	0.1-0.5	0.06	4
III	26±3	20/32	59±6	46/74	0.3-1.0	0.09	4
IV	24±3	18/30	59±8	41/74	0.3-1.0	0.1	5
V	25±3	20/31	57±9	41/74	0.3-1.0	0.3	10
VI	21±4	13/28	52±10	36/75	1.0	0.2	7

SD-standard deviation; Min/Max-minimal and maximal recorded values



Graph 1. Temperature ranges (blue curve, ^{0}C) and air humidity (red curve, % rH) during the 42-day broiler test (one-hour measurement interval)

Broiler nutrition

Broiler feed used up to the 35th day of fattening was purchased on the market. Starter and grower pelleted broiler complete feed mixtures were used, and the chosen commercial feed is an average quality (standard) option in the offer for broiler producers from the feed industry on the local market (feed factories mostly offer three price/quality options: economical, standard and premium program). From 36-42 days, the finisher complete mash broiler feed based on maize and soybean meal produced at the Institute of Animal Husbandry was used.

All used feed was chemically and microbiologically tested by accredited methods in the laboratory of the Institute of Animal Husbandry. The summarized results of the analysis of the basic chemical composition and microbiological correctness of all complete feed mixtures used in the test are shown in Table 2.

Table 2. Laboratory-determined characteristics of complete feed mixtures used in the test

Investigated parameters	Starter (0-15 days)	Grower (16-35 days)	Finisher (36-42 days)
Form of feed	Crumbles	Pellets	Mash
Moisture, %	8.69	8.03	10.28
Crude protein, %	22.21	19.45	18.71
Crude fat, %	5.04	5.44	5.72
Crude fibre, %	5.40	5.08	4.62
Ash, %	6.80	6.77	6.02
Calcium, %	0.94	0.96	0.82
Tot. phosphorus, %	0.90	0.81	0.67
Sodium, %	0.12	0.18	0.13
Starch, %	35.09	41.18	42.75
Soluble sugars, %	7.76	7.65	5.88
NFE*	51.86	55.23	54.65
ME, MJ/kg**	12.9	13.6	13.7
Mikrobiol. correct	Yes	Yes	Yes

* Nitrogen-free extractives (NFE) determined by calculation

** Metabolic energy (ME) estimated according to the Carpenter and Clegg equation (*Leeson and Summers, 2005*)

Measurement of broiler production parameters

The health condition of broilers was monitored and determined daily. All deaths in the trial were immediately recorded and measured, and mortality was calculated at the box level.

The individual body weight of each chick in the trial was measured when the chickens were housed, at the end of the first week, at the mid and at the end of fattening period (days 0, 7, 21 and 42). For the first two measurements, a calibrated scale CHYO MK 2000B (Chyo Balance Corp., Japan) with a measurement accuracy of 0.01g was used, and for the other measurements, a specialized scale for measuring poultry BAT 1 (Veit Electronics, Czech Republic) with a measurement accuracy of 1g was used. Simultaneously with the measurements of body weight, the consumption of feed per box was determined for the time interval between the two measurements.

Based on the recorded deaths, measured individual body weights of chickens and feed consumption per box, individual gain of chickens was calculated, as well as mortality and feed conversion (kg of feed/kg gain) at the box level for different observed periods of fattening.

For the duration of the experiment (42 days), the European Production Efficiency Factor (EPEF) was calculated, the usual cumulative indicator of broiler fattening success based on the achieved average body weight, vitality, feed conversion and fattening duration according to the equation: EPEF = (Liveweight,

kg x Livability, % / Age of depletion, days x Feed Conversion Ratio, kg feed/kg gain) x 100.

Statistical analysis

Body weight and weight gain were determined and analysed in each trial chicken, while box was used as the experimental unit for all other production parameters. The obtained results were processed with the statistical software package STATISTICA, version 8, (StatSoft Inc., 2009). The degree of statistical significance of differences in production parameters between groups was determined using the Tukey test. Significant were considered values with $p<0.05$.

Results of measurements are shown in the tables as the mean values (Mean) of a certain number of repetitions (n), as well as its standard deviation (SD) and standard error (SE).

