



Review Article (Derleme Makale)

Ege Üniv. Ziraat Fak. Derg., 2026, 63 (3): 435-444
<https://doi.org/10.20289/zfdergi.1897787>

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Keywords: Breast meat traits, carcass, dual-purpose genotype, male layer chick, performance

Anahtar sözcükler: Göğüs eti özellikleri, karkas, çift verim yönlü genotip, yumurtacı erkek civciv, performans

Dual-purpose chickens as an alternative to broiler and layer genotypes: Growth performance, carcass characteristics, and meat quality

Etlik ve yumurtacı genotiplere alternatif olarak kombine verimli tavuklar: Büyüme performansı, karkas özellikleri ve et kalitesi

Received (Alınış): 25.02.2026

Accepted (Kabul Tarihi): 11.07.2026

ABSTRACT

Increasing social awareness regarding animal welfare has led to a reassessment of traditional practices such as the culling of male layer chicks in the egg industry. Several European countries have banned this practice due to ethical concerns. Alternative methods, such as determining and sorting eggs containing male layer chicks during the incubation period and evaluating male layer chicks for meat production are being developed to solve this problem. The fact that the male chicks of existing commercial layer strains have very inadequate meat yield characteristics is seen as the most important obstacle to evaluating these chicks for meat production. The development of dual-purpose genotypes, where females are used for egg production and males for meat production, stands out as an alternative to solve this problem. In this review, the performance, carcass, and breast meat characteristics of dual-purpose genotypes were examined in comparison with other chicken meat sources and the potential of these genotypes in chicken meat production was discussed. Furthermore, the review examines the interactions between alternative rearing systems, dietary interventions, and genotype, and their effects on feed efficiency, growth performance, welfare, and meat quality characteristics.

ÖZ

Hayvan refahı konusunda artan toplumsal farkındalık, yumurta endüstrisindeki erkek yumurtacı civcivlerin itlaf edilmesi gibi geleneksel uygulamaların yeniden değerlendirilmesine yol açmıştır. Birkaç Avrupa ülkesi etik kaygılar nedeniyle bu uygulamayı yasaklamıştır. Bu sorunun çözümüne yönelik kuluçka döneminde erkek yumurtacı civcivlerin yer aldığı yumurtaların belirlenerek ayıklanması ve erkek yumurtacı civcivlerin et üretimi yönünde değerlendirilmesi gibi alternatif yöntemler geliştirilmektedir. Mevcut ticari yumurtacı soyların erkek civcivlerinin et verim özelliklerinin oldukça yetersiz olması, bu civcivlerin et üretimi yönünde değerlendirilmesinin önündeki en önemli engel olarak görülmektedir. Bu sorunun çözümüne yönelik dişilerin yumurta üretiminde, erkeklerin ise et üretiminde kullanıldığı çift verim yönlü genotiplerin geliştirilmesi bir alternatif olarak öne çıkmaktadır. Bu derlemede, çift verim yönlü genotiplerin performansı, karkas ve göğüs eti özellikleri diğer tavuk eti kaynaklarıyla karşılaştırmalı olarak incelenmiş ve bu genotiplerin piliç eti üretimindeki potansiyeli ele alınmıştır. Ayrıca bu derleme, alternatif yetiştirme sistemleri, besleme müdahaleleri ve genotip arasındaki etkileşimleri ve bunların yemden yararlanma etkinliği, büyüme performansı, hayvan refahı ve et kalite özellikleri üzerindeki etkilerini incelemektedir.

INTRODUCTION

From the mid-20th century onwards, efforts to develop hybrid genotypes were accelerated with the aim of maximizing production capacity in commercial poultry farming; during this process, selection programmes focused on specialized genotypes (meat or egg). As a result of intensive and systematic breeding programmes, broiler lines with high growth performance and commercial layer genotypes with superior egg production have been developed today. In the production of chicken meat, the most widely consumed meat worldwide, selected, high-yield, fast-growing broiler genotypes are used (Tixier-Boichard, 2020; OECD/FAO, 2024). Chickens with a daily live weight gain of less than 50 g are defined as slow-growing chickens (Rayner et al., 2020). In recent years, both commercial genotypes and locally bred chickens with slow-growing characteristics have been evaluated for meat production. With slow-growing chickens, production is carried out with an emphasis on animal welfare as well as certain meat quality characteristics such as taste, aroma, and colour (Turgut et al., 2025). Although it varies according to geographical, cultural, and economic conditions around the world, layer hens that have completed their economic production period are consumed as food (Fan & Wu, 2022). The meat of layer hens which have low quality characteristics can be separated by mechanical methods and used as raw material in the production of further processed products (Karakaya et al., 2010).

