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Bodyweight and Egg Weight of Campero Casilda Dual-Purpose Hen

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ABSTRACT

Background: The implementation of productive strategies using semi-captivity hens under more familiar conditions to the natural behavior of the species requires adapted phenotypes. These populations require dual-purpose animals, which can produce meat and eggs as part of the current industrial aviculture. **Aim.** To evaluate the dynamic growth patterns and egg weight, compared to the commercial heavy breeders. **Materials and methods:** The body weight was checked weekly, between birth and 60 weeks, and the eggs were weighed between sexual maturity and the end of the cycle, in 100 Campero Casilda hens. The body weight data versus chronological age were adjusted according to the Gompertz model, and the egg's weekly weight versus egg age, according to the Weatherup & Foster model. The same adjustment was done to the data collected from the managing guides corresponding to heavy breeding hens Ross308® and Cobb500®. The average values of parameter estimators with a biological significance for the Gompertz and Weatherup & Foster for the Campero Casilda were compared to the reference values corresponding to the commercial breeders, using Student T for a single population sample. **Results:** Campero Casilda showed better asymptotic body weight and a lower rate of maturation than the two reference genotypes. The asymptotic weight and egg maturation rates did not differ significantly from Ross308® and were higher than Cobb500®. **Conclusions:** Campero Casilda showed a favorable combination of both dynamic patterns –body weight and egg weight. It is a choice of dual-purpose genotype for alternative poultry systems.

Keywords: poultry, meat, eggs, mathematical models (*Source: MeSH)*

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INTRODUCTION

Among the alternative nutritional systems, the implementation of productive strategies using semi-caged birds under more familiar conditions to the natural behavior of the species requires adapted phenotypes. These populations require dual-purpose animals, which can produce meat and eggs as part of the current industrial aviculture. The utilization of this type of bird avoids sacrificing every one-day-old male chicken born, a practice opposed to the philosophy in favor of organic production and the ethical principles of a world in which millions of people suffer from chronic hunger, or die directly due to the lack of food (Leenstra *et al*., 2011; Krautwald-Junghanns *et al*., 2018; Busse *et al*., 2019).

If these birds are unsuitable for intensive production (Leenstra, Horne, and Krimpen, 2010; Damme, 2015), they can be useful to farmers who can utilize a particular niche of the market associated with the demand for products generated in more friendly systems, both to the animal and the environment (Hammershøj, Kristiansen, and Steenfeldt; 2021). Its production is also linked to vulnerable populations in terms of food safety and greater productivity of yard aviculture based, generally, on the rearing of highly rustic local birds, with limited yields (Mack, Hoffmann and Otte, 2005; Alders and Pym, 2009). Campero Casilda is crossbred from three lines, which is suggested as a dual-purpose bird to be used in alternative systems that preserve animal wellbeing, and evaluated for meat production satisfactorily (Canet *et al*., 2021). The utilization of females as layers, and eventually as culled hens, faces the challenge of genetic incompatibility between the growth speed (associated with meat production), and the reproductive traits linked to oviposition (Robinson *et al*., 1993; Barbato, 1999).

Although the laying curve is adequate (Romera *et al*., 2020), the characterization of these heavy birds for laying requires the study of the growth patterns and increased egg growth. This paper aims to evaluate the dynamic growth patterns and egg weight, compared to two genotypes of heavy commercial breeders.

MATERIALS AND METHODS

Birds

The study evaluated the Campero Casilda birds, a three-way crossing including AH synthetic rooster population (50% Hubbard, 50% gray Anak line) and hens from the crossing between ES synthetic males (87.5% Cornish Colorado 12.5% Rhode Island Red), and A synthetic females (75% Cornish Colorado 25% Rhode Island Red). The synthetic populations were generated and are maintained in the Aviculture Section of the Experimental Agricultural Station Agricultural Eng. Walter Kugler, belonging to the National Institute of Agricultural Technology (INTA), Argentina, whose facilities were used for the crossings and incubations. At birth, the animals received a shot against Marek disease, then were wing-tagged, and taken to the Faculty of Veterinary Sciences at the National University of Rosario. All the birds were included in the sanitary plan and were kept under the conditions set up in the production protocol of campero chicken (Bonino, 1997).

