



Egg production characteristics of several Bulgarian chicken breeds

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Abstract: This study aimed to investigate and analyze the egg productivity of four Bulgarian chicken breeds, namely: Rhodope painted chicken (RPCh), Southwest Bulgarian chicken (SWBCh), Bulgarian longcrower (BL), and Struma chicken (SCh). The following traits were analyzed: age of sexual maturity (at 20% egg-laying intensity) (days); average daily feed intake (g); daily egg production and culled eggs (number); daily egg weight (g); livability (%). The following productive parameters were calculated: egg number per hen-housed; egg-laying intensity; feed conversion ratio (per kg of eggs); feed conversion per egg (g feed per egg); Egg Production Efficiency Index (EPEI). RPCh was identified as the earliest maturing group, reaching 20% egg-laying intensity at 157 days of age with the highest hen-housed egg production (223.9 eggs), whereas SCh exhibited the latest maturity, reaching this stage at 250 days of age and the lowest productivity (123.9 eggs). The highest average egg weight was recorded in the SCh group (58.0 ± 0.54 g), followed by the RPCh group (56.7 ± 1.84 g) and the BL group (56.0 ± 1.68 g), while the lowest average values were observed in the SWBCh group (50.9 ± 0.68 g). Based on the findings of this study, we can conclude that among all the tested Bulgarian chicken breeds, RPCh demonstrate the highest egg-laying potential. When compared to other purebred chickens, which are part of European genetic diversity, RPCh show superior performance in terms of age at sexual maturity, number of eggs produced per productive period, and egg weight.

Keywords: Rhodope Painted Chicken, Southwest Bulgarian Chicken, Bulgarian Longcrower, Struma Chicken

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Introduction

Global poultry production has steadily increased, driven by rising demand for affordable and accessible animal protein sources (OECD-FAO, 2017). According to OECD-FAO (2024), of the approximately 354 million tonnes of meat produced worldwide in 2023, around 139 million tonnes were from poultry, making it the leading category with nearly 40% of the total production. The majority of this poultry meat production is chicken, with about 103.5 million tonnes produced in 2023 (USDA FAS, 2024). A similar trend is observed in egg production, with approximately 97 million tonnes produced in 2023, of which around 94% were chicken eggs (FAO, 2024). Regionally, the EU produced about 13.3

million tonnes of poultry meat (Eurostat, 2024) and 6.7 million tonnes of eggs (EC, 2023a) in 2023. This highlights the dominant role of domestic chickens in both global and regional poultry farming. In Bulgaria, poultry farming is one of the most advanced livestock sectors, with poultry meat accounting for over half of the country's total meat production (Genchev and Lukanov, 2025).

Parallel to the positive development of the poultry sector, a negative trend is observed regarding the preservation of genetic diversity in domestic chickens (Malomane et al, 2019). In modern industrial poultry farming, highly productive lines from just a few chicken breeds are used (Teneva et al, 2015; Preisinger, 2021) out of the vast number of breeds known worldwide. In addition to productive purposes, the domestic chicken serves a variety of other functions in human life (ornamental, exhibition, sporting, etc.), which form the foundation for the breed diversity observed within the species

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(Lukanov, 2017a). Historically, numerous attempts have been made to classify chicken breeds based on factors such as origin, purpose, plumage, body size and other characteristics (BDRG, 2006; Roberts, 2008; APA, 2023; Kochish *et al*, 2023). Among these, the combined classification appears to be the most comprehensive. It categorizes chicken breeds into the following groups: meat breeds, egg-laying breeds, dual-purpose breeds, fighting breeds and ornamental breeds (including long-tailed, long-crowing, true bantams, miniature breeds and other ornamental varieties) (Lukanov, 2017a). The preservation of breed and genetic diversity in domestic chickens globally is predominantly attributed to the efforts of hobbyist poultry breeders, in conjunction with national poultry genetic centres, where such institutions are present (Teneva *et al*, 2015; Pavlova and Lukanov, 2024).

In Bulgaria, a total of ten chicken breeds are recognized, seven of which are of standard body size, and three are true bantams (Lukanov, 2023). Birds that do not exhibit signs of dwarfism are considered standard breeds, whereas those that do are classified as bantams. These include the Katunitsa chicken, Black Shumen chicken, Stara Zagora Red chicken, Struma chicken, Southwest Bulgarian chicken, Bulgarian longcrower, Rhodope painted chicken, Bregovska dzhinka, Struma bantam, and Southwest Bulgarian dzhinka (Lukanov and Pavlova, 2021; Pavlova and Lukanov, 2024). Among these, the Struma chicken (SCh), Rhodope painted chicken (RPCh), Southwest Bulgarian chicken (SWBCh) and Bulgarian longcrower (BL) share a similar geographical origin in Southwestern Bulgaria (Lukanov, 2023). The referenced study has investigated the incubation characteristics of eggs from these four breeds, while another has examined the exterior traits of these local Bulgarian chicken breeds (Pavlova and Lukanov, 2023). All four breeds are of standard size (standard chicken breeds), with three of them (SWBCh, SCh and BL) being typical ornamental breeds, while RPCh can be classified as a dual-purpose breed. Egg production is one of the most important economic factors in the poultry industry (El-Sabrou *et al*, 2022), as it is essential for both table egg production and hatching eggs. In this context, the traits that characterize egg productivity are significant for various branches of poultry farming, including backyard and ornamental poultry. To date, there has been no assessment of RPCh, SWBCh, BL and SCh egg-laying productivity, which would reveal their potential in this area. In this context, the aim of the present study was to investigate and analyze the egg productivity of RPCh, SWBCh, BL and SCh breeds.

