Suitability of dual-purpose cockerels of 3 different genetic origins for fattening under free-range conditions

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ABSTRACT The utilization of male chickens for fattening constitutes a potential advantage of the dual-purpose concept. In addition to the use of commercial hybrids, producers could introduce alternative chicken genotypes or further develop local breeds. To gain more information about the genetic effect on growth performance, carcass characteristics, physicochemical meat traits, and sensory attributes, 60 cockerels belonging to Les Bleues (developed from the French breed Bresse Gauloise), Canarian (Spanish local breed), and Dominant Red Barred D459 (DRB D459; commercial dual-purpose hybrid) genotypes were reared under free-range conditions in a warm tropical climate and slaughtered at 15 wk of age. The major findings were as follows: (i) Les Bleues chickens exhibited the best growth rate and the body weight of 2.44 kg reached by this strain at 15 wk would be gained only after 18 to 19 wk with DRB D459 and it would take even 2 wk longer for Canarian breed, according to the growth modeling using the Morgan equation, although the body weights between the latter were statistical similar at 15 wk; (ii) Les Bleues strain had a good capability in terms of meat production performance, presenting carcasses with significantly heavier commercial cuts, and higher fleshiness than the other 2 genotypes; (iii) although significant differences among genotypes appeared in the physical characteristics of the breast meat, especially those concerning the skin and meat color and water-holding capacity, which was significantly reduced for Canarian chickens, no significant differences were detected in the chemical composition and fatty acid profile of the breast meat; (iv) trained panelists (n = 8) pointed out that leg meat of none of the genotypes is better in terms of global appreciation, but untrained consumers (n = 99) perceived that the Les Bleues leg meat was significantly more palatable than the DRB D459 leg meat.

Key words: dual-purpose chicken, growth parameter, carcass characteristic, meat quality

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INTRODUCTION

Genetic selection performed by the commercial poultry industry has produced highly specialized lines/strains for egg and meat production (Buzala and Janicki, 2016). Thereby, the fattening of male chickens derived from layer lines is not profitable due to low growth rates and poor slaughter performances, and they are culled immediately after hatching. The culling of 1 day-old male chicks has raised concerns in welfare-sensitive societies that are demanding an end of this practice (Kaleta and Redmann, 2008). One way of solving this predicament is in ovo sex identification and the accompanying possibility to eliminate the male embryos before they hatch (Weissmann et al., 2014). However, it is not clear whether this method can be applied profitably under practical conditions in the future and/or whether it will be accepted by all kinds of customers.

Another solution is the use of dual-purpose breeds, where males are bred for fattening and females for laying (Leenstra et al., 2011). In performance of egg number and meat production, dual-purpose chickens are behind of specialized layers and broilers, respectively (Bruijnis et al., 2015), and dual-purpose production will consume more natural resources (Damme et al., 2015). Nevertheless, poultry production systems that would be economically profitable, ecologically sound, and socially acceptable could be pursued to serve specific market segments. In the case of dual-purpose production, chickens are usually reared under free-range conditions, which eggs and meat may reach premium prices due to consumer-perceived positive impacts on health, environment, and taste (Hemmerling et al., 2013). In this way, the choice of breed is a critical factor for

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small- and medium-scale producers (Jaturasitha et al., 2008), which have regard to the capacity of animals to adapt to local conditions, their vitality, and their tolerance to disease or health problems (Council of the European Union, 2007).

The potential of dual-purpose genotypes adapted to free-range production should be determined through systematic performance tests, which support producers to make decisions about their farm management. This work is testing the capability of males belonging to 3 widely divergent chicken genotypes for fattening: (1) Les Bleues chickens that genetically originate from the French breed Bresse Gauloise, (2) Canarian chickens that represent a local breed from Canary Islands (Spain), and (3) Dominant Red Barred D459 (**DRB D459**) chickens which are a commercial dual-purpose hybrid developed in the Czech Republic. The objectives of this study were to determine the growth performance and carcass characteristics of potential dual-purpose genotypes reared under free-range conditions in order to provide production benchmarks for poultry farmers, and to evaluate the meat quality parameters in order to have suitable information for consumers and product promotion.

