Original Research

Journal of Advanced Veterinary Research
(2026) Volume 16, Issue 1, 100-105

Comparative study on the performance and phenotypic characteristics of indigenous chickens in Purwokerto and Dili

Elly Tugiyanti1*, Krismiwati Muatip[1], Annistia R. Ulfah[1], Neotico D. da Gama Ximenes[2], Armando Alfonso[2]

[1]*Faculty of Animal Science Universitas Jenderal Soedirman, Banyumas 53122, Central Java, Indonesia.*
[2]*Fakuldade Agrikultural Universidade Oriental De Timor Lorosae, Dili, Timor Leste.*

ARTICLE INFO

Received: 02 October 2025

Accepted: 19 December 2025

*Correspondence:

Corresponding author: Elly Tugiyanti
E-mail address: elly.tugiyanti@unsoed.ac.id

Keywords:

Diversity, Local chicken, Phenotypic characteristics, Tropical climate.

ABSTRACT

Poultry settles and adapts to environments that allow them to live and reproduce. Timor Leste has a dry tropical climate with temperatures ranging from 24-34°C and low rainfall. In contrast, Indonesia has a tropical climate with daily temperatures ranging from 23-29°C and relatively higher rainfall compared to Timor Leste, although this depends on the location. These environmental differences allow local chickens to develop differently. This research was conducted using a purposive sampling data collection method, involving qualitative and quantitative observations of local chickens in Indonesia and Timor Leste. The number of local chickens measured was 40 female local chickens aged 10-12 months, 40 female local chickens aged 13-15 months, and 10 male chickens raised in open areas by the community in Dili, Timor Leste, as well as by the community in Purwokerto, Indonesia. The measured variables are body weight, carcass weight, digestive organ size, and qualitative characteristics (feather color, comb color and type, beak color, eye color, and leg color). Data from both areas were then tabulated and described descriptively. Local chickens from Purwokerto (Indonesia) and Dili (East Timor) showed significant differences in body and carcass weight, with Indonesian chickens being heavier. Despite being geographically separated, their digestive organ profiles are very similar, indicating comparable digestive functions. However, phenotypic traits such as feather color, comb type and color, and beak, eye, and leg color vary greatly within both populations, likely due to different breeding histories and genetic introductions.

Introduction

Chicken plays a crucial role as one of Indonesia's local genetic resource assets (Edi, 2020; Sumantri *et al*., 2020; Firdaus *et al*., 2023). Its presence includes both native Indonesian strains and introduced strains that have successfully adapted and reproduced for several generations in the country. One of the main advantages of local chickens is their ease of care and higher resistance to disease compared to foreign chicken breeds (Bakrie *et al*., 2021). Most local chickens in Indonesia are raised extensively using traditional systems (Henuk and Bakti, 2018), allowing them to roam freely in search of food and rest in the environment surrounding human settlements. This condition indirectly builds natural resistance in local chickens. More than just meeting economic needs, local chickens are also an important source of animal protein that significantly contributes to food and nutritional security for the Indonesian people (Alders *et al*., 2018).

Historically, Indonesian domestic chickens have several possible ancestral origins, as revealed by experts. This opinion encompasses two main scenarios: first, that all domestic chicken breeds are descended from two or more existing wild jungle fowl species (Kanginakudru *et al*., 2008; Lawal *et al*., 2020). Second, there is a possibility that Mediterranean chicken breeds, such as the White Leghorn, originated from the red jungle fowl (Moiseyeva *et al*., 2003; Ceccobelli, 2013), while Asian chicken breeds, such as Cochin, Brahma, and Langshan, may have other ancestors that are now extinct (Heinrichs, 2019; Kanakachari *et al*., 2022). Thus, the polyphyletic theory suggests that chicken domestication occurred more than once and involved more than one evolutionary lineage. The second scenario can be explained by differences in the morphophysiological and temperamental characteristics between extant junglefowl and Asian breeds (Eda, 2021). In addition to the potential contribution of certain extinct ancestors to the emergence of Asian chicken breeds, the polyphyletic origin of domestic chickens is suggested by phenotypic traits that may have evolved from various types of wild junglefowl. Additionally, hybrids between wild junglefowl and domestic chickens have, in some cases, been proven fertile (Desta, 2019).

Generally, local chickens in Indonesia are the result of domesticating the red junglefowl (Gallus gallus) (Setianto *et al*., 2017; Setianto, 2021), which have been raised by their ancestors from generation to generation and spread to almost all islands in Indonesia, now more commonly known by the Latin name Gallus domesticus. Local chickens are classified into several types, which are influenced by genetics and the environment in each region. The diversity of genetic characteristics in local chickens can manifest in phenotypic traits such as feather color, skin, beak, meat, comb shape, plumage, production performance, growth, and reproduction (Ahmad *et al*., 2024). There are several types of local chickens in Indonesia, such as Kedu chickens, Pelung chickens, Marawang chickens, Sentul chickens, Gaok chickens, and Arab chickens. Kampung chickens have several different feather colors, such as black in Kedu chickens, red and black in Pelung chickens, white in Gaok chickens, and others (Sartika *et al*., 2022). Male native chickens have larger bodies than females, with upright combs and red teeth except for Kedu chickens.