Material and methods

Experimental design

The study was conducted from September 2022 to November 2023 at the experimental station of the Poultry Science Section, Faculty of Agriculture, Trakia University, Stara Zagora, Bulgaria. For the purposes of the study, hatching eggs were collected for incubation from various breeders of the tested breeds as follows: 276 hatching eggs from the RPCh breed (6 farms, 6 breeding groups), 366 from the BL breed (4 farms, 7 breeding groups), 254 from the SWBCh breed (5 farms, 5 breeding groups), and 180 from the SCh breed (2 farms, 5 breeding groups). The resulting chicks were reared at the same experimental station until the beginning of the trial. The study included typical representatives of the Rhodope painted chicken (RPCh), Southwest Bulgarian

chicken (SWBCh), Bulgarian longcrower (BL), and Struma chicken (SCh) breeds, all at the same initial age of 140 days. Four groups of 25 pullets each were formed, corresponding to the four breeds and designated as RPCh, SWBCh, BL and SCh. The study covered one laying cycle, from the onset of egg production (20% laying rate) to the start of natural molting, lasting 52 weeks in RPCh, 49 weeks in SWBCh, 52 weeks in BL, and 40 weeks in SCh. The differences in the test period are due to variations in age at sexual maturity among the breeds.

Experimental bird management

The birds were housed on a deep litter system in a semi-enclosed facility divided into four pens, each measuring 2.5×4 m, with an initial density of 2.5 birds per m^2 . Each group's housing was fitted with natural light openings of identical size, providing an approximate individual area of $3m^2$ and allowing continuous exposure to diffused natural daylight throughout the full natural photoperiod. Perches were provided at one end of the pen, ensuring a minimum perch space of 20cm per bird. A nest was provided for every five hens (a module of five individual nests in each pen). The facilities were equipped with manually refillable pan feeders and automatic cup drinkers, appropriately adjusted to the number of birds in each pen (Genchev and Lukanov, 2025). Feeding was *ad libitum* with a balanced compound feed in two phases: pre-laying and laying phase (Table 1). Feed consumption was recorded daily by weighing the feed residue remaining 24 hours after the feed was supplied, and was calculated as the average daily feed intake (ADFI) per bird. Eggs were collected regularly throughout the period of highest laying activity, from morning until early afternoon, with an additional collection in the late afternoon. The total number of eggs collected per day was considered the daily yield and was used to calculate daily egg production. Following collection, the eggs were weighed to calculate the average daily egg weight. Climate control was not implemented due to the facility's specifics and the birds' management system. Temperature (instantaneous, minimum and maximum) was monitored using a digital thermometer (TFA Dostmann Ltd.) installed in the 'birds' room', away from direct sunlight. The minimum recorded temperature during the entire period was $-6.6^{\circ}C$ on 11 February 2023, while the maximum was $38.5^{\circ}C$ on 4 August 2023. The presented data on ambient temperature refer to the average daily values recorded by the Stara Zagora meteorological station.

For the purposes of the study, a lighting programme with additional artificial lighting was used, similar to those applied in intensive poultry farming in open-house systems. In our conditions, the birds were housed with a natural day length of approximately 12 hours. Additional artificial lighting was applied for ten days (until they reached 150 days of age) to gradually extend the day length to 14 hours by the end of these ten days. At 157 days of age, the day length was further increased by one hour, reaching 15 hours, with nine hours of darkness. Two weeks later (171 days of age), the day length was increased by one more hour, reaching 16 hours of daylight and eight hours of darkness. By the end of the test period, a day length of 16 hours was maintained. The extension of the photoperiod was accomplished by delaying the onset of the dark phase, with artificial lighting provided following the end of the natural daylight period.