Results and Discussion

Ambient conditions and nutrition

Ambient conditions measured at the broiler level (Table 1, Graph 1) were relatively optimal in the first three weeks of fattening, but suboptimal conditions were often recorded during the last three weeks, especially in terms of temperature (oscillations influenced by the outside temperature) and elevated gas concentration. Our test also confirmed the justification of the great attention paid to the problem of environmental control in genetic selection (*Tixier-Boichard, 2020*), as well as in the latest recommendations of both hybrid manufacturers (*Aviagen, 2018; Cobb-Vantress, 2018a*), especially given that extreme hot summers and cold winters are becoming more frequent globally, so their impact should be minimized as much as possible.

The results of feed analyses (Table 2) correspond to the declared, legally prescribed and expected basic chemical composition and quality, indicating that the feed used could potentially meet the average needs of the tested hybrids in terms of nutritional composition. It should be noted that, according to the manufacturer's declaration on the product, in used food there were no other additives (e.g. prebiotics, probiotics, phytoadditives) except the basic ones (synthetic lysine and methionine, phytase, coccidiostat).

In relation to the recommendations for tested hybrids, the food quality and nutrition program was not optimal for any of the hybrids. In general, the Cobb 500 requires a slightly lower crude protein and energy content, and four complete mixtures with a different inclusion schedule over 42 days of fattening (*Cobb-Vantress, 2018b*), while Ross recommends a slightly higher protein content (and lower energy) in the feed, and four mixtures in the nutrition program (*Aviagen,*

2019b). Also, for both hybrids, pelleted food is recommended until the end of fattening.

Body mass, weight gain and feed conversion ratio

Body weights of broilers in the trial determined during measurements at a certain age are shown in Tables 4 and 5. The achieved daily gains in the monitored periods of fattening are shown in Table 6.

The weight of hatched chickens was statistically significantly ($p<0.01$) lower in Ross 308 hybrids originating from the younger breeder flock (52 weeks), both compared to chickens from half a year older parents of the same hybrid, and compared to parents of the same age hybrid Cobb 500. Until the end of 42 days of fattening, these chickens remained nominally the lightest in the trial, and statistically significantly differed in body weight and daily gain from Cobb hybrids when measured at mid ($p<0.01$) and end of the trial ($p<0.05$), despite the fact that at the end of the first week of fattening they had uniform masses and gains.

In regard to the weight and quality of day-old chicks, it is known that with age in laying hens increases the size and weight of eggs and that larger one-day-old chicks can be expected from the breeding eggs of older parent flocks, which was confirmed in our research. *Nangsuay et al. (2016)* examined the influence of broiler parents age and broiler strain on hatched chickens, noting that primarily due to more feed for the embryo (especially yolks) and more oxygen due to better shell conductance in incubated eggs, differences in chicken development and quality can be expected. They have established that older parents also have more yolks in eggs of the same weight than younger ones, and that the Ross 308 is generally characterized by better conductivity of the shell of incubated eggs than the Cobb 500, which is not affected by the age of the flock. *Tona et al. (2010)* have monitored the parameters of embryonic development in the incubator and juvenile development in the first week after hatching of Cobb 500 and Ross 308 chickens originating from parents of the same age (52 weeks), concluding that Cobb and Ross embryonic chickens have different development trajectories, hence different patterns of juvenile growth, and that Cobb chickens reached higher weights at the end of the first week of growth, which was not confirmed in our study of the current genotypes of these hybrids.

Table 4. Average body weight (g) of chickens at housing and at the end of the first week of fattening

Group	0 day				7th day			
	n	Mean	SD	SE	n	Mean	SD	SE
Cobb	180	44.21^{A}	3.98	0.297	178	165.9^{ab}	23.59	1.768
Ross 52	180	42.23^{B}	3.32	0.247	177	162.9^{b}	21.42	1.609
Ross 79	180	43.35^{A}	3.45	0.257	175	169.5^{a}	21.56	1.649
Ross mix	180	43.15^{AB}	3.80	0.283	179	169.1^{a}	19.48	1.456
p value	$p<0.01$				$p<0.05$			

a-b - values between groups marked with different letters are significantly different (p <0.05)
A-B - values between groups marked with different letters are significantly different (p <0.01)

Table 5. Average body weight (g) of chickens after three and after six weeks of fattening