A significant ethical issue for the egg industry is the culling of male layer chicks because they cannot be economically utilized (Englmaierová et al., 2020). Approximately 7 billion male chicks are culled worldwide each year (Jia et al., 2023). While 330 million of these are culled in the European Union (EU) (Rosenbruch, 1997), no information on the direct culling numbers in Türkiye has been found, but the average number of eggs set for incubation for layer chick production between 2015 and 2024 was 189,047,500 (Gülaç, 2025). Based on the average fertility and hatchability rates of layer breeder flocks, and assuming an approximately 1:1 sex ratio at hatch, it is estimated that around 85 million male layer chicks are produced annually. The ban on the culling of male chicks came into effect in Germany in 2022 and in France in 2023, and it has been announced that the ban will also be implemented in Italy by the end of 2026 (Corion et al., 2023). Considering the potential culling of male layer chicks, the ethical concerns arising from this practice necessitate the development of new approaches (Coppola et al., 2024). These approaches are expected not only to comply with animal welfare principles but also to ensure economic sustainability and be compatible with existing production systems (Corion et al., 2023). The production of meat from male chicks of commercial layer lines is generally considered economically unsustainable, primarily because of their prolonged rearing period, poor feed conversion efficiency, low carcass yield, and inferior meat quality compared with conventional broiler chickens (Bruijnjs et al., 2015; Torres et al. 2019). There are only a few uses for culled day-old chicks, primarily their sale as feed for zoological institutions, pet food, and fur farms (de Klerk & van de Braak, 2023). Additionally, in the production of male layer chicks, prolonged rearing periods, low feed conversion efficiency, and elevated resource consumption collectively intensify the environmental burden, leading to increased emissions of greenhouse gases, greater land and water use, and an enhanced potential for acidification and eutrophication (Bessei, 2022). Importantly, this ecological footprint is deeply exacerbated when alternative, non-cage, or free-range housing systems are utilized; the increased locomotor activity and exposure to fluctuating microclimates shift a significant portion of dietary energy toward metabolic maintenance rather than structural growth, inherently inflating the total feed volume required per kilogram of meat produced (Leinonen et al., 2012). Given the economic and ethical challenges associated with rearing male layer chicks, alternative approaches are increasingly being explored new options are being evaluated (Lambertz et al, 2018).

Currently, proposed alternatives for overcoming the culling problem include sorting out eggs containing male chick embryos during incubation and using male chicks from dual-purpose genotypes for meat production. Despite its technological advantages, *in ovo* sex determination may face ethical

challenges, particularly concerning the potential perception of pain by embryos during early-stage sexing procedure (Corion et al., 2022). Although in ovo sexing technologies have been implemented on a limited scale in certain EU countries, a method that simultaneously meets food safety requirements, ethical standards, and large-scale commercial feasibility has yet to be fully established (United Egg Producers, 2021). Another proposed solution is the development of dual-purpose breeds capable of producing eggs of acceptable market quality in females while providing suitable meat production performance in males. This approach is considered as a potential solution to the male chick culling problem. It is predicted that such genotypes may have a unique share in the market in the future (Gautron et al., 2021).

In recent years, consumers have increasingly demanded improvements in animal production systems not only regarding ethical issues but also in terms of animal welfare. The welfare conditions of chickens in commercial production systems have emerged as a progressively significant determinant of consumer preferences and market demand (Stavropoulos et al., 2026). This demand, which is particularly pronounced in Europe and North America, is becoming increasingly widespread worldwide (Gautron et al., 2021).