MATERIALS AND METHODS

Animals, Diets, and Rearing System

The trial was carried out at the experimental farm of the Instituto Canario de Investigaciones Agrarias in Tenerife (Spain). For the duration of the experiment, from September to December 2016, the mean ambient temperature was 22.3°C (ranged from 19 to 29°C) and the mean relative humidity was 70.3% (ranged from 58 to 82%). Les Bleues hatching eggs were purchased from Hetzenecker Küken (Neumarkt-Sankt Veit, Germany). This genotype belongs to a strain of Bresse Gauloise originating from France and has already been considered for dual-purpose production in Germany. DRB D459 hatching eggs were purchased from the firm Dominant CZ (Koněšín, Czech Republic). It is a commercial dual-purpose hybrid and the result of crossing Rhode Island Red paternal stock with Sussex maternal stock. These hatching eggs were imported to Spain following the rules for intracommunity trade (Council of the European Union, 2009a). Canarian hatching eggs were obtained from the Association of Breeders of Canarian Chickens (Tenerife, Spain), who work for the recovery, selection, and breeding of these animals since 2013. All eggs were incubated together for 21 D. After hatching, chicks were separated by genotype and marked using leg tags. Birds were vaccinated against Marek and Newcastle diseases. No other veterinary treatments were applied during the study.

A total of 20 male chickens were randomly selected from each genotype and were raised under free-range conditions until 15 wk. For the first 8 wk of life, the birds were kept in 3 indoor pens (15 m^2 per pen) covered with wood shavings as litter. Later and until slaughter, the birds had access to a grass paddock (24 m^2 per pen). Birds were confined to indoor pens at night. All chickens were fed with a starter feed (1 to 28 D), a growth standard feed (29 to 60 D), and a finisher feed (61 to 105 D), whose main ingredients were soybean meal, corn, wheat, soybean oil, barley, and calcium carbonate (Graneros de Tenerife SL, Santa Cruz de Tenerife, Spain). Feed and water were supplied ad libitum. The composition of the feed is shown in Table 1. Body weight (**BW**) was recorded weekly.

Table 1. Composition of the experimental feeds.

	Starter (1–28 D)	Growth (29–60 D)	Finisher (61–105 D)
Crude protein (%)	20.1	19.5	18.7
Crude fat (%)	3.1	2.8	3.7
Methionine (%)	0.5	0.5	0.4
Lysine (%)	1.2	1.1	1.0
Calcium (%)	0.9	0.8	0.7
Phosphorus (%)	0.7	0.6	0.5
Metabolizable energy (MJ/kg)	12.0	12.6	12.3

Sample Collection and Analytical Determinations

All chickens were slaughtered at 15 wk of age. Feed was withdrawn 12 h prior to slaughter, and they were weighed, electrically stunned, killed by manual exsanguination, plucked, and eviscerated, as required by the Council Regulation (2009b). Carcasses were refrigerated for 24 h at 4°C to determine carcass weight, and dressing percentage. Breast and legs (drumstick + thigh) were removed, weighed, and calculated as a percentage with respect to carcass. The left breast was used to measure pH, color parameters, water-holding capacity (**WHC**), cooking loss, and shear force. These parameters were determined 24 h post-mortem. The right breast and legs were vacuum-packed and kept at −20°C until chemical composition and fatty acid profile determination and sensory analysis.

