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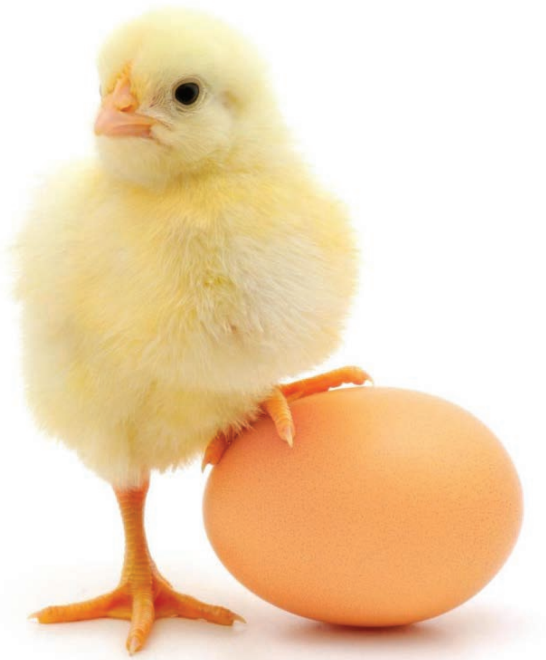

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Research Article
The Importance of Weight Control at Rearing in the Productive Aspects of Free-Range Hens

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Abstract
Background and Objective: Alternative production systems have been welcomed and supported by consumers and egg producers. However, the classic free-range layer farming is a profitable business and suitable to produce egg and meat. The production performance of a layer is determined during the rearing phase. Thus, proper management is essential in order to achieve adequate weight and body composition at the beginning of the production phase so that the birds may reach the fullness of their genetic potential. In this sense, this study was conducted to evaluate the effect of the management on maintaining the weight uniformity of birds during rearing phase and on the production performance of laying hens. **Materials and Methods:** This study used the database of the Laboratory of Poultry Science, referring to Hy Line Brown® chickens of the AVIUFSC Lot 018, raised during the period from March 28, 2019 to January 22, 2021. The obtained data were used to determine the growth curves until the end of the rearing phase. The data were also used for exploratory principal component analysis (PCA). Mean and variance of body weight per week per group in the rearing phase before and after the relocation was calculated. **Results:** Raising semi-heavy chickens without controlling weight uniformity during rearing phase produced lighter and more heterogeneous pullets. During rearing, grouping of pullets according to their weight produced more uniform and heavier pullets at transfer age. Heavier pullets become hens with higher egg production per week up to 49 weeks of age. **Conclusion:** Grouping of pullets according to weight during rearing phase produced more uniform and heavier pullets at transfer age.

Key words: Free-range model, hens, hy-line brown, layer farming, productive aspects

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Layer farming has greatly developed in Brazil due to increased technological investment in genetic improvement, nutrition, health and management of commercial strains. In addition, the growing demand for high quality and low-cost animal protein has increased the per capita egg consumption (255 eggs per capita in 2021) that is almost 4 eggs more than the previous year[1].

Commercial layer farming depends on the production of a quality chicken. Therefore, Therefore, it is essential to acquire healthy chicks from suppliers. Proper poultry management is an important component from arrival of chicks at the farm to the growth and transfer of the birds to the production house. Thus, with adequate weight and body composition at the beginning of the production phase, the birds will tend to reach the fullness of their genetic potential. If the flock has problems during rearing phase, the deficiencies are unlikely to be corrected in the production phase[2].

Chicken weight is the most practical and common way to evaluate flock quality, at rearing. However, at the time of transfer to the production house, the weight should not be considered as the only evaluation tool, it should be accompanied by a history of bird development [3].

The development of laying birds follows a multiphase pattern. The first growth wave occurs from the first to fifth week of age, a period when the digestive system and vital organs develop rapidly. The second growth wave occurs from the sixth to the twelfth week of age, a period when the bones, muscles and feathers develop most rapidly. Finally, the third growth wave occurs from the 12th week until the end of the rearing phase, when the development of the reproductive system occurs[4,5]. Thus, the maintenance of optimal growth, in each of the phases, will be reflected in the productivity of the future chicken. It is also desirable to end the rearing phase with a good fat reserve in order to provide body reserve for the pre-peak phase that can lead to sudden increase in egg production when birds are still growing and have low feed intake[6].