Table 1. Nutritional composition of the compound feed used. *, time of first egg production in the group

Component	Pre-lay phase (140 days of age – maturity*)	Laying phase (whole egg-laying period)
Metabolized energy, MJ/kg	11.6	11.5
Crude protein, %	17.5	17.0
Lysine, %	0.75	0.8
Methionine, %	0.36	0.35
Calcium, %	2.0	3.8
av. Phosphorus	0.43	0.38

Egg production data collection

The following traits were analyzed: age of sexual maturity (at 20% laying rate) (days); average daily feed intake (g); daily egg production and culled eggs, number; daily egg weight (g); livability for the entire production period (including culled birds) (%). The following productive parameters were calculated: egg number per hen-housed; egg-laying intensity (laying rate) (%); feed conversion ratio (per kg of eggs); feed conversion per egg (g feed per egg). The egg production efficiency index (EPEI) was calculated by using the formula (Lukanov et al, 2023):

$$\text{EPEI} = [(L \times \text{DEMP}) / \text{FCR}] \times 100,$$

where: L is livability for the period (%), DEMP is daily egg mass produced (kg), and FCR is the feed conversion ratio (kg/kg egg mass).

$$\text{DEMP} = (\text{CHDEP} \times \text{AEW}) / t,$$

where: CHDEP is the cumulative hen-day egg production for the period (number), AEW is the average egg weight (kg), and t is the period (days).

Statistical analysis

Statistical analyses were conducted using the IBM® SPSS® Statistics software package (version 26). A one-way analysis of variance (one-way ANOVA) was applied to assess inter-group differences. The following statistical parameters were calculated for data analysis and interpretation: mean value ($\bar{x}$) and standard error of the mean (SEM). Data are expressed as mean $\pm$ SEM.

Inter-group differences were considered statistically significant at $P < 0.05$, based on the LSD post hoc test, provided that the assumptions of normality (Shapiro–Wilk test; $n < 50$) were met and the ANOVA model was significant (F-test, $P < 0.05$). Microsoft Excel 16.0 (2018, Windows version) was used for the graphical presentation of the results.

Results

Figure 1 illustrates the changes in egg-laying intensity over the entire productive period for the tested groups of hens. Peak values of 77.1% laying intensity for RPCh group were recorded during the 24th productive week, with an average weekly ambient temperature of 10.4°C.

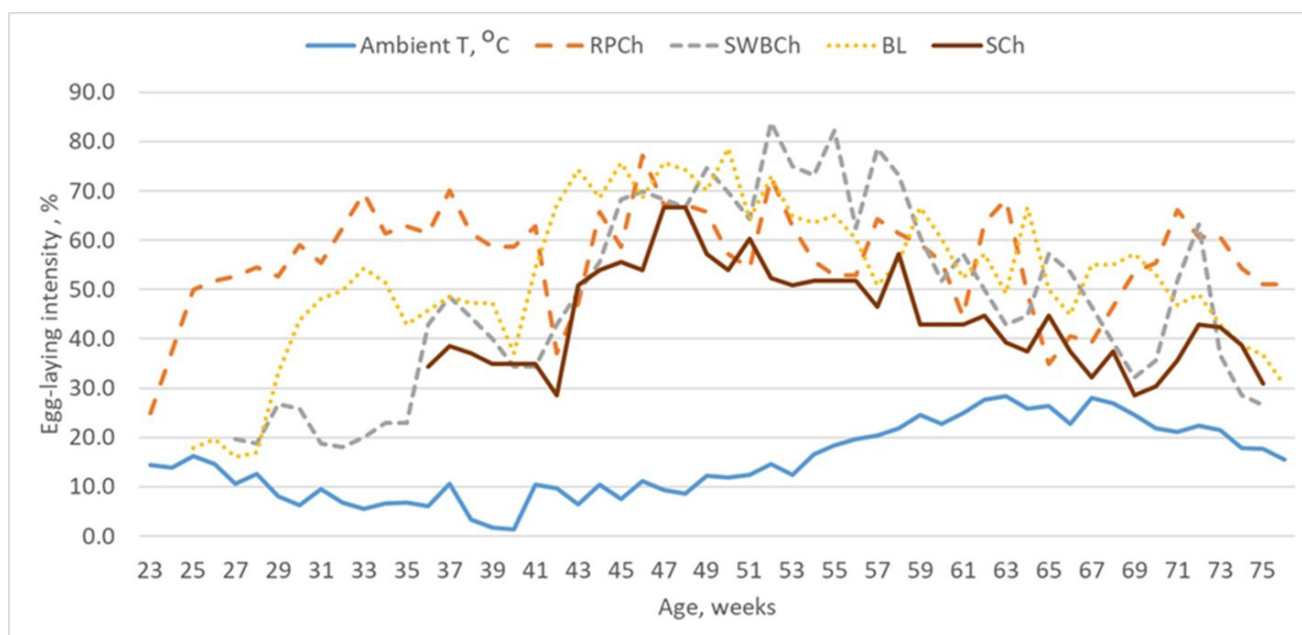


Figure 1. Egg-laying intensity recorded throughout the entire productive period. RPCh, Rhodepe painted chicken; SWBCh, Southwest Bulgarian chicken; BL, Bulgarian longcrower; Sch, Struma chicken.

In contrast to RPCh, the SWBCh group showed a significantly delayed onset of productive maturity, reaching 20% laying rate at 179 days of age. This breed was characterized by a slow increase in laying performance, with the 50% threshold commonly used in industrial poultry production being reached only at 217 days of age. In this group, a sharp increase in laying intensity was observed after the 15th production week, reaching a peak value of 83.9% in the 26th week. A high laying rate was maintained until approximately the 32nd production week, after which the curve showed a marked decline. The SWBCh group also exhibited a shorter productive period. By week 49, the average weekly egg production had declined to 26.5%, with the majority of birds already undergoing molt.