There is still little information available about the genetic resources of Indonesian local chickens. This information is very important for the future development of chicken farming. Chicken development in general must be accompanied by improved management practices and enhanced genetic quality (Chebo *et al*., 2022). Improving the genetic quality of chickens, whether meat-producing, egg-laying, or pets, is necessary to obtain superior birds. Improving genetic quality can be done through breeding, which involves selection or crossbreeding (Fulla, 2022). The breeding policy adopted must be appropriate for the current condition of the chickens. As part of the development of certain gallus breeds, a comparative study is needed on the quality of Indonesian local chickens with local chickens from other regions that are closely related to Indonesia. Timor Leste is a country close to Indonesia, with its northern border

ISSN: 2090-6277/2090-6269/

bordering the Wetar Strait, its eastern border bordering the Arafura Sea, its southern border bordering the Timor Sea, and its western border bordering East Nusa Tenggara (NTT). From a genetic conservation perspective, understanding the qualitative variation between chickens in both countries can help identify unique characteristics and potential genetic traits that may not have been explored yet.

Timor Leste has a dry tropical climate with temperatures ranging from 26-32ºC and low rainfall. The quality of soil types in Timor Leste is often found to contain limestone, coral, thick clay, and sandy soil; only a few soils are classified as volcanic. This condition is similar to the conditions in the NTT region of Indonesia, which is why many savannas are found in Timor Leste. The biodiversity found in Timor Leste is not significantly different from that found in the Nusa Tenggara Islands (NTT and NTB). The native chicken on this island is the red junglefowl (Gallus gallus). Characteristics of the red junglefowl include having a black base color, glossy red or yellow feathers on the neck, wings, and tail, curved and thick tail feathers, a single serrated comb with 4-6 teeth, red wattles located between the two lower jawbones (Syahar *et al*., 2014)(Syahar *et al*., 2014). The head shape of the red junglefowl is smaller than that of domestic chickens, and the lobe is white. The characteristics of the female red junglefowl are that they have a dark brown base color with black stripes, similar to most local chickens. Birds will migrate to find places with environmental conditions suitable for their survival.

To conduct a comparative study of two countries, a specific location is needed to improve the genetic quality of chickens. The two selected areas are Dili, located in Timor Leste, and Purwokerto, located in Central Java, Indonesia. This location was chosen as the sampling site for local chickens because the population and consumption of chicken meat in the Timor Leste region are quite high, at 38%. Local chicken meat accounts for 71% of the total chicken consumed, and 47% of this is consumed during ceremonies and celebrations. Similarly, in Purwokerto, Central Java, with a population of 292,909 residents, the population and consumption of native chickens are high, at 1,298,251 birds and 393,558 kg per year. People in Dili and Purwokerto prefer free-range chicken meat and eggs because the taste sensation is more suitable for their palates. So far, to meet needs and ensure the sustainable availability of local chickens, farmers have been breeding their local chickens. Research is very important because understanding the performance and phenotypic traits of chickens is crucial for enriching the world's biodiversity and chicken variation.

Therefore, basic research is needed on the phenotypic characteristics of qualitative and quantitative traits of each type of local chicken in a specific region in Central Java. The overall development of chickens must be accompanied by improved management practices and enhanced genetic quality. Improving the genetic quality of chickens, whether they are meat-producing or egg-laying, is necessary to obtain superior chickens. Improving genetic quality can be done through breeding, which involves selection or crossbreeding. The breeding policy implemented must be appropriate for the current condition of the chickens. Therefore, various information is needed regarding the characteristics and diversity of local chicken phenotypes in Indonesia. Studies on phenotypic diversity can be conducted to determine the genetic diversity of chickens. Basic research on phenotypic diversity and characteristics needs to be carried out to obtain valid data for breeding policies.

Materials and methods

Every animal treatment used in this study complies with ethical standard number 021/EA/PDH/III/2024 from the Indonesian Veterinary Medical Association (PHDI) Central Java Branch, Indonesia, in addition to national and institutional regulations regarding the use and observation of animals. Slaughtering and sampling of animal body parts were conducted by standard sampling procedures for observational purposes.

Data collection

This study was conducted using a purposive sampling data collection method, by making qualitative and quantitative observations of local chickens in Purwokerto-Indonesia and Dili-Timor Leste. The two locations were chosen because in both locations, local chickens are the most consumed livestock to meet the animal protein needs of the community. In addition, the way of raising and the scale of raising, and the purpose of raising local chickens carried out by the community are almost the same. The number of chickens observed in each location was 20 hens aged 10-12 months, 20 hens aged 13-15 months, and 10 roosters aged 12-15 months. Consideration of the age of 10-12 months old hens observed because based on the initial survey of hens at that age is high egg production (49-56%), 12-15 months old hens are still producing but has begun to decline between (40-44%), roosters are widely traded 12-15 months old (Sartika *et al*., 2022).

Material and data analysis

Tools and materials used in this study include recording devices, digital scales, rulers, measuring tapes, cameras for documentation of activities, raffia. The observed variables consisted of body weight, carcass, digestive organ size and phenotypic characteristics (feather color, cockscomb type and color, beak color, eye color and shank color). Analysis of the phenotypic frequency of a trait in local chickens follows suggestions (Dako *et al*., 2019).

Phenotypic frequency= Local chicken with the same qualitative properties/Number of chicken samples x100%

Results

The results of the study are presented in tables containing a comparison between body weight and shape characteristics of chickens. This research was conducted by observation and recording from several chicken farms owned by residents for consumption purposes in Purwokerto, Indonesia and Dili, Timor-Leste. The following research data results are displayed in Tables 1, 2, and 3.

Table 2 presents comprehensive data on the weight of various diges-

Table 1. Body weight and carcass (gram) of free range of local chicken in Dili-Timor Leste (TL) and Purwokerto-Indonesia (INA).