This review aims to evaluate the potential of commercial dual-purpose genotypes, developed as an alternative to conventional layer strains in which male chicks are culled and females are selected for high laying performance, for broiler meat production, with emphasis on meat quality.

Dual-purpose genotypes

In this approach, which aims to add economic value to both sexes, females are evaluated for egg production after hatching, while males are raised for meat production (Malchow & Schrader, 2021). Due to negative correlation between egg production and body weight, dual-purpose genotypes generally exhibit slightly lower egg production than specialized laying genotypes (Baldinger & Bussemas, 2021). Similarly, the meat yield of dual-purpose males is lower than that of fast-growing broiler genotypes; however, their fattening performance is considerably superior to that of commercial layer males, making them more acceptable for commercial meat production (Giersberg & Kemper, 2018). The commercial layer genotypes produce 360–380 eggs/house at 80 weeks of age, with an egg mass of 23.10–23.48 kg/egg and a feed conversion ratio (FCR) of 2.00–2.25 (kg feed/kg egg mass) in conventional systems (Hendrix Genetics, 2024a, b; Lohmann Breeders, 2024). It is reported that a dual-purpose genotype reared for 80 weeks in an alternative rearing system produced 310 eggs/hen and 18.79 kg of egg mass/hen, while exhibited a feed conversion ratio (kg feed/kg egg mass) of 2.15–2.25 (Lohmann Dual, 2024). The 72-week egg production of another commercial dual genotype is reported to be 304 eggs/hen, egg mass 18.6 kg of egg mass/hen, and feed conversion ratio 2.7 (kg feed/kg egg mass) (Hendrix Genetics, 2018).

The performance of male chicks from 2013, the year dual-purpose genotypes were first introduced to the market, they reached a 3500 g body weight in 70 days with a feed conversion ratio of 2.50 (Lohmann Breeders, 2013), and the same genotype, still in the development process, reached 2000 g live weight at 56 days of age with an FCR of 1.71 under indoor housing conditions in 2020 (Tiemann et al., 2020). The fast-growing broilers have been intensively selected for rapid growth, high breast muscle ratio, and efficient feed utilization under standardized conventional indoor conditions. In contrast, slow-growing and dual-purpose genotypes are commonly evaluated under more diverse production systems, including alternative, free-range, or organic conditions, slaughter age, feed composition, and nutrient density may substantially affect body weight and FCR. Various studies are being conducted to examine the performance of dual-purpose genotypes. The performance of broilers with different growth rates, dual-purpose and male layer are presented in Table 1. The performance of dual-purpose genotypes, under indoor housing conditions or alternative broiler production systems, lags behind that of fast-growing broilers bred specifically for broiler meat production (Siekman et al., 2018a). However, researchers have

reported that the performance of dual-purpose genotypes is comparable to that of slow-growing broilers in terms of body weight (BW) and FCR (Tiemann et al., 2020). The comparison of growth performance among fast-growing broilers, slow-growing broilers, dual-purpose genotypes, and layer males should be interpreted with caution because the studies included in this review were conducted under different production conditions. Fast-growing broilers are generally evaluated under conventional indoor systems with optimized nutrition and management, whereas dual-purpose genotypes are frequently assessed in free-range, organic, or other alternative production systems. Such differences in production environment may substantially influence body weight gain, feed conversion ratio, carcass yield, and meat quality traits.

Table 1. Growth performance of slow- and fast-growing broiler chickens, dual-purpose genotypes, and commercial layer males ¹

Çizelge 1. Yavaş ve hızlı gelişen etlik piliçler, çift verim yönlü genotipler ve ticari yumurtacı erkeklerin büyüme performansı