In the BL group, 20% laying intensity was reached at 179 days of age, while the threshold of 50% was attained at 215 days. As with the other studied breeds, a typical laying curve characteristic of intensive poultry systems was not observed. A laying intensity of approximately 70% or higher was maintained between the 18th and 28th productive weeks, corresponding to ambient temperatures favourable for the species. Peak average weekly laying performance reached 78.6% during the 26th productive week. Unlike SWBCh birds, BL hens showed no sharp temperature-induced decline. A more substantial decrease was recorded only after the 48th productive week, likely linked to the onset of molting in some individuals and a gradual reduction in egg production within the group, declining to 30.6% by the 52nd productive week.

The SCh group was identified as the slowest-maturing among all the studied breeds, reaching a 20% laying rate at 250 days of age, with the first egg being laid slightly earlier, at 232 days. The genetic background, combined with the natural rearing conditions, is directly associated with the observed short productive period in the SCh group, which lasted for 40 weeks. When analyzing the dynamics of the trait change over the testing period, no significant differences in the laying curve are observed compared to the RPCh and BL groups. The later sexual maturity of the birds is also linked to the fact that the first half of the productive period occurred under more favourable ambient temperatures, which likely

contributed to the relatively rapid achievement of peak production. For the SCh group, peak egg production values can be considered those above 50%, sustained between the 8th and 23rd productive weeks. The highest weekly average values for this trait were recorded in the 13th productive week (66.7%). Similar to the other groups, a decline in productivity is observed in parallel with the increasing age of the birds and ambient temperatures, with the dynamics of this decline being comparable to those of RPCh and BL groups.

The change in egg weight during the productive period in the RPCh group followed a typical growth curve with increasing age (Figure 2). At the start of the productive period, the average egg weight was 41.8g, gradually rising to the threshold of 53g by the 13th week. As the ambient temperature increased, a significant decline in laying intensity was observed, which coincided with the final third of the productive period. In terms of changes in SWBCh egg weight, no significant variation was observed throughout the entire laying period. In comparison to RPCh, which exhibited a 33.2% difference between the minimum and maximum average weekly egg weight, the variation in SWBCh was considerably lower, amounting to only 17.9%. At the beginning of the production cycle, the average weekly egg weight was 45.5g, reaching approximately 50g within 5–6 weeks. Peak values were recorded in the middle of the laying period (weeks 17–29), coinciding with favourable ambient temperature conditions. Unlike RPCh, the SWBCh group was characterized by a significantly lower egg weight, almost entirely falling within the S size category (< 53g) (EC, 2023b).

The egg weight in the BL group showed a rate of change throughout the productive period similar to the RPCh group, with the difference between the minimum and maximum weekly averages being 32.3%. In this breed, the optimal egg weight of 53g was reached by the 12th productive week and was maintained within the range of 53–62g until the end of the testing period. The highest weekly average egg weight was 62.2g, recorded in the 50th productive week.

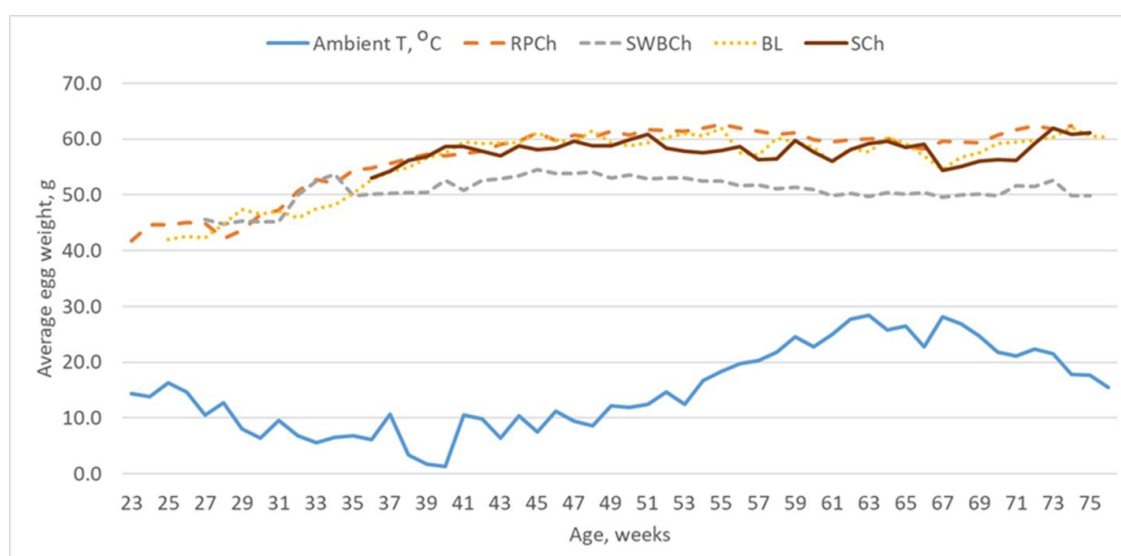


Figure 2. Average egg weight recorded throughout the entire productive period. RPCh, Rhodope painted chicken; SWBCh, Southwest Bulgarian chicken; BL, Bulgarian longcrower; SCh, Struma chicken.