Variable	Hen 10-12 month		Hen 13-15 month		Rooster 1 year	
	TL	INA	TL	INA	TL	INA
Final Body Weight	745±76.22	820.45±63.42	1053.25±138.78	1102.67±101.43	858.4±44.21	1004.42±90.24
Dresscarcass	667.8±66.27	738.4±57.48	955.75±145.4	1014.46±138.01	751.11±55.54	903.98±23.48
Carcass	466.6±39.93	533.29±29.28	670±82.00	669.54±68.94	520.72±49.53	642.83±37.24
Left Thigh	77±8.37	80.4±7.78	107.75±14.76	112.47±15.19	95.46±9.19	102.45±12.47
Right Thigh	78.2±8.23	81.02±8.25	109.42±17.12	111.98±15.02	93.22±8.05	102.92±10.42
Left Wing	32.8±3.90	36.92±3.05	34.94±2.95	44.18±2.98	35.84±3.54	41.18±4.67
Right Wing	32.6±2.61	36.2±3.28	35.04±3.23	43.25±2.69	35.7±3.81	41.68±3.88

tive organs of local chickens from two different geographical locations: Dili, Timor Leste (TL) and Purwokerto, Indonesia (INA). These data were stratified by sex and age group (10-12-month-old females, 15-18-month-old females and 12-15-month-old males). This analysis aimed to provide an overview of variations in the weights of digestive organs such as the proventriculus, gizzard, small and large intestine, cecum, liver, pancreas and spleen, which are essential indicators in understanding the digestive efficiency and metabolic health of local chickens in both regions. The data, presented in kilograms (kg), also includes standard deviations, indicating the level of variability within each group.

Table 3 presents a detailed overview of the phenotype characteristics of local chickens raised in Dili, Timor Leste (TL) and Purwokerto, Indonesia (INA). These data describe a variety of observable physical traits, ranging from feather colour in females and males, cockscomb type (in females and males), cockscomb colour, beak colour, to eye colour and shank colour. Comparisons between these two locations provide essential insights into the genetic diversity and local adaptation of chicken populations in each region, while highlighting potential differences or similarities in inheritance patterns of morphological traits.

Discussion

Based on Table 1, body weight of Timor Leste hens at the ages of 10-12 months, 13-15 months, and roosters at 12-15 months is around 745±76.22 g, 1053.25±160.92 g, and 858.4±44.21 g. This is different from the body weight of local Indonesian chickens. Based on previous research, 2-month-old Indonesian local chickens have a body weight of around 512 grams (Urfa *et al*., 2017) . Other research also stated that the weight of 8-week-old local chickens is around 697.42 grams (Eriko *et al*., 2016). Mariandayani *et al.* (2013) state that 7-month-old local chickens have a live body weight of 1146.10 g±86.12. Indonesia has local chickens from breeding, which are also commonly called super local chickens. Super local chickens have higher productivity and faster growth compared to local chickens that have not gone through the livestock breeding process. At the age of 2 months, the live weight of super local chickens can reach 1.5 kg.

This is different from Tamzil and Indarsih (2020), where 13-week-old super local chickens have a body weight of 1.3 kg for males and 1.06 kg for females. The body weight of other local Indonesian chickens, as a comparison, including the Merawang chicken, has an average male body weight of around 2.147±469 kg and a female 1.438±243 kg (Hidayat *et al*., 2017). Timor Leste's 12-15 months old male local chicken has a live body weight of around 858.4±44.21 g/head. This tends to be lower compared to Indonesian local chickens, in the study of Nur *et al*. (2022) reported that local Indonesian chickens (Burgo Chicken, Ketaras Chicken, and Kampung chicken) aged 20-48 weeks had body weights of 1.00±0.01 kg/head, 1.23±0.19 kg/head and 1.93±0.16 kg/head, respectively.

Research results from Ulfah (2005), a study stated that the body weight of male Merawang chickens aged 9-12 months ranged from 1.9-3.1 kg/head, and female Merawang chickens ranged from 1.35-2.5 kg/head. The average weight of kampung chickens aged±1 year in Manokwari Regency, which were raised traditionally, ranged from adult males 2368.5±626.3 g and females 1876.1±413 g (Zurahmah *et al*., 2023). The diversity of chicken weights from each region is thought to be influenced by several factors such as genetics, environment, feed, and management. The body size of local chickens and local chickens in East Timor differs from each other, thought to be due to differences in genetic potential, age, livestock origin, maintenance system, and mating applied.

Carcass is the weight of a chicken that has been separated from feathers, entrails, head, neck, and shank. Carcass is one of the indicators that determines the quality of meat. High carcass weight usually follows high body weight. The carcass weight of Timor Leste chickens aged 10-12 months obtained from observations was around 466.6±39.93 g/head. These results are slightly different from local chickens in Indonesia. The descendants of Indonesian local chickens, as researched by Hanafi *et al*, showed that the carcass weight of SenSi-1 Agrinak chickens (one

Table 2. Digestive organ weights (gram) of local chickens in Dili, Timor Leste (TL) and Purwokerto, Indonesia.

Variable	Hen 10-12 month		Hen 15-18 month		Rooster 12-15 months	
	TL	INA	TL	INA	TL	INA
Proventriculus weights	2.2±0.84	2.64±1.02	3.3±0.40	3.46±0.80	5.44±2.53	5.84±1.64
Gizaard weights	22±2.35	22.82±2.87	23.22±8.12	23.04±5.90	22.44±2.53	24.33±3.73
Small Intestine weights	66.78±28.73	66.84±10.43	74.70±10.55	76.8±8.90	90.3±15.00	98.45±7.80
Large Intestine weights	6.63±1.56	8.43±1.86	8.62±2.23	7.98±1.05	8.5±1.66	9.24±2.80
Caecum weights	10.42±1.89	11.05±1.80	10.71±3.86	11.08±2.98	13.3±1.79	15.65±3.80
Liver weights	19.84±5.47	19.9±2.58	23.43±6.11	24.58±8.24	26.96±2.30	29.42±4.02
Pancreas weights	6.96±3.06	7.26±0.08	9.35±2.86	9.5±1.97	8.66±0.94	10.54±1.78
Spleen weights	0.07	0.08	0.09	0.09	0.09	0.09

Table 3. Qualitative characteristics of local chickens in Dili-Timor Leste (TL) and Purwokerto-Indonesia (INA).

