Research Article

Morphometric and Phenotypic Characterization of Indigenous Highland Chickens in Northern Iraq

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Abstract | This study aimed to describe the morphometric and phenotypic characteristics of the indigenous Highland chicken breed in northern Iraq (Highlands region). A total of 419 adult native chickens (190 roosters and 229 hens) were evaluated, sourced from markets and urban, semi-urban, and rural areas. Data collection included direct observation, weight measurement, and morphometric evaluation in accordance with FAO standards for phenotypic characterization. The findings revealed a high degree of phenotypic diversity in plumage color, comb type, and body structure, with significant differences observed between sexes. The average adult body weight was 1,458 ± 342 grams, with roosters being 31.1% heavier than hens. All morphometric traits were significantly greater in males ($p < 0.01$). Feathered metatarsus individuals exhibited larger body dimensions, indicating a phenotypic association with body size. Plumage coloration was highly variable, with black (17.2%), white (15.3%), and gold (12.9%) being the most common. Feather texture was predominantly smooth (69.9%), while 30.1% of birds showed a superficially silky texture. Normal plumage type was observed in 64.2% of chickens, with additional phenotypes such as crested feathers (10.7%), feathered digits (22.4%), and rare bare-necked types. A simple-type comb was present in 81.1% of birds, mostly red, as were whiskers (87.8%). Beak shapes varied between curved (66.1%) and straight (33.9%), with coloration ranging from horn-colored (48.7%) to green (0.48%). Breastbone development was well-defined in 15.7% of birds. Skin and leg colors were mainly white but also included pink, yellow, black pigmentation, and steel blue (legs). Eye color was predominantly orange (58.2%), and facial skin was mainly red (75.9%). The observed high phenotypic variability suggests substantial potential for selective breeding aimed at improving productivity in rural poultry systems. Future research should focus on genetic characterization and performance traits to support breed conservation and sustainable poultry development in the Highlands region of northern Iraq.

Keywords | Morphometric, Phenotypic, Traits, Indigenous highland chickens, Northern Iraq

Received | March 09, 2025; **Accepted** | May 02, 2025; **Published** | May 26, 2025

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Citation | Shareef HM, Ahmed AJ, AL-Zargani, E. K. A. (2025). Morphometric and phenotypic characterization of indigenous highland chickens in northern Iraq. J. Anim. Health Prod. 13(2): 426-434.

DOI | https://dx.doi.org/10.17582/journal.jahp/2025/13.2.426.434

ISSN (Online) | 2308-2801

INTRODUCTION

In developing countries, rural poultry production plays a crucial role as a primary source of animal protein and a key income generator, particularly for women and small-scale farmers (Gueye, 2009; FAO, 2012). Enhancing village poultry farming and gradually improving poultry performance can significantly contribute to economic development, food security, and biodiversity conservation (Alders and Pym, 2009; Muchadeyi *et al.*, 2007).

In northern Iraq (Highlands region), local chicken populations are widely distributed across rural areas and are predominantly raised in backyard systems. Despite challenges related to low productivity, disease susceptibility, and management limitations, local chickens account for approximately 80% of the total poultry population in the region and are kept in nearly 70% of rural households (FAO, 2019; Padhi, 2016). However, scientific documentation of local chicken genetic resources in the Kurdistan Region of Iraq remains limited, making their genetic and phenotypic characteristics largely unknown. Furthermore, crossbreeding with exotic commercial breeds poses a serious threat to their genetic integrity, increasing the risk of genetic erosion and loss of valuable adaptive traits (Tadelle *et al*., 2013; Mpenda *et al*., 2019).

Historically, local chicken populations in this region have been shaped by natural selection rather than targeted breeding programs, leading to high genetic diversity and strong environmental adaptability (Dana *et al*., 2010; Okeno *et al*., 2012). However, the absence of structured breeding programs and limited knowledge about their genetic potential make it difficult to develop conservation strategies or harness their full productive capacity. Therefore, a comprehensive inventory, phenotypic characterization, and genetic cataloging of the local chicken population are essential to support sustainable breeding programs and improve rural poultry productivity.

This research aims to expand the understanding of the genetic and phenotypic diversity of indigenous poultry in northern Iraq (Highlands region). Specifically, this study focuses on describing the morphometric diversity of local chicken populations in the highland areas of the Kurdistan Region of Iraq. By characterizing these chickens, we can lay the foundation for future genetic conservation efforts, performance enhancement programs, and the sustainable development of local poultry production.