Between the confinement and 35 days of age, the chickens were reared on the floor, having an initial stocking rate of 25 birds/m^2 until 15 days. Then it was reduced to 10 birds/m^2, decreasing photoperiod with a minimum dark cycle of 8 hours and free access to water and food. In the 5th week of age, 100 chickens chosen at random were placed in individual laying cages (30 cm wide x 42 cm high x 50 cm deep). The birds received the starter feed (18 % PB; 2.875 kcal EM) between birth and 8 weeks; development feed (15,4 % PB; 2.881 kcal EM), between weeks 9 and 16; pre-laying feed (16 % PB; 2.833 kcal EM), between weeks 17 and 22; and Laying feed (15,6 % PB; 2.824 kcal EM), from week 22 on. As heavy birds, in week 6, feed consumption was reduced, following the handling protocols for campero breeding birds, depending on their body weight and egg production from that moment and until the end of the cycle.

Method:

The individual bodyweight of all hens was checked weekly, between birth and 60 weeks. The eggs laid between sexual maturity and the end of the first laying cycle were weighed.

The individual data of body weight (g), chronological age (weeks), were fit to the Gompertz sigmoid model (Fitzhugh, 1976): Wp(t)= Ap exp (-b exp (-k*t)), where: Wp(t) = body weight in time t, Ap = asymptotic body weight (Wt value when $t \rightarrow \infty$, b = position parameter integration constant without a biological value , k = maturation rate (approximation speed to A), and t = chronological age (weeks).

The average weekly egg weight (g) and laying age (weeks) of every bird were fit to the Weatherup and Foster asymptotic exponential model (1980): Wh(t) = Ah - B * (r^t), where Wh(t) = egg weight (g) in time t, Ah = asymptotic egg weight, B = egg weight range between the start of laying and the asymptote, (A-B) = theoretical weight of the first egg, r = maturation rate for egg weight, approximation speed to the value of A ($0 \leq r \leq 1$), and t = laying time in weeks.

In the two cases, the fits were performed through non-linear regression, using an iterative technique based on the Marquardt algorithm (Marquardt, 1963), and its goodness was evaluated according to the convergence of the iterations of the non-linear regression program in a solution of the coefficient value of the non-linear determination fit (R^2), and normality (D'Agostino & Pearson omnibus test), and random (test of cycles or streaks) of residual distribution. Simultaneously, the same fit was done to the data of body and egg weight collected from the managing guides corresponding to heavy breeding hens Ross308® and Cobb500® and published by the respective commercial companies Aviagen (2017) and Cobb-Vantress (2013).

Statistical analysis

The parameter estimators with a biological significance, asymptotic body weight (Ap) and maturation rate for body weight (k), asymptotic egg weight (Ah), egg weight range between the beginning of laying and the asymptote (B), and maturation rate of egg weight (r), were treated as new random variables. The average values of parameter estimators above were compared to the reference values corresponding to the commercial breeders, using a Student T-test for a single population sample.

RESULTS AND DISCUSSION

Dynamic pattern of dimensional growth

The Campero Casilda birds grew to asymptotic weight Ap= 3.468 ± 33.7 g (arithmetic mean ± standard error), which was significantly lower than the one corresponding to the two reference genotypes (Ross308®: 4.168 g; t= 20.8; p< 0.0001 and Cobb500®: 4.119 g; t= 19.3; p< 0.0001). Contrary to expectations, due to the frequent negative association between the asymptotic size and the speed to reach it, Campero Casilda showed a lower maturation rate of body weight (k= 0.0816 ± 0.00152 g^{-1}) than Ross308® (k= 0.0943 g^{-1}; t = 8.322; p< 0.0001) and Cobb500® (k= 0.1009 g^{-1}; t = 12.68; p< 0.0001). Fig. 1 summarizes the behavior of the theoretical growth curves of the three genetic groups.