Variable	TL	INA
Feather color of hens	Gray, white spotted black, brown	Plain white but the head and neck are black bitnik, black, gray, white with black spots.
Feather color of cock	Red with yellow	Red with yellow, red with black and striated
Female comb type	Single (30%), Rose (25%), Pea (45%)	Single (35%), Rose (40%), Pea (25%)
Male comb type	Pea (100%)	Rose (20%), Pea (80%)
Color of hens comb	Red (100%)	Red (100%)
Color of cocks comb	Read (98%), White (2%)	Red (100%)
Hens beak color	Whitish yellow (100%)	Whitish yellow (100%)
Cocks beak color	Yellow (90%), White (10%)	Yellow (90%), White (10%)
Eye color of hens	Orange (80%), White (20%)	Orange (40%), White (60%)
Eye color of cocks	Red (100%)	Red (70%), Yellow (30%)
Shank color of hens	Yellow (40%), Black (40%), White (20%)	Yellow (40%), Black (40%), White (20%)
Shank color of cocks	Yellow (60%), Black (10%), White (30%)	Yellow (50%), Black (10%), White (40%)

of the purebred meat-type local chickens) aged 3 months was around 424.34±30.57 g/head (Hanafi *et al*., 2022). Carcass weight can be influenced by age, because the older the age, the energy in the chicken's body is no longer used for growth but for production, namely, meat and eggs.

The carcass weight of Timor Leste hens aged 13-15 months is higher compared to that carcass weight of 10-12 months, namely 670±82.00 g and 520.7±49.33 g. This is different from local Indonesian chickens, such as Merawang chickens in the study of Nuraini *et al*, where 1-year-old male Merawang chickens have a carcass weight of 1417.08 g and females 830.08 g (Nuraini *et al*., 2018). The carcass weight produced in each type of chicken varies because carcass weight can be influenced by genetic factors, environment, quality and quantity of rations, gender, and age.

Commercial cuts are carcasses that are cut into several parts to be marketed to meet community needs. Commercial cuts include wings, thighs, chests, and backs. The weight of commercial cuts from local Timor Leste chicken carcasses aged 10-12 months is left thigh 77.0±8.37 g, right thigh 78.2±8.23 g, left wing 32.8±3.90 g, right wing 32.6±2.61 g, breast 135±11.73 g, and back 111±10.84 g. In contrast to local Indonesian chickens, research by Astuti *et al* reported that the weight of the carcass parts of 2-month-old super kampung chickens included lower thigh weight of 98.67±98.60 g, upper thigh 90.00±4.36 g, breast 164.67±11.50 g, wings 90.00±4.359 g, and back weight 114.67±43.54 g (Astuti *et al*., 2020). Based on this comparison, Indonesian super kampung chickens have a higher weight compared to local Timor Leste chickens. The existence of these variations can also be influenced by genetics, environment, feed and maintenance systems.

The weight of digestive organs in hens aged 10-12 months, hens aged 15-18 months, and roosters aged 12-15 months, those kept in Dili-Timor Leste (TL) and Purwokerto-Indonesia, is relatively the same. Organ weights, when compared with previous studies, are still the same and within the normal range. This is because the way they are reared, the type of feed given to the chickens, and their body size are also relatively the same. The difference is that chickens in Dili, Timor Leste (TL), are sometimes given granulated corn if the community has finished harvesting, whereas in Purwokerto-Indonesia, the additional feed given to chickens is leftovers from home or uncooked vegetables (Svihus, 2014; Svihus *et al*., 2002).

The factor that influences the weight of the proventriculus is the protein content of the ration, which will be broken down with the help of the pepsinogen enzyme. Tugiyanti and Susanti (2021), stated that the protein content of feed influences the size of the proventriculus, because the proventriculus works to produce hydrochloric acid (HCl), pepsin, and enzymes that can break down the protein and crude fibre of the feed given. The higher the crude protein content in the feed, the heavier the relative weight of the proventriculus because it has to secrete more enzymes and HCl. Local chickens in Dili and Purwokerto have relatively similar rearing patterns and are given the same feed, so that the weight of the proventriculus is no different.

Likewise, the size of the Gizzard is greatly influenced by the size of the feed particles and the crude fibre content of the feed. Larg feed particle size and crude fibre content will increase the work of the ventricular muscles in breaking down and reducing the size of the feed (Svihus, 2014; Tugiyanti and Susanti, 2021). The size of the Gizzard is no different for Hens 10-12 months, Hens 15-18 months, and Roosters 12-15 months because the weight of the chicken is also relative, and the gizzard only functions to break up the size of the feed. The type of feed given to chickens in Dili and Purwokerto is no different, so the size of the Gizzard is also relatively the same.

Based on Table 2, the weight of the small intestine, large intestine, caecum, and accessory organs (liver, pancreas, spleen) also did not differ between 10-12-month Hens, 15-18-month Hens, and 12-15-month Roosters between local Dili and Purwokerto chickens. This is because the type of feed given and the way the chickens are raised make them comfortable, even though the environmental conditions in Dili and Purwokerto are different. The small intestine, large intestine, cecum, and accessory organs (liver, pancreas, spleen) still function normally, so that chicken growth is normal and body weight is achieved according to their age. Body weight is correlated with the weight of the chicken's digestive organs, so that chickens of the same age range with the same body weight have the same size of digestive organs (Huang *et al*., 2022; Juanchich *et al*., 2021).