Group	21st day				42nd day			
	n	Mean	SD	SE	N	Mean	SD	SE
Cobb	169	867.3^{A}	145.2	11.55	164	2644^{a}	380.3	31.26
Ross 52	175	798.2^{B}	132.9	10.16	173	2512^{b}	384.1	29.89
Ross 79	173	826.9^{AB}	119.9	9.19	172	2523^{b}	339.7	26.53
Ross mix	175	806.1^{B}	119.3	9.15	172	2584^{ab}	354.9	27.63
p value	p<0.01				p<0.05			

a-b - values between groups marked with different letters are significantly different (p <0.05)
A-B - values between groups marked with different letters are significantly different (p <0.01)

Table 6. Average daily gain of broilers in the trial, g/chicken/day

Group	0-7 days				0-21 days				0-42 days			
	n	Mean	SD	SE	n	Mean	SD	SE	n	Mean	SD	SE
Cobb	178	17.41^{ab}	2.89	0.22	169	39.24^{a}	6.78	0.54	164	61.93^{a}	8.99	0.74
Ross 52	177	17.26^{b}	2.64	0.20	175	36.01^{b}	6.19	0.47	173	58.81^{b}	9.09	0.71
Ross 79	175	18.04^{a}	2.72	0.21	173	37.32^{b}	5.6	0.43	172	59.05^{b}	8.04	0.63
Ross mix	179	17.99^{a}	2.34	0.17	175	36.35^{b}	5.55	0.42	172	60.51^{ab}	8.39	0.65
p value	p<0.05				p<0.05				p<0.05			

a-b - values between groups marked with different letters are significantly different (p <0.05)

Recent data on monitoring and analysis of differences in quality and weight of one-day-old Cobb 500 and Ross 308 chickens from parents aged 32, 42 and 52 weeks in an incubator in Poland (*Nowak et al., 2019*) may be particularly relevant for our study, as they indicate relatively equal incubation results, quality and weights of hatched chickens in both genotypes, as well as to significantly higher weights of chickens of older parents. Also, *El-Tahawy et al. (2017)* following the results of 130 broiler farms in Egypt raised by these two hybrids, also have found no significant difference in the weights of day-old chicks. On the other hand, it must be emphasized that the weight of eggs and consequently the weight of hatched chickens can be influenced not only by genetics and age but also by broiler breeder flock nutrition, wich is not included in the experimental design and cannot be excluded as the cause of different weights, especially Cobb and Ross day-old chicks from parents of the same age.

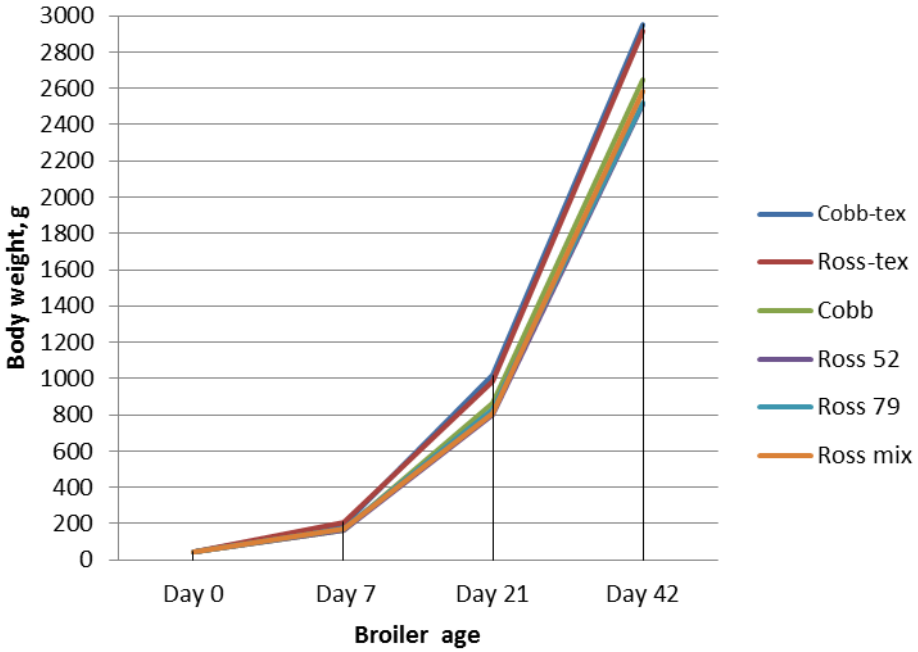
Except in the first week of fattening, Cobb 500 chickens generally reached the highest body weights and gains in the trial, although those at mid-fattening did not differ statistically significantly from the body weight of Ross 308 chickens of half a year older parents, and at the end of fattening from the mix of chickens from older and younger Ross parents. Achieved body weight and achieved daily gain of Ross 308 chickens originating from younger and older flocks did not differ statistically significantly in the mid and end of fattening, regardless of whether they