The SCh egg weight exhibited the least fluctuation when compared to the reported minimum and maximum weekly average values throughout the entire productive period across all tested groups, with a difference of only 14.33%. This breed also showed the highest initial weekly average weight, which was 53.04g in the first productive week. The maximum weekly average egg weight was recorded in the 38th productive week, at 61.9g. In contrast to all other breeds included in the experiment, only the Struma chicken maintained egg weights throughout the entire productive period that consistently fell within the M weight category (53–62g) (EC, 2023b), based on the weekly average.

Patterns of average daily feed intake were generally similar among the four experimental groups, although RPCh exhibited more pronounced fluctuations up to approximately mid-lay (Figure 3). The highest intakes were recorded during the first half of the productive cycle, with RPCh consistently showing the greatest values (peaking above 160 g/day), followed by SWBCh, BL and SCh. As average daily ambient temperatures increased in late spring and summer,

feed intake gradually declined across all groups, remaining at lower levels until the onset of molting or the end of the experimental period. The SCh group maintained the most stable intake pattern throughout the cycle, with only minor variations relative to seasonal changes in temperature.

The calculated EPEI for each of the four breeds included in the study is presented in Figure 4. This index reflects the efficiency of producing both table and hatching eggs. Lower EPEI values indicate less efficient production. Notably, the RPCh group recorded the highest efficiency (EPEI = 65.08), clearly distinguishing itself from the other breeds. The second-highest value was observed in the BL group, although it was 32.6% lower than that of RPCh. The least efficient performance was observed in the SWBCh and SCh groups, with EPEI values of 28.84 and 29.89, respectively. Liveability is one of the main parameters influencing the EPEI. Over the entire production period, the overall liveability of hens from the four groups was identical at 80%, with five birds per group lost due to mortality or culling, predominantly during the final stage of the laying period.

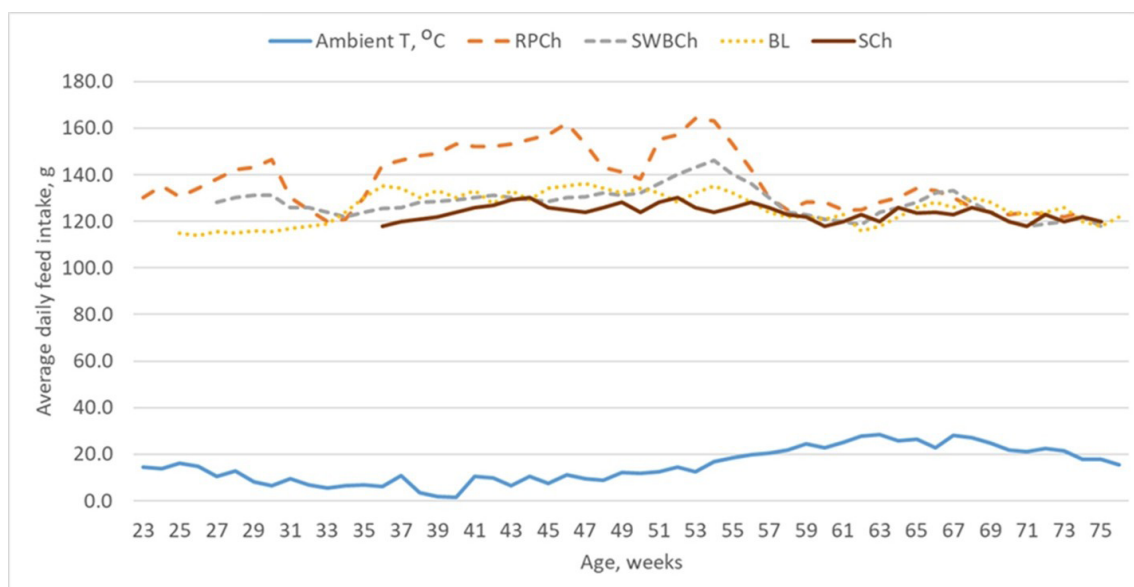


Figure 3. Average daily feed intake recorded throughout the entire productive period. RPCh, Rhodope painted chicken; SWBCh, Southwest Bulgarian chicken; BL, Bulgarian longcrower; SCh, Struma chicken.