The pH of the meat was determined introducing a penetration pH electrode in the sample and the measurement was carried out in triplicate with a pH meter GLP 21 (Crison Instruments SA, Barcelona, Spain). Color parameters (L*, a*, b*) were measured using a Minolta CR-400 (Minolta Camera Co. Ltd., Osaka, Japan) on breast skin and on breast meat (CIE, 1976). Breast meat color was taken immediately after skin removal. For each sample, 3 measurements were performed at the same anatomical position. Water-holding capacity and cooking loss were measured according to procedures described by Díaz et al. (2010). Shear force was measured with a TA-HD-Plus texture analyzer equipped with a Kramer Shear Cell (Stable Microsystems, Surrey, UK). Shear tests of cooked meat were made in triplicate by cutting cores (1 cm^2 in cross-section and 3 cm long) parallel to the muscle

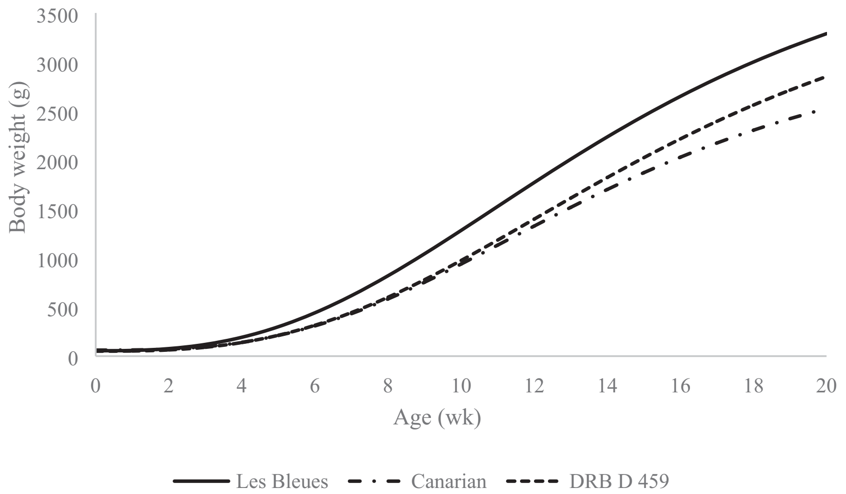

Figure 1. Growth curves of 3 dual-purpose male chicken genotypes[1]. [1]The lines indicate fitted values based on the Morgan equation.

fibers. Chemical analyses (moisture, protein, fat, and ash) and fatty acid profile were performed by Trouw Nutrition Masterlab (Madrid, Spain) accredited for agro-food product tests (ISO 17025, 2005).

Sensory Analysis

A trained 8-member sensory panel performed a descriptive analysis of the chicken meat in a special room following the instructions given by the norm ISO 8589 (2007). Legs (right and left) were cooked in a preheated 180°C oven to a core temperature of 75°C, without salt or spice. Legs were removed from the oven and tempered 15 min in the pan, and separating them into thighs and drumsticks. The panelists considered appearance and chicken odor in whole drumstick, and then they removed *Peroneus longus* muscle to assess the attributes of chicken flavor, hardness, elasticity, juiciness, and greasiness. Finally, they made also a global appreciation for each sample. The different attributes were quantified on a rating scale from 1 (very low) to 9 (very high) (ISO 4121, 2003) in 2 sessions: a training session for these samples and the evaluation session. Panelists evaluated 9 samples (3 samples/genotype). In parallel, the thigh meat of each genotype was sliced and 99 untrained consumers performed a sensory acceptability test for each one (ISO 11136, 2014). They expressed their overall palatability on a 9-point hedonic scale. The thigh meat of each genotype was coded randomly and was presented in the same conditions for all consumers.

Statistical Analysis

Growth curve parameters were estimated according to the Morgan equation. It provides a flexible model for animal growth capable of describing sigmoidal and diminishing returns behavior (López et al., 2000):

$$f(x) = \left(W_0K^b + W_fx^b\right) / \left(K^b + x^b\right)$$

Table 2. Calculated growth parameters corresponding to Morgan equation of 3 dual-purpose male chicken genotypes.[1]

	Les Bleues	Canarian	DRB D459	SEM	*P*-value
W_o (g)	54.66[a,b]	61.57[b]	50.65[a]	1.496	0.008
K (wk)	14.59	14.36	15.73	0.364	0.261
b (wk^{-1})	2.69[a]	2.92[b]	2.81[a,b]	0.033	0.019
W_f (g)	4673.51[b]	3463.66[a]	4278.90[a,b]	152.930	0.003
timeI (wk)	10.74	11.12	12.00	0.233	0.075
BWI (g)	1486.67[b]	1165.10[a]	1401.80[b]	42.505	0.004
GRI.day (gr/d)	35.27[c]	27.49[a]	30.20[b]	0.616	0.001