MATERIALS AND METHODS

Study Area Description

The northern highlands of Iraq are located between latitudes 36° - 38°N and longitudes 42° - 45°E. This region features highly diverse topography, with elevations ranging from 500 to 3,000 meters above sea level. The climate exhibits significant temperature variations, ranging from 5°C to 35°C, while relative humidity fluctuates between 30% and 80%.

The annual average rainfall in the region extends over a single wet season from October to May, averaging 600 mm per year, with a minimum of 250 mm and a maximum of 1,200 mm. The climate is classified as modified Mediterranean, adjusted by altitude, where higher elevations experience lower temperatures and increased precipitation, making it suitable for poultry and livestock farming.

Agriculture and livestock rearing are extensively practiced by nearly all residents of this region. Poultry farming plays a significant role in food security and rural livelihoods, with local poultry accounting for approximately 35% of the total national poultry population, including those raised in commercial, traditional, and backyard farming systems (FAO, 2019; Padhi, 2016).

Morphobiometric Characterization

Data collection: All measurements were conducted over a dispersed time period, and the study adhered to the general principles of research ethics and animal welfare. Morphometric characterization of local chickens was carried out on adult birds obtained from urban, semi-urban, and rural farms, as well as from livestock markets in the highlands of the Kurdistan Region of Iraq. A total of 419 adult indigenous chickens (190 roosters and 229 hens) were sampled to ensure a broad representation of phenotypic diversity.

Morphometric measurements were collected using a digital scale (precision: 0.01 g), fine calipers (0.02 mm precision), and a measuring tape, following FAO (2012) phenotypic characterization guidelines (Yakubu *et al*., 2009; Ajayi, 2010). Qualitative traits were assessed using direct visual observations by trained evaluators to maintain consistency (Dana *et al*., 2010).

Measured traits: The study examined two main categories of traits:

1. Morphological traits (Qualitative Data).Following morphological traits were recorded:

- Feather characteristics (type, coloration, and distribution)
- Comb type and structure (single, double, crested, or rose)
- Beard and earlobe dimensions and color
- Eye pigmentation
- Beak shape and color
- Leg features (shank color, polydactyly, spur presence)
- Skin pigmentation and variations

1. Biometric characteristics (Quantitative Data). The following body measurements were recorded:

- Body Length: Distance from the tip of the upper mandible to the tip of the tail (excluding feathers).
- Chest Circumference: Measured just below the wings,

at the level of the most prominent part of the sternum (keel bone).
- Wing Length: Distance from the humerus-spinal junction to the tip of the wing (excluding feathers).
- Beak Length: Distance from the tip of the upper mandible to the articulation of the lower mandibles.
- Shank Length: Distance from the hock joint (tarsal joint) to the base of the toes.

Each measurement was taken three times per individual, and mean values were used for statistical analysis (Yakubu *et al.*, 2009; FAO, 2012).

Statistical Analysis

Descriptive statistics were used to evaluate means, standard deviations, and variations between sex and phenotypic groups. Independent t-tests were applied to compare biometric traits between males and females. Chi-square tests (χ^2) were used to examine the distribution of qualitative traits. Data were analyzed using SPSS version 24, with statistical significance set at $p < 0.05$ (Ajayi, 2010; Dana *et al.*, 2010).

Table 1: Plumage color distribution in indigenous highland chickens of northern Iraq.

Plumage Color	♂ (n)	♂ (%)	♀ (n)	♀ (%)	♂♀ (n)	♂♀ (%)
Black	19	10.0	53	23.1	72	17.2
White	37	19.5	27	11.8	64	15.3
Golden	44	23.2	10	4.37	54	12.9
Red	40	21.0	1	0.44	41	9.78
Brown	2	1.05	34	14.8	36	8.60
Mahogany	7	3.68	27	11.8	34	8.11
Wild	0	0	26	11.3	26	6.20
Barred	8	4.21	12	5.24	20	4.77
Partridge	0	0	13	5.68	13	3.10
Ermine	8	4.21	8	3.49	16	3.81
Blue	8	4.21	4	1.75	12	2.86
Speckled	9	4.74	0	0	9	2.15
Yellow	3	1.58	3	1.31	6	1.43
Gray	0	0	4	1.75	4	0.95
Mille-fleur	1	0.53	3	1.31	4	0.95
Fawn	2	1.05	2	0.87	4	0.95
Chestnut	0	0	2	0.87	2	0.48
Silver	2	1.05	0	0	2	0.48

RESULTS AND DISCUSSION

Qualitative Characteristics

Plumage colour: The highland chickens of northern Iraq (Highlands region) exhibited a highly diverse plumage coloration (Table 1). The most predominant colors observed were black (17.2%), which was more common in females, and white (15.3%), which was more prevalent in males. Other observed colors included golden, brown, red, and mixed plumage, indicating a broad phenotypic variation within the studied population.