Wiranata *et al* stated that the appearance of local chickens is still very diverse, as well as their genetic characteristics, such as feather colour, body size, and production ability, which are not the same, which reflects the genetic diversity of native chickens (Wiranata *et al*., 2013). Free-range chickens have quite high genetic and phenotypic variations (Sartika *et al*., 2022). Qualitative characteristics indicate variations in feather color an d feather color patterns (white, black, brown, yellow, reddish yellow or a combination thereof), comb shape (pea, single, walnut and rose), color of leg or shank scales (white, yellow and black) and beak color (white, yellow and black) (Dako *et al*., 2020). These qualitative characteristics were found in free-range chickens kept both in the Dili-Timor Leste area and in the Purwokerto-Indonesia area in terms of feather color, comb type, comb color, and eye color.

The hue of chicken feathers is determined by the amount of melanoblast pigment, which develops during the early embryonic stage, approximately 8 hours into incubation (Inaba and Chuong, 2020) . There are three basic feather colours: black, white, and red (gold). The fur colour scheme is controlled by the E gene for black, the I gene for white, and the S gene for golden silver yellow (Rusdin, 2007) . Several genes interact with each other to produce coat colours and patterns. Technically, white is the result of all colours combined, and black is the lack of reflected light in the visible range. Blue feathers result when black-feathered chickens have the blue gene, which weakens the black colour. White colour can be obtained in various ways by inhibiting black and red pigmentation with a combination of genes (Wang *et al*., 2020) . The low frequency of black patterns is because the black colour in chickens is not stable, so it can be influenced by wild patterns. The interaction of the ee and eb alleles at the E locus greatly inhibits the formation of black expression based on the cross test (Adam *et al*., 2020) .

The female comb type of local chicken in the Dili-Timor Leste area and the Purwokerto-Indonesia area is relatively the same, while the Male comb type of chicken in the Purwokerto-Indonesia area is found to have the Rose type apart from the Pea, while in the Dili-Timor Leste area, only the Pea type is found. The comb is an accessory on the chicken's head that is influenced by the testosterone hormone, which can be used as an indicator of an individual's fertility (Lestari *et al*., 2021) . The Rose comb type is controlled by the R gene, while the Pea comb type is controlled by the P gene. Variations in comb shape indicate the diversity of comb shape phenotypes of native chickens. The comb shape of local Indonesian chickens is more varied because many local Indonesian chickens have experienced crossbreeding with Rhode Island Red (SR), White Leghorn (WL), and Barred Plymouth Rock (BR) chickens, which were imported in the 1950s (Rusdin, 2007). Comb growth in free-range chickens is one of the characteristics of masculinization due to prominent androgen activity and is the easiest to observe (Mukhtar and Khan, 2012) .

Combs are made up of collagen filaments that help chickens control their body temperature. The comb acts as a vessel to help store and discharge body warmth based on their environment. The warmer the chicken, the greater the comb. This is often because their blood is pumping faster to discharge warmer, making a bigger comb. The colour of the comb on a chicken is preferred as an indication of whether the chicken is healthy or not. Healthy chickens have bright red combs and a rough texture, while sick chickens have the opposite characteristics. The white colour of the chicken's comb is possible. The chicken feels uncomfortable because the chicken is in a high-temperature environment (Maharani *et al*., 2021). The beak is an external structure of birds consisting of the upper and lower mandibles covered with a thin keratinised layer of epider-

mis (Seki *et al*., 2010). The avian beak is a multipurpose organ playing a vital role in a variety of functions, including feeding, drinking, playing, grasping objects, mating, nesting, preening, and defence against predators and parasites. The beak is covered with a sheath of hard material called keratinised (Bhullar *et al*., 2015) .

In general, beak colour is influenced by the same genes that influence dermal and epidermal expression in chickens (Chebo *et al*., 2023). The hue of a bird's beak is determined by the quantities of pigments, melanins, and carotenoids within the epidermal layers, including the rhamphotheca (Davis and Clarke, 2022). Carotenoids constitute the foundation for the hues red, yellow, and orange, serving as the fundamental pigment for the extensive colour diversity observed in birds. In their research, the team identified a mutation that influences the expression of a critical carotenoid pigment gene, resulting in an accelerated deposition of carotenoids in the beaks of birds with the mutation, thereby producing the noted yellow colouration (Enbody *et al*., 2021). The red, orange, and yellow colours of the bill are caused by more than a dozen different carotenoids. Hue is determined by the proper mixture of red and yellow pigments, while saturation is determined by the density of the embedded pigment (Mc-Graw, 2004). Most local chickens have yellow beaks, but some have whitish beaks. The allele frequencies in local male Indonesian chickens in this study varied based on Table 3, as in the results of research by Rofii *et al*. (2018) and local chickens in Thailand (Yaemkong and Ngoc, 2019).

The observation of diverse eye colours in local chickens across Dili, Timor Leste, and Purwokerto, Indonesia, highlights a fascinating aspect of their genetics and environmental influences. The prevalence of orange, white, and red eye colours in both regions suggests a shared underlying genetic predisposition within these local chicken populations. This phenotypic variability is largely attributed to the extensive, uncontrolled mating systems common in traditional rearing practices. The lack of controlled breeding leads to unrestricted genetic mixing with other chicken types, a phenomenon known as cross-breeding, which is a significant driver of this eye colour diversity (Besbes, 2009) . Specifically, orange eye colour was remarkably dominant in the study by Maharani *et al*. (2021) , observed in 75.53% of males and 57.14% of females. This striking variation in eye colour is intricately linked to the presence and concentration of carotenoid pigments and the blood supply within the eye (Crawford, 1990) . Consequently, the expression of these colours is influenced by a trifecta of factors: the chicken's dietary intake and efficiency of carotenoid utilisation, its unique genetic makeup, and the degree of crossbreeding among different genotypes (Cabarles, 2013; Kosba *et al*., 2009). This means that what a chicken eats, its inherited genes, and who its ancestors mated with all play a role in determining its eye colour.