[a–c]Means with different superscripts within the same row are different ($P < 0.05$).
[1]W_0 and W_f are the zero- and infinite-time values of BW, respectively, K and b are constants, timeI is time of inflection, BWI is BW at inflection time, and GRI.day is the growth rate per day at inflection time.

where f(x) is BW at age x, W_0, and W_f were the zero- and infinite-time values of BW, respectively, and K and b were constants (Porter et al., 2010). BW and age were given in grams and weeks, respectively. Calculations were carried out with non-linear regression option in SPSS 15.0 software (SPSS Inc., Chicago) with the Levenberg–Marquart estimation method. From these parameters, time of inflection (**timeI**), BW at inflection (**BWI**), and the growth rate per day at inflection (**GRI**) were calculated according to Porter et al. (2010). For the statistical analysis of the results of carcass and meat quality, the genotype effect was determined using an ANOVA followed by the post hoc Tukey's method for all parameters considered in the study. Statistical differences were considered significant at $P < 0.05$.

RESULTS AND DISCUSSION

Growth Performance and Carcass Characteristics

Growth curves and their functional parameters according to Morgan equation are presented in Figure 1 and Table 2, respectively. The parameter that described the mature BW (W_f) of the chickens was significantly different, with Les Bleues showing a higher growth rate than Canarian chickens. Furthermore, the exponent b, which determines the sigmoidal shape in the Morgan equation, was also different between these 2 genotypes ($P < 0.05$). All genotypes attained inflection at 11 to 12 wk. The BW of 2.44 kg reached by Les Bleues in the present experiment at 15 wk would be gained only after 18 to 19 wk with DRB D459 and it would take even 2 wk longer for Canarian chickens, although the BWs between the latter were statistical similar at 15 wk. The growth speed during inflection (**GRI.day**) of Les Bleues was the highest (ca. 35 g/day), followed by DRB D459 (ca. 30 g/day) and Canarian (ca. 27 g/day) chickens ($P < 0.01$). Compared with the growth performance of the chicken genotypes used in this study, the growth profile of a slow-growing genotype selected for meat production (Sasso T-44) was characterized by a further increased maximum daily gain and by an additionally elevated magnitude of the growth curve (Franco et al., 2012). On the other hand, Les Bleues and DRB D459 had higher asymptotic weights than another traditional chicken (Moula et al., 2013) and slow-growing lines (Muth and Valle Zárate, 2017). It is to be noted that those previous studies modeled the growth curve parameters based on the Gompertz equation. The better growth performance exhibited by Les Bleues could be caused by selection on growth traits. In France, the Bresse Gauloise breed, from which the Les Bleues originate, has a good reputation as a meat-type chicken and is raised under quality standards of production since 1957 (Baéza et al., 2009).

Carcass characteristics of Les Bleues, Canarian and DRB D459 are shown in Table 3. As expected, BW and carcass weight at 15 wk were higher in Les Bleues cockerels due to its higher growth rate ($P < 0.01$). In comparison to cockerels of another Bresse Gauloise-derived strain developed in southern Germany, the BW and the carcass weight of Les Bleues were either lower (Muth et al., 2018, reporting 2.57 and 1.77 kg, respectively, at a slaughter age of 12 wk) or similar (Lambertz et al., 2018, reporting 2.33 and 1.56 kg, respectively, at a slaughter age of 12 to 15 wk). Regarding the weights and yields of main joints, no significant differences were found between Canarian and DRB D459. The BW of the Canarian cockerels was lower than those reported by Baéza et al. (2010) for Géline de Touraine roosters (2.99 kg) and by Moula et al. (2009) for Famennoise roosters (ca. 2.30 kg) slaughtered at similar age. Nevertheless, the Canarian breed exhibited a higher BW than chicken males belonging to Castellana Negra (1.72 kg) and Extremeña Azul (1.77 kg) reported by Miguel et al. (2008) and Durán (2004), respectively. It should be noted that many local breeds, categorized as slow-growing, are slaughtered after 190 D, so that they can reach an optimal market weight.