Genotype		Sex	Housing system	Feed ² (period : content)	Slaughter age (day)	BW (g)	FCR	References
Fast growing broilers	Ross 308	Male	Conventional indoor	• 0 - 10d: 12.4 MJ/kg - 23.0% CP	31	2008	1.34	Aviagen, 2022a (feed), Aviagen, 2022b (BW and FCR)
		Female		• 11 - 24d: 12.8 MJ/kg - 21.5% CP	33	1972	1.37	
		Mixed		• 25 - 33d: 13.0 MJ/kg - 19.5% CP	32	1999	1.34	
	Cobb 500	Male	Conventional indoor	• 0 - 12d: 12.1 MJ/kg - 21.5% CP	29	2014	1.32	Cobb-Vantrerss, 2022
		Female		• 13 - 28d: 12.3 MJ/kg - 19.5% CP	32	2049	1.42	
		Mixed		• 25 - 33d: 12.8 MJ/kg - 18.5% CP	30	1989	1.36	
Slow growing broilers	Hubbard JA757	Male	Alternative indoor	• 0 - 14d: 12.5 MJ/kg - 21.6% CP	45	2136	1.85	Tůmová et al., 2021
		Female		• 15 - 35d: 12.9 MJ/kg - 19.6% CP • 36 - 45d: 13.5 MJ/kg - 18.5% CP	45	1848	2.15	
	Sasso T451	Male	Alternative semi-intensive	• 0 - 14d: 11.9 MJ/kg - 21.0% CP	62	2719	2.36	Barbaresi et al., 2019
		Female		• 15 - 28d: 12.1 MJ/kg - 20.5% CP • 29 - 42d: 12.3 MJ/kg - 20.0% CP • 43 - 62d: 12.4 MJ/kg - 19.0% CP	62	2313	2.27	
Dual-purpose genotypes	Lohmann Dual	Male	Standard indoor	• 0 - 14d: 12.4 MJ/kg - 21.5% CP • 15 - 63d: 12.4 MJ/kg - 21.0% CP • 64 - 70d: 12.4 MJ/kg - 20.0% CP	70	2565	1.92	Tiemann et al., 2020
			Organic farming	• 0 - 14d: 12.4 MJ/kg - 19.5% CP • 15 - 84d: 12.8 MJ/kg - 21.0% CP	84	2142	2.92	Mueller et al., 2020
	ISA Dual	Male	Conventional indoor	• 0 - 14d: 12.5 MJ/kg - 21.6% CP • 15 - 35d: 12.9 MJ/kg - 19.6% CP • 36 - 80d: 13.5 MJ/kg - 18.5% CP	80	2224	3.11	Tůmová et al., 2021
			Free range	• 0 - 14d: 12.5 MJ/kg - 21.6% CP • 15 - 35d: 12.9 MJ/kg - 19.6% CP • 36 - 80d: 13.5 MJ/kg - 18.5% CP	80	2238	3.03	
Layer genotypes	Lohmann Brown	Male	Alternative non-cage	• 0 - 14d: 12.4 MJ/kg - 19.5% CP • 15 - 84d: 12.8 MJ/kg - 21.0% CP	84	1428	3.55	Mueller et al., 2020
				• 0 - 14d: 12.4 MJ/kg - 19.5% CP • 15 - 126d: 12.8 MJ/kg - 21.0% CP	126	2146	NA	
	Atak-S	Male	Free range	• 0 - 21d: 11.7 MJ/kg - 18.0% CP • 22 - 63d: 11.5 MJ/kg - 18.0% CP	84	1556	3.28	Yeter & Akyar, 2020
				• 64 - 84d: 13.4 MJ/kg - 18.0% CP	84	1549	3.43	

¹ Average body weight of 2000 g, ² MJ: megajoule, CP: crude protein, NA: It has exhibited feed wastage.

Birds reared in free-range or organic systems generally exhibit greater locomotor activity and higher maintenance energy requirements than birds raised under intensive indoor conditions. Consequently, a larger proportion of dietary energy may be directed toward maintenance rather than growth, which can result in lower body weight gain and less efficient feed utilization. This environmental and metabolic interaction is clearly demonstrated in Table 1. For instance, while Lohmann Dual males achieved an efficient FCR of 1.92 under standard indoor conditions (Tiemann et al., 2020), their FCR reached 2.92 at 84 days under organic farming conditions (Mueller et al., 2020). Similarly, high FCR

values exceeding 3.00 in ISA Dual and Atak-S genotypes are directly linked to free-range production (Yeter & Akyar, 2020; Tůmová et al., 2021), where increased physical activity and potential feed wastage (as noted for layer lines) inherently compromise feed efficiency. Likewise, differences in dietary nutrient density, protein-to-energy ratio, and feed ingredient composition may influence muscle deposition, carcass composition, and physicochemical characteristics of meat. Therefore, some of the variation observed among studies summarized in Tables 1-3 may reflect differences in rearing and feeding conditions rather than genotype alone. This issue is particularly important when evaluating the production potential of dual-purpose chickens because many of these genotypes are intended for alternative production systems in which management conditions differ considerably from those used in conventional broiler production.