This diversity in plumage coloration suggests a heterogeneous genetic background, which could be influenced by natural selection, environmental adaptation, and historical crossbreeding with exotic poultry breeds (Dana *et al.*, 2010; Msoffe *et al.*, 2004; Ajafar et al., 2024b)

Plumage color distribution in indigenous highland chickens of northern Iraq: Table 1 presents the distribution of plumage color in indigenous highland chickens of Northern Iraq. The data revealed significant color diversity, with the most common colors being black (17.2%) and white (15.3%). Black plumage was more frequent among females (23.1%) compared to males (10.0%), whereas white plumage is more prevalent among males (19.5%) than females (11.8%). This color variation may be influenced by natural selection, environmental adaptation, and genetic diversity due to possible crossbreeding with exotic poultry breeds.

Other plumage colors observed include red, brown, mahogany, wild, barred, partridge, ermine, blue, speckled, yellow, gray, mille-fleur, fawn, chestnut, and silver, with frequencies ranging from 9.78% to 0.48%. The observed diversity suggests a heterogeneous genetic background influenced by selective pressures and environmental adaptation.

Type and distribution of plumage in indigenous highland chickens of northern Iraq: Table 2 presented the type and distribution of plumage in indigenous highland chickens of Northern Iraq. The results indicate that there were two main plumage types: smooth and superficially silky. Smooth plumage was predominant, accounting for 69.9% of the population, and was significantly more common in females (96.9%). In contrast, the superficially silky type represented 30.1% of the population and was more prevalent in males.

Regarding feather distribution, normal plumage was the most common trait (64.2%). Crested plumage was present in 10.7% of individuals, while 22.4% exhibited feathered tarsus and metatarsus. Only 1.90% of the population had a naked neck. Combinations such as crested + feathered tarsus and crested + naked neck were rare, each constituting only 0.24% of the total population. Additionally, 50.5% of chickens had feathered cheeks, and 15.7% possess a bushy tail.

Type and coloration of the comb in indigenous highland chickens of northern Iraq: Table 3 presented the type and coloration of the comb in indigenous highland

chickens of Northern Iraq. The results indicate that the simple comb was the most prevalent type, accounting for 81.1% of the population. Other forms, such as the rose (smooth and spiky) and triple combs, were found in smaller proportions. Regarding coloration, the majority of combs were red (87.8%), with some individuals displaying pink (7.64%) or black-pigmented (4.53%) combs.

The results indicate that the comb coloration largely follows the same distribution as the wattles, with approximately similar proportions of red (87.8%), pink (7.64%), and black-pigmented (4.53%) combs. These findings suggest a strong genetic basis for comb and wattle coloration.

Table 2: Type and distribution of plumage in indigenous highland chickens of northern Iraq.

Characteristic	♂ (n)	♂ (%)	♀ (n)	♀ (%)	♂♀ (n)	♂♀(%)
Plumage Type						
Smooth	71	37.4	222	96.9	293	69.9
Silky	119	62.6	7	3.06	126	30.1
Total	190		229		419	
Plumage Distribution						
Normal	129	67.9	140	61.1	269	64.2
Naked Neck	7	3.68	1	0.44	8	1.90
Feathered Tarsus	48	25.3	46	20.1	94	22.4
Crested	5	2.63	40	17.5	45	10.7
Naked Neck + Feathered Tarsus	1	0.53	0	0	1	0.24
Crested + Feathered Tarsus	0	0	1	0.44	1	0.24
Naked Neck + Crested	0	0	1	0.44	1	0.24
Feathered Earlobe	0	0	6	2.62	6	1.43
Feathered Cheeks	52	27.4	168	73.4	220	50.5
Bushy Tail	48	25.3	18	7.86	66	15.7

Shape and coloration of wattles and earlobes in indigenous highland chickens of northern Iraq: Table 4 presents the shape and coloration of wattles and earlobes in indigenous highland chickens of Northern Iraq. The results indicate that wattles predominantly match the coloration of the comb, with red being the most frequent (87.1%), followed by pink (9.31%) and black-pigmented (3.58%). Regarding earlobe shape, the oval form was the most common, observed in 82.6% of individuals, particularly in males (97.4%). Earlobe coloration varies, with red (40.3%) and white (35.6%) being the most prevalent. However, red was dominant in males (66.8%), while white was more common in females (48.9%).