Similarly, the shank colour in these local chickens predominantly displayed a yellow hue. This yellow colouration is primarily due to the deposition of dietary carotenoid pigments in the epidermis, occurring specifically when melanic pigment is absent. Conversely, the presence of melanin pigment in both the dermis and epidermis results in black skin. A more complex interplay arises when black pigment is present in the dermis and yellow in the epidermis, leading to greenish shanks. If both melanic and carotenoid pigments are absent, the shanks will appear white (Maharani *et al*., 2021). This demonstrates that shank colour is a visual indicator of the delicate balance between pigment absorption from diet and genetic expression of melanin. In essence, both eye and shank colouration in these local chicken populations serve as compelling examples of how traditional rearing practices, uncontrolled breeding, and the interplay of genetics and dietary factors contribute to a rich tapestry of phenotypic diversity.

Conclusion

Local chickens from Purwokerto, Indonesia, and Dili, Timor Leste, exhibit significant differences in body and carcass weight, with Indonesian native chickens being heavier. Despite geographical separation, their digestive organ profiles are remarkably similar, suggesting comparable digestive functions. Phenotypic traits, however, show considerable variation within both populations, including diverse feather color, comb type and color, beak color, eye color, and leg color. This rich genetic diversity, expressed through various gene combinations controlling these traits, likely stems from distinct breeding histories and genetic introductions in each region.

Acknowledgements

The authors would like to thank the Rector and Head of the Research and Community Service Institute at Jenderal Soedirman University for providing funds so that this research can be carried out according to the International Research Collaboration scheme with contract number 26.276/UN23.35.5/PT.01/II/2024, dated 26 February 2024.

Conflict of interest

The authors have no conflict of interest to declare.

References

Adam, F., Dako, S., Datau, F., Laya, N.K., Fathan, S., Saleh, U., 2020. Keseimbangan genetik eksternal pada ayam hasil silangan. Jambura Journal of Animal Science 2, 76–89.
Ahmad, M.A., Salman, S., Ali, Q., Abbas, A., 2024. Analysis to uncover relationships between morphological traits, sex and their distribution in various chicken breeds. Bulletin of Biological and Allied Sciences Research 2024, 78.
Alders, R.G., Dumas, S.E., Rukambile, E., Magoke, G., Maulaga, W., Jong, J., Costa, R., 2018. Family poultry: Multiple roles, systems, challenges, and options for sustainable contributions to household nutrition security through a planetary health lens. Matern Child Nutr 14, e12668.
Astuti, A.T.B., Santi, S., Arfan, M., 2020. Respon pemberian pakan maggot black solder fly (Hermetia illucens) terhadap kualitas karkas dan non karkas ayam kampung super. AGROVITAL : Jurnal Ilmu Pertanian 5, 65.
Bakrie, B., Rohaeni, E.S., Yusriani, Y., Tirajoh, S., 2021. The development of a newly formed superior local chicken in Indonesia-A review. Journal of Hunan University Natural Sciences 48.
Besbes, B., 2009. Genotype evaluation and breeding of poultry for performance under sub-optimal village conditions. Worlds Poult Sci J 65, 260–271.
Bhullar, B.-A.S., Morris, Z.S., Sefton, E.M., Tok, A., Tokita, M., Namkoong, B., Camacho, J., Burnham, D.A., Abzhanov, A., 2015. A molecular mechanism for the origin of a key evolutionary innovation, the bird beak and palate, revealed by an integrative approach to major transitions in vertebrate history. Evolution (N Y) 69, 1665–1677.
Cabarles, J.C., 2013. Phenotypic cluster and diversity analysis of native chickens in western visayas, philippines. Animal Genetic Resources/Ressources génétiques animales/Recursos genéticos animales 53, 1–9.
Ceccobelli, S., 2013. Genetic diversity of mediterranean autochthonous chicken breeds. Università degli Studi di Padova, Padova.
Chebo, C., Betsha, S., Melesse, A., 2022. Chicken genetic diversity, improvement strategies and impacts on egg productivity in ethiopia: A review. Worlds Poult Sci J 78, 803–821.
Chebo, C., Melesse, A., Betsha, S., 2023. Morphological descriptors of indigenous chickens: As a selection guide. J Appl Anim Res 51, 729–742.
Crawford, R., 1990. Origin and history of poultry species. Poultry Breeding and Genetics 1–42.
Dako, S., Ilham, F., Laya, N., Masili, S., Azar, M., 2019. Crossbreding between native chiken and leghorn chiken strain ISA Brown. Jurnal Peternakan 16, 1.
Dako, S., Ilham, F., Laya, N.K., Yusuf, F.M., 2020. Nheritance of external genetic characteristics in chicken through triple crossing model. International Journal of Advanced Science and Technology 29, 549–558.
Davis, S.N., Clarke, J.A., 2022. Estimating the distribution of carotenoid coloration in skin and integumentary structures of birds and extinct dinosaurs. Evolution (N Y) 76, 42–57.
Desta, T.T., 2019. Phenotypic characteristic of junglefowl and chicken. Worlds Poult Sci J 75, 69–82.
Eda, M., 2021. Origin of the domestic chicken from modern biological and zooarchaeological approaches. Animal Frontiers 11, 52–61.
Edi, D.N., 2020. Analysis of regional potency and local feed resources to develop native chicken in east java province. Jurnal Ternak 11, 7–22.
Enbody, E.D., Sprehn, C.G., Abzhanov, A., Bi, H., Dobreva, M.P., Osborne, O.G., Rubin, C.-J., Grant, P.R., Grant, B.R., Andersson, L., 2021. A multispecies BCO2 beak color polymorphism in the darwin's finch radiation. Current Biology 31, 5597-5604.e7.
Eriko, Jatmiko, Nur, H., 2016. Pengaruh penggantian sebagian ransum komersial dengan dedak padi terhadap performa ayam kampung. Jurnal Peternakan Nusantara 2, 27–33.
Firdaus, R.A., Daud, A.R., Asmara, I.Y., 2023. Economic valuation of sentul chicken in the framework of providing incentives and sustainability of animal genetic resources (AnGR) in ciamis district, west java. Anim Prod 25, 31–39.
Fulla, S.T., 2022. Review on potential and impact of chicken crossbreeding in developing countries. World Sci News 166, 28–42.
Hanafi, N.D., Tafsin, M., Sitindaon, S.H., Sadeli, A., Simanungkalit, K., 2022. Pengaruh penggunaan bungkil inti sawit taraf 40% dalam ransum terhadap bobot potong, karkas, potongan komersil karkas dan kualitas daging ayam SenSi-1 agrinak. Jurnal Agripet 22, 62–71.
Heinrichs, C., 2019. How to raise chickens: Everything you need to know. Voyageur Press.
Henuk, Y.L., Bakti, D., 2018. Benefits of promoting native chickens for sustainable rural poultry development in Indonesia. In: Talenta Conference Series: Agricultural and Natural Resources (ANR). pp. 69–76.
Hidayat, Z., Nuraini, Asmarhansyah, 2017. Studi Karakteristik dan Ukuran-Ukuran Tubuh Ayam Merawang F2 di Kp Petaling Kepulauan Bangka Belitung. In: Prosiding Seminar Nasional Agroinovasi Spesifik Lokasi Untuk Ketahanan Pangan Pada Era Masyarakat Ekonomi ASEAN. pp. 907–915.
Huang, Q., Wen, C., Yan, W., Sun, C., Gu, S., Zheng, J., Yang, N., 2022. Comparative Analysis of the Characteristics of Digestive Organs in Broiler Chickens with Different Feed Efficiencies. Poult Sci 101, 102184.
Inaba, M., Chuong, C.-M., 2020. Avian pigment pattern formation: Developmental control of macro- (across the body) and micro- (within a feather) level of pigment patterns. Front Cell Dev Biol 8.