This project was developed to evaluate the effect of body weight of laying hens during rearing, laying and production phase. The present study aimed to evaluate the effect of homogenization management of laying hens on pullet development and its implications on the productive characteristics during the productive phase.

MATERIALS AND METHODS

Bird management and facilities: The heating, lighting, vaccination and feeding program for Hy-Line Brown chicken was managed according to the manual. The birds were reared up to 17 weeks of age (rearing phase) and they were transferred to the production house at 8 weeks of age and grouped according to the weight. The rearing house was divided into three stalls, equipped with a tubular feeder and pendular (bell type) drinking trough, providing food and water at will.

The production house was also divided into 3 units, for Light weight (16 m^2), Medium weight (30 m^2) and Heavy weight (16 m^2) birds. Each unit was equipped with tubular feeders, pendular drinkers, nests for egg collection and perches. The birds had access to external enclosures for foraging and performing other natural behavioral practices. The pasture was composed of grass (*Cynodon dactylon*) and *Cynodon* spp.. Population density in the outdoor environment was two birds per m^2.

Experimental birds were handled as recommended by the manual of the strain. Birds were vaccinated according to the standard protocol of the Aviculture-UFSC Laboratory. The birds were weighed weekly, until culling of birds, at 92 weeks of age. Eggs were collected four times a day, three in the morning and one in the evening.

Experimental design and variables analyzed: To conduct this study, the database of the Laboratory of poultry science was used, referring to Hy Line Brown® chickens of the AVIUFSC Lot 018, raised during the period from March 28, 2019 to January 22, 2021, making up 92 weeks of age. Upon housing, the birds were weighed individually to obtain the average weight and standard deviation (33.5 g$\pm$3.36 g), Birds were divided into 3 groups according to their weight: Light weight group (23-29 g, n = 75), Middle weight group (30-36 g = 150) and Heavy weight group (37-44 g, n = 75). The birds were weighed weekly and at eight weeks of age, they were regrouped, according to the new weight. The new categories established were: Lightweight (<600 g = 75), Middle weight (651-690 g = 150) and Heavyweight (>690 g, n = 75).

The growth profile of the pullets during the entire rearing phase (up to 17 weeks of age) was performed to verify the effect of grouping on the productive performance of the hens. The growth curve for different weight categories was obtained by weighing the pullets weekly from day 0-8 weeks of age. Using these data, the prediction equations for the growth curve up to 17 weeks of age were determined, when the birds were transferred to the production phase.

After regrouping, weight of the birds was maintained until transfer to the production phase. These weighing data were used to determine the growth curves until the end of the rearing phase. The data obtained were also used for exploratory principal component analysis (PCA), to verify if the regrouping of the birds at 8 weeks of age improved the production performance of the hens.

Average egg production per bird per week was recorded from start of laying to 49 weeks of age to measure the production performance of hens. That is, in each week it was found that which group of birds (heavy, medium, or light) showed the highest egg production per bird. The hens with the highest egg production per week were placed in class 1 and those with the lowest production were placed in class 2.

Mean and variance of body weight per week per group in the rearing phase before the relocation (from housing to 8 weeks of age) and after the relocation (from 7-17 weeks of age) was calculated. The influence of regrouping according to the weight of birds in classes 1 and 2 was also studied.

RESULTS AND DISCUSSION

The predicted growth curves up to 17 weeks of age in pullets of different weight categories are shown in Fig. 1. It is possible to observe that during the rearing phase, body weights fit a simple linear regression model.

Thus, this model was applied for each weight category, considering the weighing data from 0-8 weeks of age (Table 1-3). The regression analysis for the Heavy group of birds is presented in Table 1.

The analysis indicated that during the rearing phase, birds were classified as "heavy birds" at housing (weight = 0.098753/week). The probability value ($p = 2.2*10^{-16}$) showed a linear relationship between the data. Coefficient of determination ($R^2 = 0.9697$) indicated 96.97% of the variance for a dependent variable and best fit of the model to the data. The regression analysis for the average weight of birds from 0-8 weeks of age is presented in Table 2.

The analysis indicated that during the rearing phase the average weight of bird was 0.0890086/week. The p-value ($2.2*10^{-16}$) and coefficient of determination ($R^2 = 0.9668$) indicated that there was a linear relationship between the weight and age of birds (weeks) and the linear model explained 96.68% of the variance in weight and age (weeks) and model was best fit for the given data set. The regression analysis for the light weight birds from 0-8 weeks of age is presented in Table 3.