Visual carcass characteristics and carcass parts ratios, especially breast muscle yield, constitute key marketing parameters (Güler & Şeremet Tuğalay, 2022). The carcass and breast meat ratios of dual-purpose genotypes are lower than those of fast- and slow-growing commercial genotypes, while the ratios of leg and wing parts are higher (Table 2). The breast meat is a carcass part that is in high demand by the end consumer and is also highly used in the production of processed poultry meat products. The lower breast meat ratio of dual-purpose genotypes is one of the prominent disadvantages, resulting in an even more visible keel bone and thus a less desirable carcass appearance from a market perspective (Mueller et al., 2020).

Table 2. The carcass and cut yields (%) of slow- and fast-growing broiler chickens, dual-purpose genotypes, and commercial layer males

Çizelge 2. Yavaş ve hızlı gelişen etlik piliçler, çift verim yönlü genotipler ve ticari yumurtacı erkeklerinin karkas ve karkas parça verimi (%)

Genotype		Sex	Carcass	Breast	Leg	Wings	References
Fast growing broilers	Ross 308	Mixed	71.6 ²	24.3	22.9	7.6	Aviagen, 2022b
	Cobb 500	Mixed	74.4 ³	24.4	22.5	7.6	Cobb-Vantrerss, 2022
Slow growing broilers	Hubbard JA	Mixed	68.4 ³	22.9	31.1	10.7	Akyar & Yeter, 2021
	Sasso 51	Mixed	69.0 ³	20.0	32.7	11.7	Mueller et al., 2018
Dual-purpose genotypes	Lohmann Dual	Male	67.0 ³	19.4	35.8	12.1	Mueller et al., 2018
	Isa Dual	Male	74.5 ³	19.1	33.7	NA	Tůmová et al., 2021
Layer genotypes	Lohmann Brown	Male	63.8 ³	14.8	35.6	13.8	Mueller et al., 2020
	Atak-S	Male	68.0 ²	17.5	32.5	13.2	Yeter & Akyar, 2020

¹ Average body weight of 2000 g, ² cooled carcass, ³ hot carcass, NA: unspecified.

The leg and wing ratios of slow-growing and dual-purpose chickens are approximately 50% higher than those of fast-growing broilers (Table 2). Dual-purpose genotype carcasses are more suitable for whole sales due to their low breast ratio (Gautron et al., 2021). On the other hand, they have superior characteristics compared to slow-growing broilers (Hubbard JA 957) when reared with feed containing lower nutrient levels (low protein, low daily body weight gains) (Kreuzer et al., 2020). This superiority under low-input diets suggests that dual-purpose genetics retain a more robust metabolic resilience to marginal protein restrictions, maintaining their target structural growth where high-yielding broiler lines typically exhibit systemic metabolic failure (Lambertz et al., 2018).

Broiler meat quality is influenced by numerous factors, including genotype, rearing system, feeding, sex, and slaughter procedures. The breast meat characteristics of broiler chickens with different growth rates, dual-purpose, and male layer genotypes are presented in Table 3. The pH₂₄ of poultry meat indicates the acidity level at which the muscle tissue has completely transformed into meat after slaughter. It plays a decisive role in the quality, colour, texture, and processability of the meat. Normal pH₂₄ values for poultry are around 5.8 (Fletcher, 1999; Nusairat et al., 2022). The meat color is utilized as a valuable indicator of meat quality for further processing and marketing (Wideman et al., 2016). Age and