were reared separately or mixed, despite statistically significant differences in the initial ($p<0.01$) and weight after the first week of fattening ($p<0.05$).

As in the trial, chickens of different genotypes were kept in the same ambient conditions and fed the same feed, the differences in growth can be attributed primarily to the genetics of commercial hybrids, and consequently to a different reaction to suboptimal conditions. Combining previous research on the response of these two hybrids to marginal protein deficiencies in food, *Gous (2007)* points out that the Ross hybrid responds to such food with a lower growth due to lower food consumption compared to the Cobb hybrid and suggests that reason may be due to Ross breeding to growth improvement and the conversion efficiency of high-protein foods. The changes in food use in differently selected broiler genotypes depending on the differences in selection programs are indicated in the extensive study by *Tallentire et al. (2017).* It should be noted that, since the food used in the test according to the protein content was conditionally more in line with the recommended needs of the Cobb 500 hybrid (*Cobb-Vantress, 2018b*) than the Ross 308 hybrid (*Aviagen, 2019a*) whose recommendations are 1-2% higher in terms of protein content in food, this may have favoured Cobb's response to dietary conditions in our trial. Similar observations, that Ross 308 broilers may have higher lysine needs and exhibit better production performance in appropriate dietary conditions, were also made by *Sterling et al. (2006).*

By monitoring initial body weight at the beginning and end of the first week of fattening, it can be confirmed that heavier one-day-old chicks are obtained from older parent flocks, they grow better in the first week of fattening, in which the quality of the obtained chickens is crucial. However, from the results at the end of the test, it can be seen that the final body weight and daily gain in suboptimal fattening conditions are more influenced by genetics (used hybrid) than the age of the parent flock, despite higher initial weights of chickens from older parents. On the other hand, it is possible that in optimal conditions, the final test results would have been different and the influence of genetics on the final weights and achieved gains would have been lower, and the age of the parents higher. This is also indicated by *Leeson and Sumers (2005),* who reared broilers from parents aged 28, 38, 48 and 58 weeks in the same facility and standard conditions and noticed that with the age of the parents, the final and broiler carcass weights increased, especially in females. It should be noted that in our research, broilers from young and from middle-aged, the so-called prime breeders *(Yerpes et al., 2020*), were not used, but from parents in the final phase of the first cycle of laying (52 weeks) and broilers from parents in the second cycle of laying after moulting (79^{th} week), i.e. relatively old and "very" old parents regarding production life, which, judging by the available literature, was rarely compared.

Body weights achieved in suboptimal test conditions were compared with the latest technological norms of hybrid producers in Graph 2.



Graph 2. Current technological goals for body weight in intensive fattening of hybrids Cobb 500 (Cobb-tex) and Ross 308 (Ross-tex), and achieved body weights in the test of broiler Cobb 500 (Cobb), broiler Ross 308 from the parent flock of old 52 weeks (Ross 52), a flock of 79 weeks (Ross 79) and a mix of Ross broilers (Ross mix.)

In terms of the manifestation of the genetic potential of hybrids expressed by the technological goal (reaching a certain growth and body weight for a certain time of fattening on optimal conditions), in suboptimal conditions of our test both hybrids did not reach the target mass at seven days, and by the end of 42 weeks the weights were about 300 g (Cobb) to 400 g (Ross 52) lower than the current technological norms of the tested hybrids. At the same time, the maximum difference in the achieved final weights in the test among the experimental groups was significantly lower (Cobb weighs 132 g more than Ross 52 broilers). Similar to our results, *Pascalau et al. (2017)* in their evaluation of the production characteristics of these two hybrids in the same farm conditions of nutrition and care in Romania, have obtained higher final body weights in 42 days of fattening in Cobb hybrids, but generally significantly lower than the technological target (2298g for Cobb 500 and 2219 g for Ross 308), emphasizing the importance of fodder composition and optimal breeding conditions, all these varying from country to country. *El-Tahawy et al. (2017)* in a study of the productivity and

economy of 130 farms in Egypt that rear these two hybrids, also have found better final weights and gains in Cobb 500 hybrids in fattening for up to 35 days and in conditions characteristic of this country.