Figure 2 shows the predicted growth curve for birds during the rearing phase. Table 3 indicates that the weight of "light weight birds" is 0.0813154/week. The probability value ($p = 2.2*10^{-16}$), showed that there was a linear relationship between the data and a coefficient of

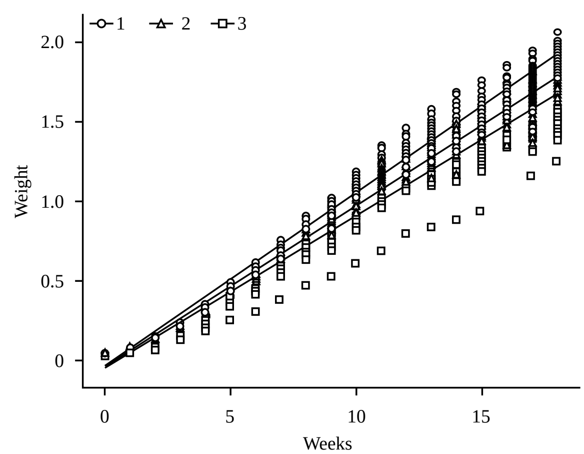

Fig. 1: Growth curves (body weight) of Hy-Line brown pullets, grouped to housing according to body weight-heavy chicks (class 1), medium weight chicks (class 2) and light weight chicks (class 3)

Table: 1: Linear regression coefficients for weight of pullets in the period from 0-8 weeks of age, grouped to the housing as heavyweight

Coefficient	Estimated	Standard error	t value	Probability
Intercept	-0.038691	0.00431	-8.969	$<2e^{-16***}$
Week	0.098753	0.001015	97.283	$<2e^{-16***}$

Residual standard deviation: 0.03769, Coefficient of determination: 0.9697

Table 2: Linear regression coefficients for weight of pullets in the period from 0-8 weeks of age, grouped to the housing as a middleweight

Coefficient	Estimated	Standard error	t value	Probability
Intercept	-0.0244147	0.0027135	-8.997	$<2e^{-}16^{***}$
Week	0.0890086	0.0006487	137.220	$<2e^{-}16^{***}$

Residual standard error: 0.3783, Determination coefficient: 0.9668

Table 3: Linear regression coefficients for weight of pullets in the period from 0-8 weeks of age, grouped to housing as lightweight

Coefficient	Estimated	Standard error	t value	Probability
Intercept	-0.0243758	0.0029149	-8.363	$4.35e^{-}16^{***}$
Week	0.0813154	0.0006967	116.717	$<2e^{-}16^{***}$

Residual standard error: 0.0391, Determination coefficient: 0.958

Table 4: Linear regression coefficients for pullet weight at 8-17 weeks of age in the new weight group of birds determined at 8 weeks of age

Coefficient	Estimated	Standard error	t value	Probability
Intercept	-0.0577007	0.0053533	-10.78	$<2e^{-16}$***
Week	0.1100256	0.0004991	220.46	$<2e^{-16}$ ***

Residual standard error: 0.07311, Determination coefficient: 0.9852

Table 5: Linear regression coefficients for pullet weight at 8-17 weeks of age grouped at 8 weeks of age in the middleweight category

Coefficient	Estimated	Standard error	t value	Probability
Intercept	-0.0411145	0.0031726	-12.96	$<2e^{-16}$***
Week	0.1004320	0.0003045	329.88	$<2e^{-16}$***

Residual standard error: 0.06463, Determination coefficient: 0.9864

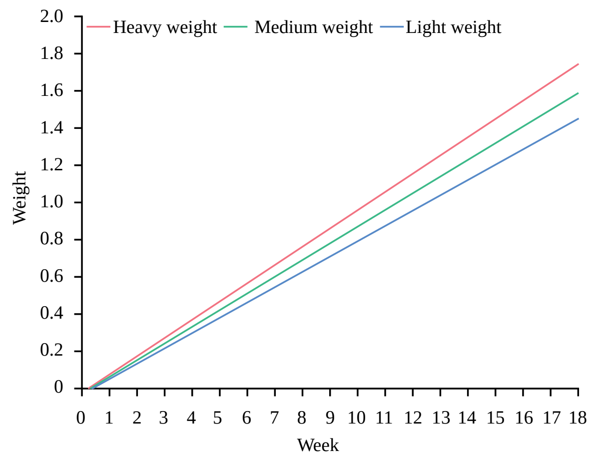

Fig. 2: Predicted growth curve (kg) for the rearing phase, in pullets grouped at housing, in body weight categories such as heavyweight, medium weight or lightweight

determination ($R^2 = 0.958$) indicated 95.8% of the variance in weight and model was best fit for the given data set.