Canarian chickens had a lower dressing percentage compared to the other 2 genotypes ($P < 0.01$). These results are in agreements with findings about the influence of the chicken strain on dressing percentages. Sirri et al. (2011) reported carcass yield of 69.2, 62.6, and 56.8% in fast-, medium-, and slow-growing strains, respectively, and Rizzi et al. (2007) found carcass yields of 55.9% in egg-type hens and 66.3% in dual-purpose hens slaughtered at a live weight of 1.73 and 3.15 kg, respectively. Moreover, Les Bleues chickens had higher weights of breast and drumstick + thigh than Canarian and DRB D459 chickens ($P < 0.05$), indicating the importance of the genetic effect on the cut-up yields. However, while Les Bleues had significant greater breast yields than DRB D459 chickens, the breast yields of Les Bleues and Canarian chickens were similar. Fanatico et al. (2005) found that the differences in breast yield among slow-growing genotypes with various growth rates were maximized at the inflexion point of the growth curve. Therefore, marked differences in breast yield could be expected between these 2 genotypes at about 11 wk.

Physical Breast Meat Characteristics

No significant differences were detected among the studied genotypes with respect to values of the pH 24 h after slaughter (Table 4), which is in accordance with previous studies (Jaturasitha et al., 2008; Almasi et al., 2015), and the values were within the expected range at the end of the postmortem process according to Amorim et al. (2016). However, it is well documented that genetic factors may influence the final

Table 3. Body weight at slaughter and carcass characteristics of 3 dual-purpose male chicken genotypes slaughtered at 15 wk.[1]

	Les Bleues	Canarian	DRB D459	SEM	*P*-value
Body weight (kg)	2.44[b]	1.84[a]	1.96[a]	0.464	0.001
Carcass weight (kg)	1.62[b]	1.18[a]	1.32[a]	0.328	0.001
Dressing percentage (%)	66.61[b]	64.34[a]	67.18[b]	0.249	0.001
Commercial cuts					
Breast (g)	285.40[b]	198.85[a]	212.65[a]	6.702	0.001
Breast (%)	17.58[b]	16.78[a,b]	16.16[a]	0.184	0.005
Drumstick + thigh (g)	772.70[c]	518.90[a]	594.30[b]	17.616	0.001
Drumstick + thigh (%)	47.58[b]	43.64[a]	45.35[a]	0.353	0.001

[a–c]Means with different superscripts within the same row are different ($P < 0.05$).
[1]Commercial cuts percentages are expressed relative to carcass weight.

Table 4. Physical characteristics of breast meat of 3 dual-purpose male chicken genotypes.[1]

	Les Bleues	Canarian	DRB D459	SEM	*P*-value
pH	5.84	5.85	5.83	0.016	0.901
Skin color					
L*	65.85[a]	68.09[a]	70.93[b]	0.531	0.001
a*	2.97[b]	1.81[a]	1.25[a]	0.154	0.001
b*	3.92[a]	7.03[b]	12.18[c]	0.559	0.001
Meat color					
L*	56.18	56.45	56.41	0.333	0.941
a*	1.22	1.02	1.17	0.089	0.658
b*	2.14[a]	3.71[b]	2.04[a]	0.200	0.001
WHC (%)	42.99[b]	39.64[a]	44.11[b]	0.591	0.004
Cooking loss (%)	16.29[a]	18.03[b]	17.26[a,b]	0.265	0.025
Shear force (N/cm^2)	31.49	31.32	29.89	0.546	0.431

[a–c]Means with different superscripts within the same row are different ($P < 0.05$).

[1]Parameters determined 24 h post-mortem.

pH. Thus, the genetically higher stress susceptibility of some chicken strains during pre-slaughter and slaughter management could deplete more glycogen stored in muscles, limiting the post-mortem pH decrease to normal values (Fanatico et al., 2007; Baéza et al., 2009).