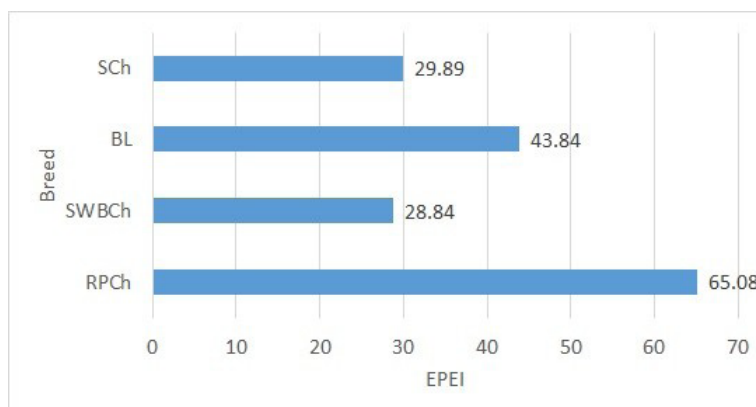


Figure 4. Egg production efficiency index (EPEI) calculated for each tested breed. SCh, Struma chicken; BL, Bulgarian longcrower; SWBCh, Southwest Bulgarian chicken; RPCh, Rhodope painted chicken.

Table 2 summarizes the results regarding the key parameters related to egg production in the four studied breeds. As previously noted, the RPCh group exhibited the earliest onset of sexual maturity, while the SCh group was the latest. The remaining two groups (BL and SWBCh) can be classified as intermediate in terms of sexual maturity.

Among the studied groups, RPCh exhibited the highest productivity, with a total of 223.9 eggs laid over a 52-week production period, corresponding to a laying rate of 57.4%. In contrast, the SCh group showed the lowest performance, producing 123.9 eggs – 44.7% less than RPCh – which equates to a laying rate of 33.9%. The remaining two groups, BL and SWBCh, displayed intermediate levels of productivity, with the BL group showing a higher production potential, recording 191.6 eggs during the same 52-week period and a laying rate of 52.5%.

According to the data presented in **Table 2**, the breed with the highest egg weight was SCh (58.0 ± 0.54 g), while the lowest was observed in SWBCh (50.9 ± 0.68 g) ($P < 0.001$). The other two groups (BL and RPCh) showed mean values similar to the SCh group, and their differences from the SWBCh group were also statistically significant ($P < 0.05$).

Considering the average egg weight and the number of eggs produced by the hen-housed, it can be summarized that the highest total egg mass per productive cycle was achieved by the RPCh group (approximately 12.7kg), followed by the BL group (10.73kg), SWBCh (8.49kg) and SCh (7.18kg).

Table 2 presents two expressions of feed converting efficiency, represented as the feed conversion ratio for producing one kilogram of egg mass or the feed required to produce a single egg. In this study, the most cost-effective feed conversion was observed in the RPCh group (244.1 ± 9.2 g of feed required to produce one egg and 4.34 ± 0.18 kg of feed required to yield one kilogram of eggs). Conversely, the least efficient feed conversion was observed in the SWBCh group (328.3 ± 47.95 g of feed required to produce one egg and 6.55 ± 1.04 kg of feed required to yield one kilogram of eggs).

Discussion

Age at sexual maturity is a major factor considered in selection for egg-laying poultry, as it represents an important reproductive trait (Xu *et al.*, 2011; Liu *et al.*, 2019; Genchev and Lukanov, 2025). Giesbrecht and Nordskog (1963) used the 20% level as the lowest point with reliable data when estimating age at sexual maturity, while suggesting 50% as the optimal threshold. Some authors propose an even lower threshold – such as a 10% laying rate – when evaluating the onset of maturity in indigenous chicken breeds (Schreiter and Freick, 2023). Hens from the RPCh group reached 20% laying rate at 157 days of age, with the age for reaching 50% laying rate, considered a benchmark in productive poultry farming (Genchev and Lukanov, 2025), being 162 days. Compared to the age of sexual maturity in modern high-performance laying hens (around 140–150 days), RPCh is relatively close, differing by approximately two weeks. When compared to purebred chickens that have not undergone targeted, scientifically based selection, RPCh ranks among early-maturing breeds, reaching sexual maturity at approximately 4.5 to 5.5 months (Lukanov, 2017a). The Spanish breed Asturian painted chicken, which is somewhat similar in exterior to RPCh but slightly larger and more massive (Pavlova, 2024), shows official data indicating a later maturation age of around 7 months (MAPA, 2025).

According to the 20% laying intensity and the threshold of 50% in the BL group, they are classified as a typical medium-maturing breed (Lukanov, 2017a). The late onset of sexual maturity, like in the SCh group, is characteristic of many large chicken breeds (Lukanov, 2017a).

The curve representing the laying intensity of the tested groups of hens does not follow the typical shape observed in hens raised under controlled microclimatic conditions. This is related to the rearing method, where the birds are kept in natural temperature conditions. In adult birds, the thermoneutral zone can be broadly defined, starting from

Table 2. Egg production parameters of the tested Bulgarian chicken breeds. Means $\pm$ SEM followed by the same letter are not significantly different at $P < 0.05$. RPCh, Rhodepe Painted chicken; SWBCh, Southwest Bulgarian chicken; BL, Bulgarian Longcrower; SCh, Struma chicken; SM, Sexual maturity (at 20% egg-laying intensity); ADFI, average daily feed intake; AMEPR, average monthly egg production rate; HHEP, hen-housed egg production; AELI, average egg-laying intensity; AEW, average egg weight; FCR, feed conversion ratio; FCE, feed conversion per egg; SEM, standard error of the mean.