Juanchich, A., Urvoix, S., Hennequet-Antier, C., Narcy, A., Mignon-Grasteau, S., 2021. Phenotypic timeline of gastrointestinal tract development in broilers divergently selected for digestive efficiency. Poult Sci 100, 1205–1212.

Kanakachari, M., Rahman, H., Chatterjee, R.N., Bhattacharya, T.K., 2022. Signature of indian native chicken breeds: A perspective. Worlds Poult Sci J 78, 421–445.

Kanginakudru, S., Metta, M., Jakati, R.D., Nagaraju, J., 2008. Genetic Evidence from Indian Red Jungle Fowl Corroborates Multiple Domestication of Modern Day Chicken. BMC Evol Biol 8, 174.

Kosba, M., Yakout, H., Ebeid, T., El-Azeem, A., Shikhon, Z., Thieme, O., Ahmed, Z., 2009. Poultry Genetic Resources used by Small Producers. In: International Poultry Conference . pp. 67–77.

Lawal, R.A., Martin, S.H., Vanmechelen, K., Vereijken, A., Silva, P., Al-Atiyat, R.M., Aljumaah, R.S., Mwacharo, J.M., Wu, D.-D., Zhang, Y.-P., 2020. The Wild Species Genome Ancestry of Domestic Chickens. BMC Biol 18, 13.

Lestari, L., Rozi, T., Kasip, L.M., Azis, A., 2021. Morfometric Based on Comb Types of Kampung Chicken in Mataram City. Jurnal Ilmu dan Teknologi Peternakan Indonesia (JITPI) Indonesian Journal of Animal Science and Technology) 7, 85–94.

Maharani, D., Mustofa, F., Sari, A.P.Z.N.L., Fathoni, A., Sasongko, H., Hariyono, D.N.H., 2021. Phenotypic Characterization and Principal Component Analyses of Indigenous Chicken Breeds in Indonesia. Vet World 1665–1676.

Mariandayani, H.N., Solihin, D.D., Sulandari, S., Sumantri, C., 2013. Keragaman fenotipik dan pendugaan jarak genetik pada ayam lokal dan ayam broiler menggunakan analisis morfologi. Jurnal Veteriner 14, 475–484.

Mc-Graw, K.J., 2004. Not all red, orange, and yellow colors are carotenoid-based: The need to couple biochemical and behavioral studies of color signals in birds. In: Proceeding Indian National Science Academy. pp. 475–481.

Moiseyeva, I.G., Romanov, M.N., Nikiforov, A.A., Sevastyanova, A.A., Semyenova, S.K., 2003. Evolutionary relationships of red jungle fowl and chicken breeds. Genetics Selection Evolution 35, 403–423.

Mukhtar, N., Khan, S.H., 2012. Comb: An important reliable visual ornamental trait for selection in chickens. Worlds Poult Sci J 68, 425–434.

Nur, A.M., Putranto, H.D., Nurmeiliasari, N., Brata, B., Suharyanto, S., Sutriyono, S., 2022. Komparasi ukuran morfometrik pada tiga jenis ayam domestik (ayam burgo, ayam ketarras, dan ayam kampung) jantan di bengkulu. Naturalis: Jurnal Penelitian Pengelolaan Sumber Daya Alam dan Lingkungan 11, 177–181.