Some color parameters of skin and meat of chicken breast were affected by genotype (Table 4; $P < 0.05$). Hence, the skin of the DRB D459 chickens was lighter (L*) and more yellow (b*) compared with the other genotypes, while Les Bleues had the highest redness index (a*) in the skin. The Canarian chickens exhibited particularly high values for yellowness (b*) of skin and meat. According to Fletcher (2002), breed affects poultry skin and meat color, and it depends on the genetic ability of the bird to produce melanin pigments in the dermis and epidermis, as well as to absorb and deposit carotenoid pigments in the epidermis. It has been reported that some indigenous breeds and slow-growing genotypes appear to have darker and yellower skin and meat than commercial broilers and fast-growing genotypes (Wattanachant et al., 2004; De Marchi et al., 2005; Almasi et al., 2015). This supports the market demands required by selective consumers for the free-range products to be yellower and darker (Castellini et al., 2008). In contrast, Muth et al. (2018) did not find differences for meat color parameters in male Bresse Gauloise and slow-growing broilers chickens slaughtered at 84 D, although myoglobin contents were higher in breast meat of the former. These authors argued that skin color plays a particularly essential role in market niches, where carcasses are often marketed as whole, while limited differences in meat color should not receive a high priority for product differentiation.

The WHC percentage of raw breast, determined by the filter paper press method, was significantly lower in the Canarian breed when compared to the other genotypes (Table 4). Additionally, the Canarian breast presented higher cooking losses when compared with Les Bleues breast ($P < 0.05$). Similar to this finding, Muth and Valle Zárate (2017) reported a favorable phenotypic relationship between growth rate and water-binding properties of breast meat within slow-growing experimental chicken lines. However, some authors did not find differences in WHC and cooking losses in breast (Jaturasitha et al., 2008; Almasi et al., 2015; Muth et al., 2018) between markedly different genotypes slaughtered at the same age. Nevertheless, previous findings showed higher cooking loss percentages in chicken lines that reached a lower live weight at slaughter (Rizzi et al., 2007; Zanetti et al. 2010), which may be related to tissue maturation and binding capacity (Petracci et al., 2013).

Table 5. Chemical composition and fatty acids profile of breast meat of 3 dual-purpose male chicken genotypes.

	Les Bleues	Canarian	DRB D459	SEM	*P*-value
Chemical composition (%)					
Moisture	72.89	72.44	72.50	0.130	0.319
Protein	24.59	25.10	25.08	0.105	0.077
Fat	1.40	1.38	1.48	0.089	0.896
Ash	1.14	1.12	1.13	0.014	0.846
Fatty acid composition (%)					
ΣSaturated	34.00	35.17	34.62	0.266	0.204
ΣMonounsaturated	42.72	40.89	41.62	0.416	0.199
ΣPolyunsaturated	23.26	23.85	23.73	0.267	0.651
Σ(n-3)	1.53	1.69	1.72	0.043	0.158
Σ(n-6)	21.73	22.16	22.01	0.231	0.756

In relation to the texture of the cooked breast meat (Table 4), shear force did not significantly differ among the studied genotypes. Other studies have also found similar shear forces among different strains of chickens (Verdiglione and Cassandro, 2013), roosters (Franco et al., 2012), capons (Díaz et al., 2010), and laying hens (Rizzi et al., 2007). In contrast, Sirri et al. (2011) found that the meat of slow-growing birds is less tender compared with both fast- and medium-growing birds, which could be due to older slaughtering age that led to thicker collagen layers (An et al., 2010). In addition, Branciari et al. (2009) confirmed differences in muscle fiber characteristics of 3 chicken genotypes characterized by different growth rates and slaughtered at 81 D might affect meat tenderness.