A total of 82.6% of earlobes exhibited an oval shape, particularly among males (97.4%). Red and white earlobes were the most common, accounting for 40.3% and 35.6% of the population, respectively. However, red was significantly more prevalent in males (66.8%), while white was more frequent in females (48.9%). Other variations include white-centered (13.4%), pink (5.25%), yellow (3.10%), and black-pigmented earlobes (2.39%). These findings highlight the diversity in external traits among indigenous chickens, which may have genetic and adaptive significance.

Table 3: Type and coloration of the comb in indigenous highland chickens of northern Iraq.

Comb Type and Coloration	♂ (n)	♂ (%)	♀ (n)	♀ (%)	♂♀ (n)	♂♀ (%)
Comb Type						
Simple	146	76.8	194	84.7	340	81.1
Double	2	1.05	1	0.44	3	0.71
Triple	14	7.37	0	0	14	3.34
Smooth Rose	2	1.05	15	6.55	17	4.06
Spiky Rose	26	13.7	19	8.30	45	10.7
Total	190		229		419	
Comb Coloration						
Red	187	98.4	181	79.0	368	87.8
Pink	2	1.05	30	13.1	32	7.64
Black Pigmented	1	0.53	18	7.86	19	4.53
Total	190		229		419	

Table 4: shape and coloration of wattles and earlobes in indigenous highland chickens of northern Iraq.

Characteristics	♂ (n)	♂ (%)	♀ (n)	♀ (%)	♂♀ (n)	♂♀ (%)
Wattle Color						
Red	188	98.9	177	77.3	365	87.1
Pink	1	0.53	38	16.6	39	9.31
Black Pigmented	1	0.53	14	6.11	15	3.58
Total	190		229		419	
Earlobe Shape						
Round	5	2.63	68	29.7	73	17.4
Oval	185	97.4	161	70.3	346	82.6
Total	190		229		419	
Earlobe Color						
Red	127	66.8	42	18.3	169	40.3
White	37	19.5	112	48.9	149	35.6
White-Centered	22	11.6	34	14.8	56	13.4
Pink	1	0.53	21	9.17	22	5.25
Yellow	2	1.05	11	4.80	13	3.10
Black Pigmented	1	0.53	9	3.93	10	2.39
Total	190		229		419	

Beak shape and coloration in indigenous highland chickens of northern Iraq: Table 5 presents the characteristics of the beak in indigenous highland

chickens of Northern Iraq. The results indicate that the beak shape was either curved (66.1%), predominantly in males (88.4%), or straight (33.9%), with females being the majority (52.4%). Beak coloration varies from green (0.48%) to horn (48.7%), with other shades such as white (8.83%), yellow (17.2%), and black (24.8%).

Table 5: Beak characteristics in indigenous highland chickens of northern Iraq.

Beak Characteristics	♂ (n)	♂ (%)	♀ (n)	♀ (%)	♂♀ (n)	♂♀(%)
Beak Color						
Horn	90	47.4	114	49.8	204	48.7
Black	41	21.6	63	27.5	104	24.8
Yellow	47	24.7	25	10.9	72	17.2
White	12	6.31	25	10.9	37	8.83
Green	0	0	2	0.87	2	0.48
Total	190		229		419	
Beak Shape						
Curved	168	88.4	109	47.6	277	66.1
Straight	22	11.6	120	52.4	142	33.9
Total	190		229		419	

The results highlight that curved beaks were more common in males (88.4%), whereas straight beaks were more frequent in females (52.4%). The most prevalent beak color was horn (48.7%), followed by black (24.8%), yellow (17.2%), white (8.83%), and green (0.48%). These variations may be linked to genetic factors and adaptive traits related to environmental conditions.

Keel bone development in indigenous highland chickens of northern Iraq: Table 6 presents the keel bone development in indigenous highland chickens of Northern Iraq. The results indicate variation in keel bone development both between and within sexes. A greater proportion of females (36.2%) exhibit a poorly developed keel bone compared to males (18.94%), whereas males show a higher frequency of well-developed keel bones. This suggests that selection based on keel bone development could be twice as effective in males compared to females.

Table 6: Keel bone development in indigenous highland chickens of northern Iraq.

Keel Bone Development	♂ (n)	♂ (%)	♀ (n)	♀ (%)	♂♀ (n)	♂♀ (%)
Poor	36	18.94	83	36.2	119	28.4
Moderate	116	61.05	118	51.5	234	55.8
> Average	38	20.0	28	12.2	66	15.7
Total	190		229		419	

The variation in keel bone development indicates potential for selective breeding. The higher frequency of well-developed keel bones in males suggests that selection based on this trait would be more effective in males compared to females. Further genetic and nutritional studies could help optimize keel bone growth for improved poultry productivity.