Breed	SM, days	ADFI, g	AMEPR, eggs	HHEP, eggs	AELI, %	AEW, g	FCR, kg/kg	FCE, g/egg
RPCh n = 25	157	138.5 ± 3.67 abc	17.2 ± 0.62 a	223.9	57.4 ± 2.08 a	56.7 ± 1.84 a	4.34 ± 0.18 ab	244.1 ± 9.2 a
SWBCh n = 25	191	129.0 ± 1.67 ad	13.9 ± 1.56	166.6	46.3 ± 5.19 ab	50.9 ± 0.68 abc	6.55 ± 1.04 a	328.3 ± 47.95
BL n = 25	179	127.1 ± 2.85 b	14.7 ± 1.22	191.6	52.5 ± 4.08 c	56.0 ± 1.68 b	5.45 ± 0.98	291.2 ± 38.56
SCh n = 25	250	122.1 ± 2.52 cd	12.4 ± 0.89 a	123.9	33.9 ± 2.98 abc	58.0 ± 0.54 c	5.35 ± 0.41 b	308.8 ± 22.49 a
ANOVA (P-value)		< 0.001	< 0.05		< 0.05	< 0.01	< 0.05	< 0.05

16°C (Poku et al, 2024) and reaching up to 29.9°C (Ribeiro et al, 2020), with an optimal range of 18°C to 22°C at a relative humidity of 50–75% (Kamanli et al, 2015). Temperature fluctuations have a significant impact on hens raised under such conditions, reflected in substantial variations in the laying curve (Gerzilov, 2011). A similarly negative effect of high daily temperatures on egg production has been reported by other authors (Gerzilov, 2011; Yoshida et al, 2011; Kim et al, 2024). This is mainly explained by heat stress, mediated by the reduced feed consumption of the birds (Getabalew and Negash, 2020). Under natural rearing conditions typical of the temperate climate in Bulgaria, birds are exposed not only to heat stress, mainly during the summer months (July, August and June), but also to cold stress, especially during the winter months (December, January and February). Cold stress is recognized as an environmental and managerial challenge, particularly in regions where temperatures regularly fall below 18°C (Kim et al, 2023). Similar to heat stress, birds exposed to temperatures lower than the thermoneutral zone exhibit negative parameters related to egg production (Torki et al, 2015; Li et al, 2020; Kim et al, 2023).

The number of eggs produced by an individual hen is a critical parameter in the selection process in modern poultry farming, while hen-housed egg production serves as a key indicator of the laying performance at the group level (Liu et al, 2019). The egg production capacity of local breeds, compared to modern results from high-productivity strains used in industrial poultry farming, shows a striking difference, especially over an extended productive period, which is commonly applied to modern egg-laying hens (El-Sabrou et al, 2022). It should be noted that modern egg-laying hybrids demonstrate this capacity under optimal rearing and feeding conditions. In contrast, local breeds are better adapted to the environment, i.e. when raised under uncontrolled conditions with limitations in optimal nutrition. This makes them valuable as a genetic reserve, including for potential inclusion in future breeding programmes (Chebo et al, 2022). The results obtained in this study position RPCh and BL as breeds with high genetic potential for egg production, when compared to other purebred chickens (BDRG, 2006; Henning et al, 2017; Lukanov, 2017a; Schreiter and Freick, 2023). Comparing RPCh with the data presented for the Asturian Painted Chicken (average of 160 eggs; MAPA, 2025), it can be said that the former shows significantly higher potential in terms of laying capacity. The egg production recorded for SCh over the productive period is comparable to that of other large ornamental chicken breeds, such as Brahma, Cochin and Orpington (Hrnčár et al, 2015).

Modern commercial laying hens produce eggs with an average weight of 62–65g over the entire laying period (Genchev and Lukanov, 2025). Globally, however, average egg weight tends to be slightly lower, around 60–61g, with regional preferences influencing egg size (Thiruvankadan et al, 2010). The detrimental impact of elevated ambient temperatures on egg weight in domestic hens has been thoroughly documented by Bennion and Warren (1933). Similar to egg production, egg weight is adversely affected by heat stress and reduced feed intake of the birds (Kilic and Simsek, 2013).