Achieved feed conversion ratios in different periods of fattening are shown in Table 7.

Table 7. Average feed conversion ratio (FCR) in broilers in the trial, kg of feed/kg gain

Group	0-7 days				0-21 days				0-42 days			
	n	Mean	SD	SE	n	Mean	SD	SE	n	Mean	SD	SE
Cobb	6	0.952	0.12	0.05	6	1.334	0.05	0,02	6	1.676	0.12	0.05
Ross 52	6	1.019	0.11	0.04	6	1.391	0.11	0,04	6	1.657	0.08	0.03
Ross 79	6	0.978	0.05	0.02	6	1.387	0.09	0,04	6	1.665	0.09	0.04
Ross mix	6	1.056	0.17	0.07	6	1.367	0.06	0,03	6	1.624	0.07	0.03
p value	p=0.476				p=0.623				p=0.789			

The obtained results indicate that the conversion of food in the experiment did not differ between the examined hybrids or in chickens obtained from parent flocks of different age. Similar to our results, *Hristakieva et al. (2014)*, in the test including these two hybrids under the same conditions, report similar feed conversion ratio, as well as heavier day-old chick and better gain of Cobb 500 hybrids, without specifying more precise ambient and feeding conditions during the test. And the authors who monitored the productivity of these two hybrids on farms in different countries (*Pascalau et al. 2017; El-Tahawy et al., 2017*) did not find significant differences in FCR between hybrids.

Mortality

The cumulative mortality of the tested broilers at the end of the experiment is shown in Table 8.

Table 8. Mortality of broilers during 42 days of fattening (% of housed chickens)

Group	n	Mortality		
		Mean	SD	SE
Cobb	6	8.89^{a}	4.67	1.91
Ross 52	6	4.17^{b}	2.74	1.12
Ross 79	6	4.44^{b}	3.75	1.53
Ross mix	6	4.47^{b}	2.74	1.12
p value:		p<0.05		

a-b - values between groups marked with different letters are significantly different (p <0.05)

In our trial, the Cobb 500 hybrid had a statistically significantly (p<0.05) higher mortality compared to Ross 308 (Table 3). This may be due to the greater sensitivity of this hybrid and/or the influence of the breeder flock (genetics, health status, nutrition, ambient conditions of the farm) on the quality and performance of

broilers, but not on the incubation as all chicks in the trial came from the same incubator. On the other hand, the Ross 308 hybrid exhibited relatively higher resistance to test conditions, which did not differ significantly in chickens originating from two different parent flocks, whether reared separately or mixed. It should be noted that the increased mortality and generally high percentages are partly due to the non-culling during the first week of fattening (which is a common practice on farms), but also to the determination on a small sample (at the level of repetition - 30 housed chickens).

Our results are contrary to the results of the authors who did not determine differences in mortality of these two hybrids, monitoring a small number of individuals in the studies (*Hristakieva et al., 2014; Pascalau et al., 2017). El-Tahawy et al. (2017)* also find no significant difference in mortality between these two hybrids on farms in general (about 2%), but indicate significantly higher mortality on small farms (up to 10,000 broilers), where Cobb 500 has a mortality of 6.15% and Ross 308 4.06%, which is explained by the relatively poorer farm conditions. On the other hand, analysing the factors that influenced the cumulative mortality in the first week of broiler fattening (including culled birds) in 2267 flocks in 253 fattening farms on 104 farms of one poultry company in Spain from 2015-2018, *Yerpes et al. (2020)* conclude that, among others, the genotype (breed) used and the age of the parents have a significant impact. The authors state that during the first week, chickens of Ross genotype died more (1.85%) than the Cobb genotype (1.72%), without specifying specific hybrids, and that broilers originating from older parents had higher mortality.

Broiler fattening production index

The calculated European Production Efficiency Factor (EPEF), the aggregate performance indicator of broiler fattening for the duration of the trial, is shown in Table 9.