Skin and leg coloration in indigenous highland chickens of northern Iraq: Table 7 presents the coloration of the skin and legs in indigenous highland chickens of Northern Iraq. The results indicate that skin color varies among white (39.4%), pink (21.9%), yellow (37.9%), and black-pigmented (0.71%). Similar color distributions were observed in the legs, with white (39.6%), pink (2.15%), yellow (39.1%), and black-pigmented (6.20%) being the dominant colors. Additionally, some chickens exhibited green (12.4%) and steel blue (0.48%) leg coloration.

Table 7: Skin and leg coloration in indigenous highland chickens of northern Iraq.

Characteristics	♂ (n)	♂ (%)	♀(n)	♀(%)	♂♀ (n)	♂♀ (%)
Skin Color						
White	74	38.9	91	39.74	165	39.4
Pink	36	18.9	56	24.45	92	21.9
Yellow	78	41.0	81	35.37	159	37.9
Black Pigmented	2	1.05	1	0.43	3	0.71
Total	190		229		419	
Leg Color						
Green	9	4.73	43	18.78	52	12.4
Black	6	3.16	20	8.73	26	6.20
Yellow	93	48.9	71	31.0	164	39.1
Pink	5	2.63	4	1.75	9	2.15
Steel Blue	0	0	2	0.87	2	0.48
White	77	40.53	89	38.8	166	39.6
Total	190		229		419	

The variations in skin and leg coloration suggest significant genetic diversity within the indigenous chicken population. White and yellow were the most prevalent colors observed, while black-pigmented, green, and steel blue colors were found in lower proportions. Further research on the genetic and environmental factors influencing skin and leg pigmentation may provide insights into selective breeding strategies.

Eye and face coloration in indigenous highland chickens of northern Iraq: Table 8 presents the coloration of the eyes and face in indigenous highland chickens of Northern Iraq. The results indicate that the predominant eye color was orange (58.2%), followed by yellow (30.8%). Other less frequent colors include red (6.52%), black-pigmented (3.58%), and white (0.48%).

Regarding face coloration, red was the most common (75.9%), particularly among males (96.8%), while pink (19.0%) and black-pigmented (5.01%) faces were also observed.

Table 8: Eye and face coloration in indigenous highland chickens of northern Iraq.

Characteristics	♂ (n)	♂ (%)	♀ (n)	♀(%)	♂♀(n)	♂♀ (%)
Eye Color						
Orange	123	64.7	121	52.8	244	58.2
Yellow	50	26.3	79	34.5	129	30.8
Black Pigmented	5	2.26	10	4.37	15	3.58
Red	10	5.26	19	8.30	29	6.52
White	2	1.05	0	0	2	0.48
Total	190		229		419	
Face Color						
Red	184	96.8	134	58.5	318	75.9
Pink	5	2.63	75	32.7	80	19.0
Black Pigmented	1	0.53	20	8.73	21	5.01
Total	190		229		419	

Table 9: Live weight (g) and body measurements (mm) by sex and coefficient of variation in indigenous highland chickens of northern Iraq.

Characteristics	♂ (n=190)	♀ (n=229)	♂♀ (n=419)	Coefficient of Variation (%)	Significance (p < 0.01)
Live Weight (Pds)	1676± 319b	1278± 242a	1458± 342	23.5	Significant
Tarsus Length (LT)	78.0± 7.16b	63.6± 6.11a	70.2± 9.74	13.8	Significant
Shank Development (DP)	30.1± 4.81b	24.5± 4.10a	27.0± 5.23	19.3	Significant
Wing Length (LA)	159± 17.4b	144± 12.15a	151± 16.3	10.8	Significant
Tarsus Diameter (DT)	15.5± 1.82b	12.7± 1.67a	13.9± 2.23	16.0	Significant
Thoracic Perimeter (PT)	409± 26.9b	376± 21.1a	391± 28.8	7.37	Significant
Body Length (LC)	415± 25.4b	365± 26.4a	388± 35.8	9.23	Significant
Comb Height (HCr)	31.9± 13.0b	12.2± 15.5a	21.1± 17.1	81.4	Significant
Beak Length (LBe)	34.8± 3.10b	31.7± 2.61a	33.1± 3.21	9.70	Significant
Comb Length (LCr)	68.6± 17.8b	32.2± 11.7a	48.7± 23.4	48.1	Significant
Wattle Length (LBa)	33.7± 11.8b	8.48± 5.13a	19.9± 15.3	77.0	Significant
Spur Length (LE)	11.0± 6.34b	5.06± 2.91a	9.79± 6.29	64.2	Significant

The results suggest that eye coloration was primarily orange and yellow, with minor occurrences of red, black-pigmented, and white eyes. Face coloration was predominantly red, especially in males, whereas pink and black-pigmented faces were more frequent in females. These variations could be associated with genetic factors and environmental adaptations.