For each weight class the good fit models for the given data set were obtained. These models made it possible to obtain the predicted mean values for each weight class from housing to 17 weeks of age. It means that it is possible to find out the average weight that each group of birds would attain in each week until their transfer to the production house.

Using these equations, the predicted values for the weights of the animals for the entire rearing period (week 0-17) was calculated. Figure 2 shows the predicted growth curve for the rearing phase.

During the rearing phase, growth of birds is natural in a heterogeneous manner and it may be possible to have larger pullets and lighter birds in the same flock[7]. This weight variation present since hatching, tends to increase as the birds grow, making the flock increasingly non uniform in Fig. 2. However, weight uniformity at the time of transfer is considered profitable because homogeneous flocks reach sexual maturity at the correct age with higher peak of laying and more uniform egg production. It also leads to higher number of eggs per bird and decreased occurrence of prolapse[8,9]. There was a correlation between the body weight of the birds at rearing and egg production. Ray *et al.*[9] and Los *et al.*[10] have already indicated this hypothesis that focused on the need of establishing reference periods regarding control and uniformity of body weight. Therefore, inadequate management at the time of training of the birds, in its different structures, can negatively impact the performance of birds in the production phase.

For this reason, at 8 weeks of age, the birds were regrouped, according to the new weight standards achieved. The new categories established were: Lightweight (<600 g, n = 75), Middleweight (651-690 g, n = 150) and Heavyweight (>690 g, n = 75). Pullets remained in their respective categories until transfer to the production phase at the end of the 17th week. With the individual weighing data, obtained weekly from this regrouping, it was possible to construct new growth curves until 17 weeks of age (Table 4).

Table 4 shows the growth profile and weight (0.1100256/week) of the pullets. This model had a significant p-value ($2.2*10^{-16}$), indicating a linear relationship between the data and coefficient of determination ($R^2 = 0.9852$) indicated 98.52% of the variance in weight and the model is best fit to the data studied.

Table 5 presents the results of the regression analysis for the middle weight group of birds during rearing, considering regrouping by weight at 8 weeks. Table 5 shows the growth curve for the average weight of birds (Weight = 0.100432/week). This model had a significant p-value ($p = 2.2*10^{-16}$), indicating a linear relationship between the data and a coefficient of determination ($R^2 = 0.9864$) indicated 98.64% of the variance in weight and best fit of the model to the data. Regression analysis of light weight birds at 8 weeks of age is presented in Table 6.

Table 6: Linear regression coefficients for pullets weight at 8-17 weeks of age, grouped at 8 weeks of age in the lightweight group

Coefficient	Estimated	Standard error	t value	Probability
Intercept	-0.0540595	0.0041830	-12.92	$<2e^{-16***}$
Week	0.0962586	0.0004137	232.66	$<2e^{-16***}$

Residual standard error: 0.08084, Determination coefficient: 0.9756

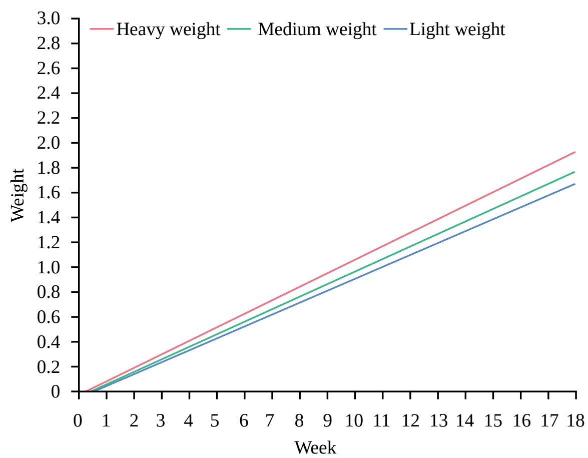

Fig. 3: Growth curve (kg) for the rearing phase, in pullets grouped at 8 weeks of age into weight categories such as heavy-weight, middleweight, or light-weight