The RPCh breed, identified in the study as having the highest laying performance, produced eggs with a lower average weight compared to the larger Asturian Painted

Chicken, which reaches an average of 65g (MAPA, 2025). The low egg weight observed in SWBCh corresponds to the lower range of the trait reported for the breed by Pavlova (2024), namely 50–55g. Regarding egg weight, the Bulgarian longcrower exhibits typical values reported for other Balkan long-crowing chicken breeds (Lukanov, 2012; Rózewicz and Kaszperuk, 2018). The Turkish breed Denizli, which is believed to be close to the Balkan long-crowing breeds (Lukanov, 2017b), is reported in various sources to have a lower average egg weight of 50–52g (Fidan and Nazlıgül, 2012; Özdemir et al, 2013) to values similar to those of BL (BDRG, 2006; Özdoğan et al, 2007; Kaya and Yıldız, 2014). In a review focused on Bulgarian chicken breeds, a lower egg weight range (50–55g) was suggested for BL; however, this estimate was based on preliminary assumptions rather than comprehensive research (Lukanov et al, 2021). According to Lukanov (2023), both RPCh and BL exhibited slightly greater egg weights, likely attributable to the advanced age of the hens, including those in their second productive cycle.

The egg weight reported by Hrnčár et al, (2015) for three large ornamental breeds (Brahma, Cochin and Orpington) is significantly lower than that of SCh. The recorded egg weight in the Struma chicken breed is consistent with the findings of a more recent study (Lukanov, 2023) and higher than the average values reported for the breed prior to these detailed investigations (Lukanov, 2012; Teneva et al, 2015; Lukanov, 2017a). Comparison with the other large native Bulgarian breed – the Katunitsa chicken – shows that the latter has higher egg weight (Gerzilov et al, 2015) and reaches sexual maturity significantly earlier (Nikolov and Gerzilov, 2011).

The average egg weight observed in all four tested Bulgarian chicken breeds is lower compared to that of commercial layers subjected to targeted selection for traits related to egg production, including egg weight. Nevertheless, the two breeds demonstrating the highest laying potential – RPCh and BL – exhibited relatively high egg weights when compared to many other local breeds. As no focused selection for this trait has been applied to these populations, their current performance suggests a promising potential for further genetic improvement in this direction.

The egg production efficiency index (EPEI) is a dimensionless indicator combining liveability, egg production and feed conversion into a single score, with higher values indicating better overall production efficiency. The calculated EPEI is significantly lower in all four studied breeds compared to the modern laying hybrids, in which the reference value is approximately 230 (Lukanov et al, 2023). These differences can be explained by the lower egg production parameters observed in the local chicken breeds included in the present study, as well as by the higher proportion of culls (which negatively affects liveability), compared with the optimal values reported for commercial hybrids in the cited study. The reduced efficiency in SCh and SWBCh groups can be largely explained by the limited laying performance in the SCh group and the lower average egg weight recorded in the SWBCh.

Feed conversion is an important economic trait that reflects the efficiency of converting feed into finished production (eggs), primarily determined by the feed conversion ratio (FCR) (Li et al, 2024). It is well known that feed constitutes a significant portion of the production cost in egg-laying poultry farming (Farooq et al, 2002; Thiruvankadan et al, 2010), with considerable variation observed depending on the farming practices applied (Kato et al, 2022). The results

obtained regarding feed conversion are comparable to those reported for EPEI. When comparing the feed transformation efficiency of the four experimental groups of hens with the current performance levels of modern white- and brown-egg laying hybrids, it is evident that the experimental groups lag considerably behind. Even the best-performing group, RPCh, exhibited approximately twice the values for both types of FCR compared with those of modern commercial laying (Churchil and Suresh, 2021; Genchev and Lukanov, 2025). Studies involving various non-commercial chicken breeds report variable FCR values, ranging from those similar to modern laying hybrids (Besari *et al.*, 2017) to higher values similar to our results (Lukanov *et al.*, 2016; Phuong and Nha, 2024), or even more striking differences in some low-performing breeds (Nguyen Van *et al.*, 2020).

Conclusion

The results of the study indicate that the Rhodope painted chicken (RPCh) breed demonstrates the highest potential in terms of egg production characteristics, followed by the Bulgarian longcrown (BL). Both breeds are distinguished by early maturity, with this trait being particularly pronounced in RPCh. Egg production in these two indigenous breeds is above average compared to other purebred chickens that are not part of industrial poultry farming. Due to their high egg production, egg weight and low feed consumption compared to the other three tested breeds, the RPCh group demonstrates the most efficient egg production. The two other tested breeds, the Struma chicken and the Southwest Bulgarian chicken, display less favourable characteristics in terms of egg productivity. The good egg production and attractive exterior of the RPCh and BL breeds provide strong grounds for their significant potential in amateur and backyard poultry farming.

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Author contributions

Hristo Lukanov and Ivelina Pavlova contributed equally to the conception and design of the study, the execution of the experimental work, data analysis, and manuscript preparation. Atanas Genchev participated in the development and optimization of the experimental methodology and provided technical support during data collection. Todor Petrov was responsible for monitoring the productivity parameters.

Conflict of interest statement

The authors declare that there is no conflict of interest.

Ethics statement

All experimental procedures involving animals were carried out in accordance with the relevant institutional and national regulations for the ethical treatment of animals. Since the study involved only routine productivity assessment under normal housing conditions, no specific ethical approval was necessary.

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