Live weight and body measurements by sex in indigenous highland chickens of northern Iraq: Table 9 summarizes the live weight and body measurements of roosters and hens in indigenous highland chickens of Northern Iraq. The average live weight of this population was 1458 ± 342 g, with a coefficient of variation of 23.5%. Live weight ranges from 975 to 2900 g in males and from 825 to 2350 g in adult females. On average, males were 31.10% heavier than females. Additionally, all other body measurements were significantly higher ($p < 0.01$) in males compared to females.

The analysis indicates that all body measurements, including live weight, tarsus length, wing length, and comb dimensions, were significantly greater in males compared to females ($p < 0.01$). The variation in these traits suggests that selection for larger body size could be more effective in males, offering potential for breed improvement and increased productivity.

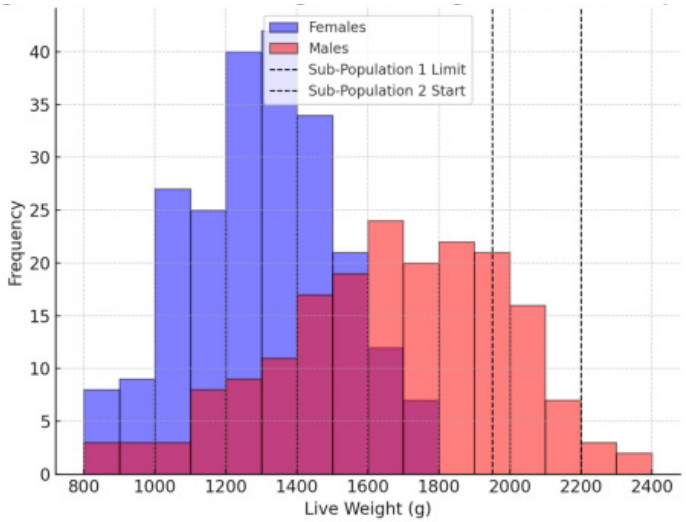

Figure 1: Distribution of weight in the indigenous chicken population.

Weight distribution in the indigenous chicken population of northern Iraq: Figure 1 illustrates the weight distribution in the indigenous chicken population of Northern Iraq. The distribution exhibits significant variability in both males and females. More than 40% of females have a weight between 1200 and 1350 g. Additionally, two distinct sub-populations emerge: one with weights below 1950 g and another consisting of chickens weighing between 2200 and 2400 g.

The observed weight distribution suggests significant phenotypic diversity within the population. This variation may result from genetic differences, environmental influences, or selective breeding pressures. Further analysis may provide insights into optimizing growth performance in indigenous chicken breeds.

Weight distribution in the rooster population of northern Iraq: Figure 2 illustrates the weight distribution in the rooster population of Northern Iraq. Approximately 30% of the individuals have a weight between 1500 and 1600 g. Additionally, three distinct sub-populations can be identified: 1) Roosters with weights ≤ 2300 g, which follow a normal distribution, 2) Roosters weighing between 2400 and 2700 g, and 3) Roosters with weights exceeding 2800 g.

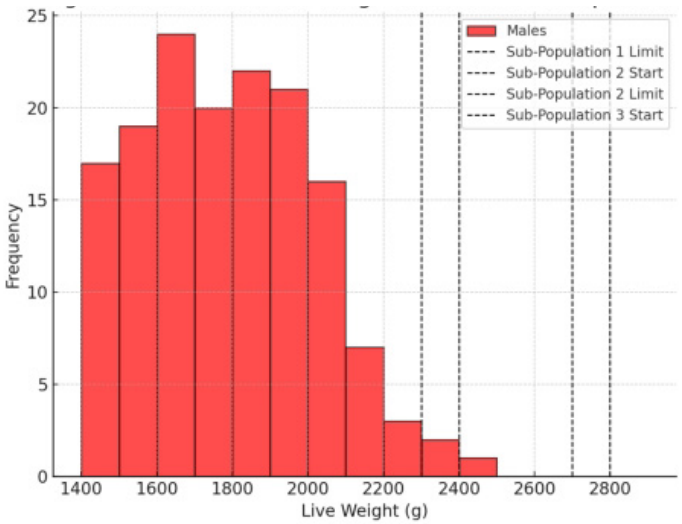

Figure 2: Distribution of weight in the rooster population.