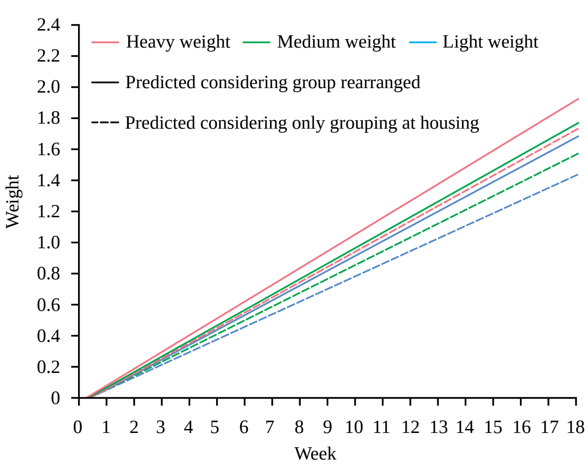

Fig. 4: Growth curve in birds grouped by weight category into: Heavy (red color), Middleweight (green color) or Lightweight (blue color)

Dashed lines indicate growth curve considering only grouping at housing and solid lines indicate group of birds rearranged by weight at 8 weeks of age

Growth of lightweight pullets with weight = 0.0962586/week is presented in Table 6. This model had a significant p-value ($2.2*10^{-16}$), indicating a linear relationship between the data and coefficient of determination (R^2 = 0.9756) showed 97.56% of the variance in weight indicating a good fit of the model to the data.

All the obtained models for each weight category showed best fit to the data, it was possible to obtain the average growth values of the birds until the transfer to the production house (Fig. 3). It is important to note that this model considers relocation at 8 weeks of age.

Figure 4 shows the importance of the grouping according to weight at rearing and at 8 weeks of age and its impact on the characteristics of the birds at transfer. Regrouping of pullets at rearing increased the weight of birds of all categories (p<0.01-comparison by t-test of angular coefficients), indicating the importance of this management practice. -In Middleweight and Lightweight category reduction in body weight was observed due to the fact that the birds in these groups were more homogeneous (Fig. 4).

Positive correlation was observed between live weight of the bird and egg weight[11], so care should be taken to ensure that birds reach the appropriate weight at the start of lay. Lighter birds, tend to be the lightest throughout life depicting the lack of compensatory growth[12,13]. At the same time, heavy birds tend to lay larger eggs. From a commercial point of view, the production of heavier eggs may be more profitable since egg weight is one of the main selection criteria for consumers. Consequently, heavier eggs are more preferred by the consumers[14,15]. Figure 5 shows the egg production of birds grouped according to weight at housing or at 8 weeks of age.

The first two principal components explain 94.9% of the variability of the data. The axis of the second principal component (vertical axis) collaborated for a greater grouping of group 1, which presented higher egg production per bird per week, separating it from group 2. The variables which influenced the group 1, on the right side, were the week weight averages, as well as the rearing weight averages. With this it can be stated that the weight of the bird on rearing is directly correlated with average weekly egg production per bird from the start of lay until 49 weeks of age.

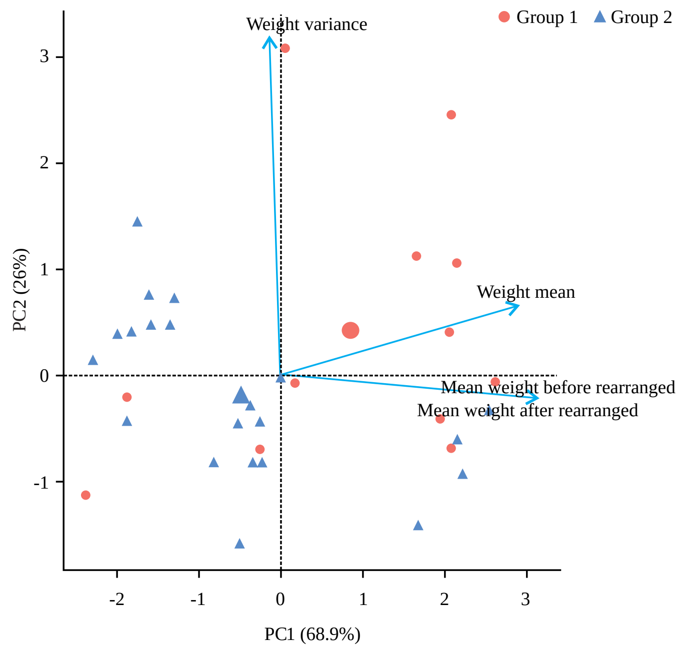

Fig. 5: Exploratory analysis for principal components (average egg production per bird per week until 49 weeks of age)

Because regrouping at 8 weeks increased the weight of birds at transfer and because of the observed relationship between average rearing weight and egg production per bird per week, it is found that this management practice increased hen productivity[10].