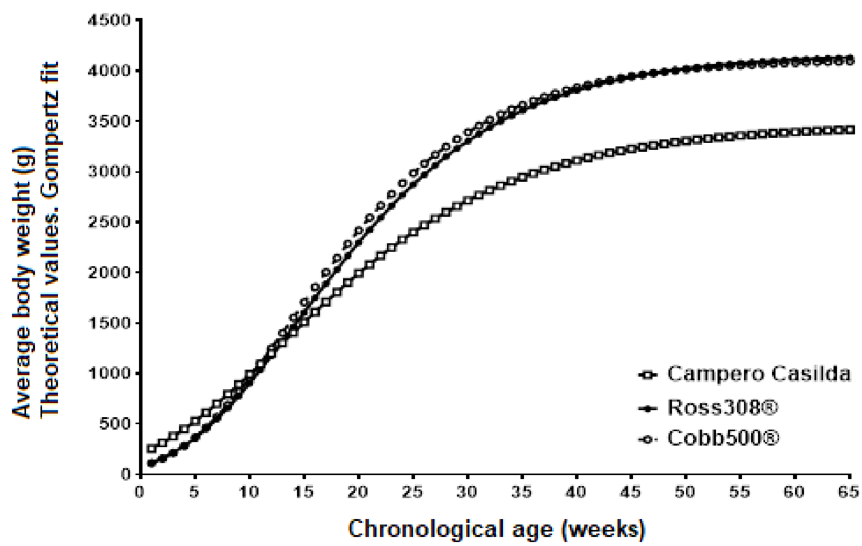

Figure 1. Pattern of theoretical dimensional growth of Campero Casilda hens and two commercial genotypes of heavy layers

Dynamic egg weight increase pattern depending on the age at laying

Campero Casilda took an asymptotic value (Ah= 72.8 ± 0.83 g) that did not differ significantly from the values corresponding to breeders Ross308® (Ah= 71.9 g; t= 1.117; p= 0.245), though it was higher than Cobb500® (Ah= 70.8 g; t= 2.465; p= 0.015). Different from the k parameter of the Gompertz sigmoid function that shows a direct relation between the value of its estimator and the maturation rate of body weight (the greater k value, the greater approximation speed to the asymptotic bodyweight Ap), the r parameter of the Weatherup & Foster asymptotic exponential function showed an inverse association with the maturation rate of egg weight (the greater the r value, the lower the speed of approximation to the egg asymptotic weight Ah). Campero Casilda underwent an average value of the estimator of the maturation rate of egg weight (r= 0.9396 ± 0.00452 g^{-1}) that did not differ significantly from the values corresponding to breeders Ross308® (r= 0.9397 g^{-1}; t= 1.351; p= 0.180), though it was higher than Cobb500® (r= 0.9056 g^{-1}; t= 6.196; p< 0.0001), which indicated a similar approximation speed to the egg asymptotic speed (Ah) in the former, and lower in the latter. The egg weight increase range (b) between the first egg and their asymptotic value (Ah) of Campero Casilda (21.3 ± 0.67 g) was similar to the two reference genotypes (Ross308®: 21.4 g; t= 0.178; p= 0.859 and Cobb500®: 21.2 g; t= 0.179; p= 0.882). Lastly, the average weight estimated (Ah-B) from Campero Casilda (51.6 ± 0.55 g) was slightly higher than the Ross308® (50.5 g; t= 1.930; p= 0.056), and significantly higher than Cobb500® (49.6 g; t= 3.574; p= 0.005). Fig. 2 summarizes the performance of the theoretical growth curves of egg weight modification in the three genetic groups.