Table 9. Achieved European Production Efficiency Factor (EPEF) during 42 days of testing

Group	n	EPEF		
		Mean	SD	SE
Cobb	6	345.3	48.8	19.9
Ross 52	6	347.2	29.6	12.1
Ross 79	6	346.5	36.2	14.8
Ross mix	6	364.2	27.9	11.4
p value:		p=0.782		

The achieved EPEF, the cumulative indicator of the final result and the success of fattening, were very similar among the trial groups, since the differences in body weight and growth rate on the one hand and sensitivity expressed by mortality on the other hand between the used hybrids countermand each other. This

leads to the conclusion that neither the different hybrids nor the age of the breeder flock affected the final result of fattening, as much as the conditions in which the chickens were reared and fed in this research, otherwise not so rare on broiler farms.

Conclusion

From the results of the comparative broiler test, it can be concluded that genetics (used hybrid) had a greater influence on the resistance expressed by mortality, final body weight and achieved daily gain in suboptimal fattening conditions than the age of the parent flock. At the same time, the greatest influence were the (suboptimal) conditions in our research (primarily nutrition) on the achievement of technological goals, in which Ross 308 showed less growth and greater resistance than Cobb 500 hybrids. On the other hand, the feed conversion ratio and the achieved production index of fattening in suboptimal conditions did not significantly depend on either the hybrid or the age of the parents. The assumption that in optimal conditions the manifested influence of genetics would be lower, and the age of the parents higher, needs to be further examined.

Komparativno ispitivanje proizvodnih osobina dva hibrida brojlera poreklom od roditelja različite starosti u suboptimalnim uslovima

Miloš Lukić, Zdenka Škrbić, Veselin Petričević, Nikola Delić, Nataša Tolimir, Vladimir Dosković, Simeon Rakonjac

Rezime

Komparativno ispitivanje proizvodnih osobina izvedeno je između brojlera COBB 500 od roditeljskog jata starog 52 nedelje i ROSS 308 od roditelja različitih starosti (52. nedelje i mitarenog jata u 79. nedelji starosti) u jednakim, relativno suboptimalnim uslovima gajenja (temperaturne oscilacije) i ishrane (tržišna hrana prosečnog kvaliteta). Ogled je izveden na ukupno 720 jednodnevnih pilića oba pola u 4 ogledne grupe (Cobb; Ross 52; Ross 79; Ross mix – mešavina Ross pilića od jata roditelja različite starosti), sa 6 ponavljanja po grupi i 30 pilića u svakom ponavljanju. Praćen je mortalitet, telesne mase (0, 7, 21. i 42. dana), prirast, konverzija hrane i proizvodni indeks (EPEF). Utvrđeno je da se od starijeg roditeljskog jata dobijaju teži jednodnevni pilići ($p<0.01$), koji bolje prirastaju u prvoj nedelji tova. Rezultata ogleda ukazuju i da na završnu telesnu masu i

ostvareni dnevni prirast u suboptimalnim uslovima testa veći uticaj ima genetika (korišćeni hibrid) od starosti roditeljskog jata. Cobb je generalno tokom testa imao najveće ($p<0.05$) telesne mase i priraste u ogledu, koje se na polovini tova nisu statistički značajno razlikovale od Ross 79 grupe pilića, odnosno na kraju tova od Ross mix grupe. Sa druge strane, Cobb 500 brojleri su imali značano veći mortalitet u uslovima testa ($p<0.05$). Konverzija hrane i ostvareni EPEF indeks tova nisu u testu značajnije varirali kod pilića različitih po genotipu, niti po starosti roditelja. Najveći uticaj je upravo (suboptimalnih) uslova u našem istraživanju na dostizanje genetičkog proizvodnog potencijala, sa supresivnim dejstvom na oba hibrida, većim na porast kod Ross 308, odnosno na otpornost merenu mortalitetom kod Cobb 500 hibrida.

Ključne reči: hibrid broilera, starost roditelja, suboptimalni uslovi, proizvodnja

Acknowledgment

This research was funded by the Ministry of Education, Science and Technological Development, Republic of Serbia, contracts: No 451-03-68/2020-14/200022, No 451-03-68/2020-14/200045, and 451-03-68/2020-14/200088.