CONCLUSION

Birds with different body weight produces lighter and more heterogeneous pullets. Grouping of pullets according to weight during rearing produces more uniform and heavier pullets at transfer age. Heavier pullets become hens with higher egg production per week up to 49 weeks of age.

REFERENCES

1. ABPA, 2023. Relatório Anual ABPA 2022. Associacao Brasileira de Proteina Animal. https://abpa-br.org/wp-content/uploads/2023/01/abpa-relatorio-anual-2022.pdf.
2. de Menezes, P.C., V.F.T. Cavalcanti, E.R. de Lima and J.E. Neto, 2009. Aspectos produtivos e econômicos de poedeiras comerciais submetidas a diferentes densidades de alojamento. Rev. Bras. Zootecnia, 38: 2224-2229.
3. Ulmer-Franco, A.M., G.M. Fasenko and E.E. O'Dea Christopher, 2010. Hatching egg characteristics, chick quality and broiler performance at 2 breeder flock ages and from 3 egg weights. Poult. Sci., 89: 2735-2742.
4. Zuidhof, M.J., 2020. Multiphasic poultry growth models: Method and application. Poult. Sci., 99: 5607-5614.
5. Klein, S.A.S.V., R.P. Kwakkel, B.J. Ducro and M.J. Zuidhof, 2020. Multiphasic nonlinear mixed growth models for laying hens. Poult. Sci., 99: 5615-5624.
6. Neme, R., N.K. Sakomura, E.H. Fukayama, E.R. Freitas, F.B. Fialho, K.T. de Resende and J.B.K. Fernandes, 2006. Curvas de crescimento e de deposição dos componentes corporais em aves de postura de diferentes linhagens. Rev. Bras. Zootecnia, 35: 1091-1100.
7. Zuidhof, M.J., D.E. Holm, R.A. Renema, M.A. Jalal and F.E. Robinson, 2015. Effects of broiler breeder management on pullet body weight and carcass uniformity. Poult. Sci., 94: 1389-1397.
8. Kling, L.J., R.O. Hawes, R.W. Gerry and W.A. Halteman, 1985. Effects of early maturation of brown egg-type pullets, flock uniformity, layer protein level and cage design on egg production, egg size and egg quality. Poult. Sci., 64: 1050-1059.
9. Ray, S., P.S. Swain, R.U. Amin, A.K. Nahak, S.K. Sahoo, A.K. Rautray and A. Mishra, 2013. Prolapse in laying hens: Its pathophysiology and management: A review. Indian J. Anim. Prod. Manage., 29: 17-24.
10. Mozos, J.D., A.I. García-Ruiz, L.A. den Hartog and M.J. Villamide, 2017. Growth curve and diet density affect eating motivation, behavior and body composition of broiler breeders during rearing. Poult. Sci., 96: 2708-2717.

11. Masso, R.D., A. Dottavio, Z. Canet and M. Font, 1998. Body weight and egg weight dynamics in layers. Poult. Sci., 77: 791-796.
12. Renema, R., F. Robinson, M. Newcombe and R. McKay, 1999. Effects of body weight and feed allocation during sexual maturation in broiler breeder hens. 1. Growth and carcass characteristics. Poult. Sci., 78: 619-628.
13. Leeson, S. and J.D. Summers, 1987. Effect of immature body weight on laying performance. Poult. Sci., 66: 1924-1928.
14. Leeson, S. and J.D. Summers, 2009. Feeding Programs for Laying Hens. In: Commercial Poultry Nutrition, Leeson, S. and J.D. Summers, (Eds.). Nottingham University Press, Nottingham, England, pp: 164–227.
15. Berkhoff, J., Cd. Alvarado-Gilis, J.P. Keim, J.A. Alcalde, E. Vargas-Bello-Pérez and M. Gandarillas, 2020. Consumer preferences and sensory characteristics of eggs from family farms. Poult. Sci., 99: 6239-6246.