Nutritional Breast Meat Characteristics

The chemical composition of the breast meat was not affected by genotype (Table 5; $P > 0.05$). The mean moisture content in breast meat for the 3 studied genotypes (72.6%) was similar to those reported by Miguel et al. (2008) in Castellana Negra cocks (72.3%), but was lower than the interval of values described for a Bresse Gauloise strain from Germany (Muth et al., 2018) and some indigenous breeds (Zanetti et al., 2010; Amorim et al., 2016), which ranged between 73.8 and 75.2%. On the other hand, the mean value of protein for Les Bleues, Canarian and DRB D459 chickens (24.9%) was similar to those described for fast-, medium- and slow-growing strains (Sirri et al., 2011) or indigenous breeds (Jaturasitha et al., 2008; Miguel et al., 2008) reared under organic conditions. However, it was higher to those found for fast- and slow-growing and indigenous chickens (De Marchi et al., 2005; Baéza et al., 2010; Petracci et al., 2013), with protein percentages in the range of 19.5 to 23.5%. Some authors noted that the genotype did not affect the protein percentages of breast meat (Jaturasitha et al., 2008; Sirri et al., 2011; Amorim et al., 2016), but Wattanachant et al. (2004) and Petracci et al. (2013) found a lower protein content in chickens with faster growth rates. Kuttappan et al. (2013) found a decrease in protein content in breast meat samples when the degree of white striping increased, and it appears to be associated with enhanced growth rate in birds.

The mean percentage of fat (1.4%) for the studied genotypes was higher than the range of values described for a Bresse Gauloise strain from Germany (Muth et al., 2018) and some indigenous breeds from Spain (Miguel et al., 2008; Franco et al., 2012), Italy (Zanetti et al., 2010), and France (Baéza et al., 2010), with fat percentages in the range of 0.6 to 1.1%. Baéza et al. (2010) found that the lipid level in breast meat was slightly affected by strain, but there was no genotype effect on the relative area occupied by adipocytes on cross sections of this muscle. These authors suggested that genotype only modified fat deposition between muscles and not the deposition into muscles. However, it has been reported that the breed is a factor that affects intramuscular fat content. Thus, Sirri et al. (2011) observed a higher content of lipids both in breast and thigh meat of fast-growing than medium- and slow-growing groups, because the fast-growing birds were selected to reach their market live weight at the maximum age of 56 to 60 D and when the slaughter age is prolonged, they increase in fatness. However, Castellini et al. (2006) attributed the lower level of intramuscular fat in Kabir chickens compared to Ross chickens (0.85 vs. 1.15%, respectively) to the behavior of these 2 strains. Ross birds were less active, with less walking, more lying, and they spent more time indoors than outdoors compared with Kabir chickens. Finally, the mean value of ash content in the breast meat (1.1%) was inside the range of values described by other authors in organic chickens and indigenous breeds (Baéza et al., 2010; Franco et al., 2012).

For the 3 studied chicken genotypes, the fatty acid fractions were predominated by monounsaturated fatty acids (**MUFA**), followed by saturated fatty acids (**SFA**) and polyunsaturated fatty acids (**PUFA**), with mean values of 41.7, 34.6, and 23.6%, respectively (Table 5). The fatty acid proportions of the breast meat for SFA, MUFA, and PUFA, including the sum of n-3 and n-6 PUFA, were not affected by genotype ($P > 0.05$). These results are in agreement with those reported by Baéza et al. (2010) and by Amorim et al. (2016) in breast meat of roosters. Previously, Rymer and Givens (2006) did not find significant differences in the efficiency of incorporation of n-3 PUFA into edible tissues using the 2 fast-growing broiler genotypes Cobb 500 and Ross 308. The lack of statistical significance among genotypes on fatty acid proportions can be attributed to the fact that the diets and rearing system were identical for all birds throughout the experimental period, overriding potential genetic differences, which might be evidenced only on higher sample sizes. However, genotype-related differences in fatty acid composition have previously been reported among indigenous breeds (Jaturasitha et al., 2008; Zanetti et al., 2010) and commercial chicken lines (Castellini et al., 2006; Sirri et al., 2011). A possible effect of the genotype could be related to the feeding behavior and the different pasture utilization in free-range systems as reported by Castellini et al. (2008). Additionally, it has been observed that the indigenous chickens tend to scratch while eating and picking up feed particles more selectively than broilers (Van Marle-Koster and Webb, 2000). It is worth noting that in the outdoor areas to which birds had access in the present trial, grass grew very little and in very limited zones and may not have contributed significant nutrients to find genotype-related differences on fatty acid profile due to feeding behavior.