The presence of these sub-populations suggests potential genetic and environmental influences on growth patterns. Further studies could help identify the factors contributing to these weight variations and optimize breeding strategies for improved productivity.

Variation in body measurements by morphological type in indigenous highland chickens of northern Iraq: Table 10 presents the biometric characteristics of the indigenous highland chickens of Northern Iraq according to their morphological type. Significant differences ($p < 0.01$) were observed among the different types for all traits, except for wing length, which showed no significant variation.

It was also observed that, similar to weight, all other quantified traits are highest in the feathered tarsus type and significantly lower ($p < 0.01$) in the crested type. This variation suggests that morphological differences play a key role in the overall body structure and growth potential of indigenous chickens.

Table 10: Weight (kg) and body measurements (mm) by phenotypic type in indigenous highland chickens of northern Iraq.

Characteristics	Normal	Feathered Tarsus	Crested	Naked Neck	Mean
Live Weight (Pds)	1.45± 0.35ab	1.55± 0.33b	1.28± 0.25a	1.47± 0.21ab	1.46 ±0.34
Shank Development (DP)	26.9± 5.19ab	28.7± 5.20b	24.7± 4.74a	26.6± 4.96ab	27.0 ±5.24
Tarsus Length (LT)	699± 95.3ab	724± 101bc	655± 91.1a	773± 73.4c	701 ±97.8
Tarsus Diameter (DT)	13.8± 2.26ab	14.7± 2.16bc	12.9± 1.86a	15.1± 1.83c	13.9 ±2.25
Body Length (LC)	386± 35.3ab	401± 34.8b	368± 32.8a	388± 16.9ab	388 ±35.8
Wing Length (LA)	150± 16.6a	156± 16.4a	147± 13.6a	148± 4.10a	151 ±16.4
Thoracic Perimeter (PT)	390± 29.5ab	403± 26.9b	375± 21.5a	395± 15.6b	391 ±29.0

In contrast to naked neck morphological types, crested and feathered shank types are well represented. According to rural farmers, these types are often preferred for their superior reproductive and growth performances, respectively, although the crested phenotype is sometimes considered a superstition by certain local communities. However, these performance claims have not yet been scientifically validated (Liu, 2006; Al-saeedi *et al.*, 2024).

As in the majority of studies conducted across the tropics, the single comb is the most frequent, followed by rose combs. It should be noted that rose combs are more represented in our study area compared to other regions. Several studies associate the rose comb with reduced fertility, mainly in homozygous males (RR), due to decreased sperm viability compared to other phenotypes (Dana et al., 2010). Chickens with rose combs have a prevalence of 14.79% in our population.

Consistent with other studies, the most common skin colors are white, yellow, and pink. Similarly, leg colors include black and steel blue. The high occurrence of yellow coloration in the legs and skin may indicate the degree of introgression of exotic genes into the local chicken population (Lawal, 2020).

CONCLUSIONS AND RECOMMENDATIONS

In the studied population of indigenous chickens, darker plumage colors were predominant, particularly in rural areas. The population exhibited a low frequency of genes associated with adaptation to high-temperature environments, such as the Na (naked neck) and F (frizzled) alleles.

Conversely, a relatively high frequency of rose combs may suggest a potential association with reduced male fertility. Sexual dimorphism was evident in breastbone development and in all other quantitative traits assessed, consistently favoring males. The values of these quantitative traits varied across different phenotypic types, including normal, feathered shank, crested, and naked neck chickens. The observed high level of genetic diversity could serve as a valuable foundation for developing more resilient and productive strains through selective breeding and crossbreeding. Concurrent improvements in husbandry practices could significantly enhance the productivity of local chickens, particularly within traditional production systems, making them a cost-effective and sustainable source of high-quality protein. However, the limited information on the degree of similarity among the various phenotypes presents a challenge for effective selection and conservation strategies.

ACKNOWLEDGEMENTS

The authors would like to express their thanks to the Department of Animal Production, College of Agriculture, Sumer University, as well as all the cooperating individuals and farm owners in the northern regions of Iraq for completing the requirements of the study.

NOVELTY STATEMENTS

The study is considered the only one in Iraq on genetic investigation of Highland Chickens.

AUTHOR'S CONTRIBUTIONS

Hussein Majeed Shareef contributed to data collection and analysis. Adnan Jawad Ahmed, AL-Zargani, E.K.A. participated in manuscript writing, preparation, and laboratory testing.