References

AVIAGEN (2018): Ross Broiler Management Handbook. https://en.aviagen.com/brands/ross/products/ross-308. (accessed on 15 April 2019)
AVIAGEN (2019a): Ross 308 Broiler Nutrition Specifications. https://en.aviagen.com/brands/ross/products/ross-308. (accessed on 8 August 2020)
AVIAGEN (2019b): Ross 308 / Ross 308 FF Broiler Performance Objectives. https://en.aviagen.com/brands/ross/products/ross-308. (accessed on 8 August 2020)
COBB-VANTRESS (2018a): Broiler Management Guide. https://www.cobb-vantress.com/resource/management-guides. (accessed 15 April 2019)
COBB-VANTRESS (2018b): Cobb 500. Broiler Performance and Nutrition Supplement. https://www.cobb-vantress.com/products/cobb500. (accessed on 8 August 2020)
EL-TAHAWY A.A.S., TAHA A.E., ADEL A.S. (2017): Effect of flock size on the productive and economic efficiency of Ross 308 and Cobb 500 broilers. European Poultry Science, 81. doi: 10.1399/eps.2017.175
GILLESPIE J., NEHRING R., HALLAHAN C. (2017): New versus old broiler housing technology: Which leads to greater profit? Journal of Applied Poultry Research, 26, 72–83.

GOUS R. (2007): Predicting nutrient responses in poultry: future challenges. Animal, 1, 57-65.
HARTCHER K.M., LUM H.K. (2020): Genetic selection of broilers and welfare consequences: a review. World's Poultry Science Journal, 76, 1, 154-167.
HRISTAKIEVA P., MINCHEVA N., OBLAKOVA M., LALEV M., IVANOVA I. (2014): Effect of genotype on production traits in broiler chickens. Slovak Journal of Animal Science, 47, 1, 19-24.
LEESON S, SUMMERS J (2005): Commercial Poultry Nutrition. 3rd edition. University Books, Guelph, Ontario.
NANGSUAY A., R. MEIJERHOF R., VAN DEN ANKER I., HEETKAMP M.J.W., DE SOUZA MORITA V., KEMP B., VAN DEN BRAND H. (2016): Effects of breeder age, broiler strain, and eggshell temperature on development and physiological status of embryos and hatchlings. Poultry Science, 95, 1666–1679.
NATIONAL CHICKEN COUNCIL: https://www.nationalchickencouncil.org. (accessed on 19 October 2020)
NOWAK B., PAWLINA E., ILSKA K., MUCHA A., KRUSZYNSKI W. (2019): Breeder line and age affects the occurrence of developmental defects, the number of culled one-day old broiler chicks and their body mass. Veterinarni Medicina, 64, 7, 323–333.
PASCALAU S., CADAR M., RADUCU C., MARCHIS Z. (2017): Evaluation of productive performances in Ross 308 and Cobb 500 hybrids. ABAH Bioflux 9, 1, 22-27.
REPUBLIČKI ZAVOD ZA STATISTIKU: https://www.stat.gov.rs. (accessed on 19 October 2020)
STERLING K. G., PESTI G. M., BAKALLI R.I. (2006): Performance of Different Broiler Genotypes Fed Diets with Varying Levels of Dietary Crude Protein and Lysine. Poultry Science, 85, 1045–1054.
TALLENTIRE C.W., LEINONEN I., KYRIAZAKIS I. (2016): Breeding for efficiency in the broiler chicken: A review. Agronomy for Sustainable Development, 36, 66. doi: 10.1007/s13593-016-0398-2
TIXIER-BOICHARD M. (2020): From the jungle fowl to highly performing chickens: are we reaching limits? World's Poultry Science Journal, 76, 1, 2-17.
TONA K., ONAGBESAN O. M., KAMERS B., EVERAERT N., BRUGGEMAN V., DECUYPERE E. (2010): Comparison of Cobb and Ross strains in embryo physiology and chick juvenile growth. Poultry Science, 89, 1677–1683.
YERPES M., LLONCH P., MANTECA X. (2020): Factors Associated with Cumulative First-Week Mortality in Broiler Chicks. Animals, 10, 310. doi:10.3390/ani10020310

Received 11 November 2020; accepted for publication 22 December 2020