Organoleptic and Sensory Evaluation of Leg Muscles

The trained sensory panel did not find significant differences among genotypes for the assessed attributes, with the exception of appearance, where Les Bleues and Canarian chickens obtained the highest and lowest rating, respectively (Table 6; $P < 0.05$). The leg conformation of Les Bleues chickens may have influenced the score given by the panelists, because the legs had a higher weight and more rounded shape than those of the indigenous breed from Canary Islands. Similarly, Franco et al. (2012) did not find differences between genetic groups on textural and taste sensations. Although the results of the trained panel evaluation pointed out that none of the genotypes is better in terms of global appreciation, the consumers perceived that Les Bleues leg meat was more palatable than DRB D459 leg meat ($P < 0.05$). Previous studies showed that the panelists discriminated different chicken meat origins

Table 6. Sensory analysis of leg meat of 3 dual-purpose male chicken genotypes.

	Les Bleues	Canarian	DRB D459	SEM	*P*-value
Panelists[1] (n = 8)					
Appearance	6.67[b]	5.58[a]	6.25[a,b]	0.176	0.038
Chicken odor	4.71	4.17	3.96	0.249	0.452
Chicken flavor	4.96	4.46	4.46	0.204	0.520
Hardness	5.00	4.58	4.73	0.177	0.628
Elasticity	5.29	5.40	5.27	0.204	0.966
Juiciness	3.38	3.42	3.96	0.149	0.207
Greasiness	4.31	4.92	4.27	0.184	0.281
Global appreciation	5.83	5.83	5.83	0.171	0.999
Consumers[2] (n = 99)					
Overall palatability	6.98[b]	6.60[a,b]	6.37[a]	0.097	0.036

[a,b]Means with different superscripts within the same row are different ($P < 0.05$).

[1]Panelists evaluated appearance and chicken odor in whole drumstick and then assessed the rest of parameters in *Peroneus longus* muscle.

[2]Consumers considered overall palatability on thigh meat.

and distinguished the quality attributes among roosters, capons, free-range chickens, and broilers (Amorim et al., 2016), between dual-purpose breeds and hybrid genotypes (Rizzi et al., 2007) and even among slow-growing chickens slaughtered at the same age (Baéza et al. 2010; Muth et al., 2018). Puchała et al. (2014) reported that the meat from slow-growing birds, including that from indigenous or locally adapted breeds, is characterized by a more intensive aroma and better flavor. Finally, Calik et al. (2017) indicated that the tasters gave significantly higher scores for aroma, juiciness, tenderness, and flavor to fattier leg muscles. Therefore, further research on aspects such as lipid composition, volatile compounds, muscle fibers, and connective tissue of meat is required in order to detect traits that allow for differentiation.

The study showed that the effect of genotype rather influenced the growth parameters and physical characteristics than nutritional properties. This work supports those previously carried out with chicken strains derived from the Bresse Gauloise under different management systems and confirms its good capability in terms of meat production performance, presenting carcasses with heavier commercial cuts, and higher fleshiness. Of course, the evaluation of meat production and quality of males has to be extended by the evaluation of laying performance of females and the value of their carcasses. Furthermore, the growth profile of Les Bleues reflects the importance of genetic selection schemes and can serve as a role model for the indigenous chickens of the Canary Islands. In any event, a genetically improved performance potential of production for locally available indigenous breeds will reinforce the emerging dual-purpose chicken sector among European poultry farmers. Finally, the quality attributes or characteristics of Canarian chickens, such as skin and meat color or their nutritional value, should contribute to consumers' purchase choice and sensory perceptions. The objective is that consumers associate the final product not only with the breed but also with a sustainable breeding system and are, therefore, willing to pay for the added value.

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