Nuraini, N., Hidayat, Z., Yolanda, K., 2018. Performa bobot badan akhir, bobot karkas serta persentase karkas ayam merawang pada keturunan dan jenis kelamin yang berbeda. Sains Peternakan 16, 69.

Rofii, A., Saraswati, T.R., Yuniwarti, E.Y.W., 2018. Phenotypic characteristics of indonesian native chickens. Journal of Animal Behaviour and Biometeorology 6, 56–61.

Rusdin, M., 2007. Analisis fenotipe, genotipe dan suara ayam pelung di kabupaten cianjur. IPB University.

Sartika, T., Saputra, F., Takahashi, H., 2022. Genetic diversity of eight native Indonesian chicken breeds on microsatellite markers. Hayati 30, 122–130.

Seki, Y., Bodde, S.G., Meyers, M.A., 2010. Toucan and hornbill beaks: A comparative study. Acta Biomater 6, 331–343.

Setianto, J., 2021. Identification of the origin of domesticated red jungle fowl by the community in bengkulu province, Indonesia. In: International Seminar on Promoting Local Resources for Sustainable Agriculture and Development (ISPLRSAD 2020). Atlantis Press, pp. 176–181.

Setianto, J., Zain, B., Sutriyono, Prakoso, H., 2017. Domestication of red jungle fowl: A case study of the red jungle fowl chicks procurement by the communities in central bengkulu, indonesia. Biodiversitas 18.

Sumantri, C., Khaerunnisa, I., Gunawan, A., 2020. The genetic quality improvement of native and local chickens to increase production and meat quality in order to build the indonesian chicken industry. In: IOP Conference Series: Earth and Environmental Science. IOP Publishing, p. 012099.

Svihus, B., 2014. Function of the digestive system. Journal of Applied Poultry Research 23, 306–314.

Svihus, B., Hetland, H., Choct, M., Sundby, F., 2002. Passage rate through the anterior digestive tract of broiler chickens fed on diets with ground and whole wheat. Br Poult Sci 43, 662–668.

Syahar, A.A.G., Zakaria, M.H., Zuki, A.B.Z., Lokman, H.I., Mazlina, M., 2014. The existence of red junglefowls (gallus gallus) in oil palm plantations in selected states in malaysia and their morphological characteristics. Jurnal Veteriner Malaysia 26, 38–40.

Tamzil, M.H., Indarsih, B., 2020. Measurement of several bodies parts of super kampong chicken reared intensively. Jurnal Ilmu dan Teknologi Peternakan Indonesia (JITPI) Indonesian Journal of Animal Science and Technology) 6, 103–110.

Tugiyanti, E., Susanti, E., 2021. Profile of digestive organ and carcass yield of broiler chickens reared with free-antibiotics feed-in different elevation area in Banyumas regency, Indonesia. International Journal of Veterinary Sciences and Animal Husbandry 6, 04–08.

Ulfah, L., 2005. Identifikasi ayam merawang jantan sebagai bibit. Universitas Padjajaran, Bandung.

Urfa, S., Indrijani, H., Tanwiriah, W., 2017. Model kurva pertumbuhan ayam kampung unggul balitnak (KUB) umur 0-12 minggu (growth curve model of kampung unggul balitnak (KUB) chicken). Jurnal Ilmu Ternak Universitas Padjajaran 17, 59–66.

Wang, M.-S., Thakur, M., Peng, M.-S., Jiang, Y., Frantz, L.A.F., Li, M., Zhang, J.-J., Wang, S., Peters, J., Otecko, N.O., Suwannapoom, C., Guo, X., Zheng, Z.-Q., Esmailizadeh, A., Hirimuthugoda, N.Y., Ashari, H., Suladari, S., Zein, M.S.A., Kusza, S., Sohrabi, S., Kharrati-Koopaee, H., Shen, Q.-K., Zeng, L., Yang, M.-M., Wu, Y.-J., Yang, X.-Y., Lu, X.-M., Jia, X.-Z., Nie, Q.-H., Lamont, S.J., Lasagna, E., Ceccobelli, S., Gunwardana, H.G.T.N., Senasige, T.M., Feng, S.-H., Si, J.-F., Zhang, H., Jin, J.-Q., Li, M.-L., Liu, Y.-H., Chen, H.-M., Ma, C., Dai, S.-S., Bhuiyan, A.K.F.H., Khan, M.S., Silva, G.L.L.P., Le, T.-T., Mwai, O.A., Ibrahim, M.N.M., Supple, M., Shapiro, B., Hanotte, O., Zhang, G., Larson, G., Han, J.-L., Wu, D.-D., Zhang, Y.-P., 2020. 863 genomes reveal the origin and domestication of chicken. Cell Res 30, 693–701.

Wiranata, G.A., Dewi, I.G.A.M.K., Indrawati, R.R., 2013. Pengaruh energi metabolis dan protein ransum terhadap persentase karkas dan organ dalam ayam kampung (gallus domesticus) betina umur 30 minggu. Jurnal Peternakan Tropika 1, 87–100.

Yaemkong, S., Ngoc, T.N., 2019. Diversity of phenotypic characteristics of white tailed-yellow chicken populations reared under free-range range system in phitsanulok province, thailand. Biodiversitas 20.

Zurahmah, N., Mu'in, M.A., Palulungan, J.A., 2023. Pendugaan bobot badan melalui ukuran shank pada ayam kampung yang dipelihara secara tradisional di manokwari. PETERPAN (Jurnal Peternakan Terapan) 5, 75–81.