genetic strain can affect meat colour (Bianchi et al., 2006). The Lightness (L^*) value, utilized in the determination of meat brightness, is also a parameter commonly employed in the identification and evaluation of quality defects in breast meat. On aged chicken, the exposed redder meat color because of myoglobin increases with age (Nishida & Nishida, 1985). The higher fat contents exposed more yellow breast meat (Berri et al., 2005). Drip loss (%), which influences the sensory quality characteristics of broiler meat and represents an economically important trait, refers to the amount of water released from raw meat under its own weight during processing, cutting, and storage, without the application of any external force (Barbut & Leishman, 2022). The loss of water that occurs during the thermal treatment applied to meat for cooking purposes is defined as cooking loss (%), and the amount of loss is an important quality parameter that affects both product weight and consumer acceptance (Pathare & Rosskilly, 2016). According to research (Table 3) the breast meat quality characteristics of dual-purpose genotypes, pH₂₄, lightness (L^*), and drip loss are similar to those of broiler genotypes, while differences are observed in a^* , b^* , and cooking loss. Meat quality traits are known to be influenced not only by genotype but also by age at slaughter, feeding regimes, and the mechanical microclimate of the production range (Petracci & Cavani, 2012).

Table 3. Breast meat characteristics of slow- and fast-growing broilers, dual-purpose genotypes, and commercial layer males

Çizelge 3. Yavaş ve hızlı gelişen etlik piliçler, çift verim yönlü genotipler ve ticari yumurtacı erkeklerinin göğüs eti özellikleri

Genotype		pH ₂₄	L^*	a^*	b^*	DL (%)	CL (%)	References
Fast growing broilers ¹	Ross 308	5.79	57.31	3.37	13.62	1.36	19.85	Helva et al., 2024
	Cobb 500	5.81	56.94	7.02	17.91	3.96	19.32	Mueller et al., 2018
Slow growing broilers ²	Hubbard JA	5.71	54.27	4.12	17.25	1.22	13.10	Helva et al., 2024
	Sasso 51	5.92	50.20	1.82	0.48	0.92	12.20	Mueller et al., 2018
Dual-purpose genotypes ²	Lohmann Dual	5.70	57.0	3.10	1.90	1.30	22.80	Siekman et al., 2018b
	Isa Dual	5.67	56.62	-2.00	9.40	-	23.42	Valenta et al., 2022
Layer genotypes ²	Lohmann Brown	5.90	38.73	11.25	22.15	1.95	33.81	Helva et al., 2024

¹ Mixed sex, ² male, L^* : lightness, a^* : redness, b^* : yellowness DL: drip loss, CL: cooking loss.

CONCLUSIONS

Animal rights, ethical demands, and regulations in some EU countries prohibiting the culling of male layer chicks have made it necessary to develop alternative solutions for culling male layer chicks. The sorting of male embryos during incubation and genetic interventions aimed at sex determination are controversial practices in terms of societal ethical values. Using male chicks obtained from dual-purpose parent genotypes resulting from the crossbreeding of meat and layer genotypes for meat production stands out as an ethically and animal welfare-acceptable alternative compared to other methods. The current broiler production system has been developed to be highly efficient, and it does not seem possible to develop an alternative system that can produce more economically. Furthermore, legal regulations in societies with high sensitivity to animal rights, and consumers' support for and willingness to pay for ethically based production that ensures high animal welfare, make the development of alternative solutions a necessity.

In conclusion, the findings indicate that the males of the dual-purpose genotypes developed as an alternative to chick culling are more suitable for alternative systems that can be produced with lower feed input, considering their current performance levels. However, ongoing breeding and selection efforts in dual-purpose genotypes may contribute to further improvements in growth performance and breast meat yield. The advantages offered by these genotypes, which are aligned with consumer expectations shaped by ethical production, animal welfare, and sustainability, may be considered an important competitive and marketing advantage.

Data Availability

Data will be made available upon reasonable request.

Author Contributions

Conception and design of the study: İBH, MA; analysis and interpretation of data: İBH, MA; visualization: İBH, MA; writing manuscript: İBH, MA.

Conflict of Interest

There is no conflict of interest, between the authors in this study.

Ethical Statement

We declare that there is no need for an ethics committee for this research.

Financial Support

This study was not financially supported.

Article Description

This article was edited by Section Editor Prof. Dr. Zümrüt AÇIKGÖZ.

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