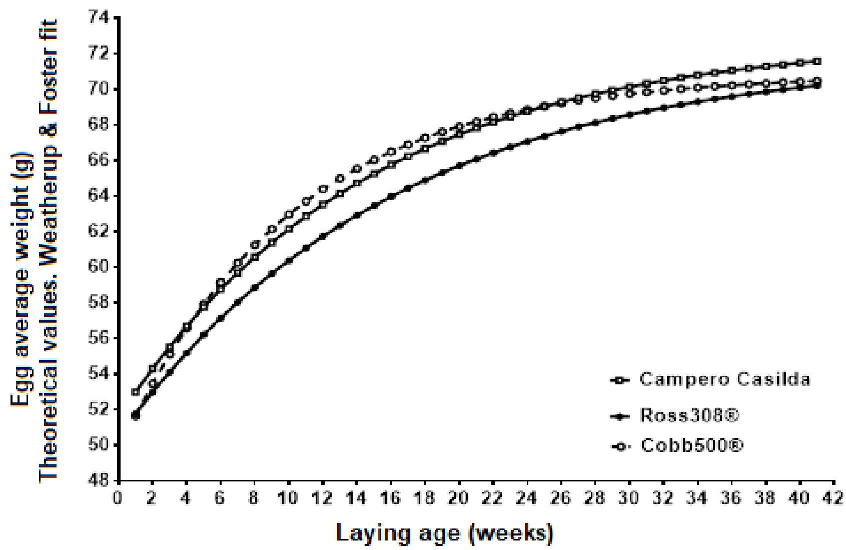

Figure 2. Theoretical pattern of egg weight increase of Campero Casilda hens and two commercial genotypes of heavy layers

The proposal of a dual-purpose production faces the challenge of creating compatibility between growth and production, two aspects with an unfavorable genetic association. The comparison of the productive behavior of Campero Casilda to commercial breeders can be explained by the condition of heavy birds. Although the comparison of the laying curves (Romera *et al*., 2020) showed a production peak of 4.7% lower than Ross308®, and 4.4% lower than Cobb500®, three weeks after Ross308®, and two weeks after Cobb500®, it is compatible with the proposal of using them as layers. Upon the addition of this piece of evidence, this study shows that compared to the two reference genotypes, the Campero Casilda birds have a growth pattern consisting of lower asymptotic weight and a lower maturation rate or speed of approximation to that weight. In light of this behavior, which is common in this experimental crossing, against the two commercial breeders, the weight of eggs from Campero

Casilda increased up to a similar asymptotic value and similar speed as Ross308®, with a range between the weight of the first egg and the asymptotic weight, respectively, and a somewhat higher theoretical weight estimated. Meanwhile, the comparison with Cobb500® revealed that the eggs laid by Campero Casilda showed a modification pattern more inclined to a greater asymptotic value at a lower speed, with an increased range between the first egg weight and the coinciding asymptotic weight, as well as the higher theoretical weight of the first egg laid. These results evidence certain independence of the genetic base with a polygenic nature that controls the dynamics of body weight and egg weight, already observed in other studies (Di Masso, *et al*, 1998), which means that there is a possibility to combine more favorable dynamic patterns in one hen from the two variables having an unquestionable productive transcendence in laying.

CONCLUSIONS

In Productive terms, and compared to the reference commercial genotypes, the three-way crossing Campero Casilda showed a favorable combination of both dynamic patterns –body weight and egg weight. Its lower body weight constitutes an advantage, since, given the positive relationship between weight and consumption, it may be linked to lower feeding costs. Simultaneously, and despite the positive body weight/egg weight relation, the lower bird weight does not have a negative effect on egg weight, making Campero Casilda a reference with at least these two attributes expressed in the females. It is a dual-purpose choice within the context of alternative aviculture context.

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AUTHOR CONTRIBUTION

Author participation was as follows: Conception and design of research: BMR, ZEC, AMD and RJDM; data analysis: BMR, RF and RJDM; data interpretation: BMR, ZEC, RF, AMD and RJDM and redaction of the manuscript: BMR and RJDM.

CONFLICT OF INTERESTS

The authors declare the existence of no conflicts of interest.