Conflict of Interest

The authors have declared no conflict of interest.

REFERENCES

Ajafar M, Al-Jebory HH, Al-Saeedi MKI (2024a). Effect of in Ova injection of lysophospholipid in hatching traits, chick's quality, and chicks physical traits of broiler (Ross 308). Adv. Anim. Vet. Sci., 12(7):1206-1213. https://doi.org/10.17582/journal.aavs/2024/12.7.1206.1213

Ajafar M, Al-Jebory HH, Al-Saeedi MKI (2024b). Effect of Feed Restriction and Manganese Supplementation on the Immunological and Physiological Traits and Glycogen Level of Broiler Ross 308. Kufa J. Agric. Sci., 16(4): 141-150. https://doi.org/10.36077/kjas/2024/v16i4.11994

Ajayi FO (2010). Genetic and Phenotypic Characterization of Nigerian Indigenous Chickens. Int. J. Poult. Sci., 9(10): 931-936.

Alders RG, Pym RAE (2009). Village Poultry: Still Important to Millions, Eight Thousand Years after Domestication. World's Poult. Sci. J., 65(2): 181-190. https://doi.org/10.1017/S0043933909000117

Al-Jebory HH, Al-Saeedi MKI, Ajafar M, Ali NAL (2024). Impact of melatonin on improving productive traits of broiler exposed to environmental stress. Adv. Anim. Vet. Sci., 12(4): 775-781. https://doi.org/10.17582/journal.aavs/2024/12.4.775.781

Al-Saeedi MKI, Ajafar M, Al-Jeobry HH (2024). Immunity and glycogen metabolism of laying hens fed diets supplemented with manganese sulfate during the force molting. J. Anim. Health Prod., 12(3): 413-419. https://doi.org/10.17582/journal.jahp/2024/12.3.413.419

Crawford RD (1990). Poultry Breeding and Genetics. Elsevier Science Publishers.

Dana N, Dessie T, van der Waaij LH, van Arendonk JAM (2010). Morphological Features of Indigenous Chicken Populations of Ethiopia. Anim. Genet. Resour., 46: 11-23. https://doi.org/10.1017/S2078633610000652

Delany ME, Robinson CM, Bloom SE (2017). Chicken as a Model for Genetics and Development. Encyclopedia of Life Sciences, Wiley.

FAO (2012). Phenotypic Characterization of Animal Genetic Resources. FAO Animal Production and Health Guidelines No. 11. Food and Agriculture Organization of the United Nations, Rome.

FAO (2019). The State of the World's Biodiversity for Food and Agriculture. FAO Commission on Genetic Resources for Food and Agriculture Assessments, Rome.

Gueye EF (2009). The Role of Family Poultry in Poverty Alleviation, Food Security, and the Promotion of Gender Equality in Rural Africa. World's Poult. Sci. J., 65(2): 211-220.

Haunshi S (2011). Characterization of Two Indian Native Chicken Breeds for Production, Egg and Semen Quality, and Welfare Traits. Poult. Sci., 90(2): 314-320. https://doi.org/10.3382/ps.2010-01013

Hillier LW, Graves TA, Fulton RS (2004). Sequence and Comparative Analysis of the Chicken Genome. Nature, 432(7018): 695-716. https://doi.org/10.1038/nature03154

Lawal RA (2020). The Wild Species Genome Ancestry of Domestic Chickens. BMC Biol., 18(1): 13. https://doi.org/10.1186/s12915-020-0738-1

Liu YP (2006). Multiple Maternal Origins of Chickens: Out of the Asian Jungles. Mol. Phylogenet. Evol., 38(1): 12-19. https://doi.org/10.1016/j.ympev.2005.09.014

Lukanov H (2019). Diversity in Chicken Plumage: Genetics, Evolution, and Selection. Avian Res., 10: 1-13.

Moazeni M (2016). Phenotypic Characterization of Indigenous Chickens in Iran. Trop. Anim. Health Prod., 48(6): 1213-1217.

Mpenda FN, Schilling MA, Campbell ZA, Mngumi EB, Buza JJ (2019). The Genetic Diversity of Indigenous African Chickens: A Potential for Conservation. World's Poult. Sci. J., 75(3): 451-470.

Msoffe PL, Mtambo MMA, Minga UM, Juul-Madsen HR, Gwakisa PS, Olsen JE (2004). Productivity and Natural

Disease Resistance of Rural Chickens in Tanzania. Livestock Res. Rural Dev., 16(9): 1-10.

Msoffe PLM (2002). Diversity Among Local Chicken Ecotypes in Tanzania. Livestock Res. Rural Dev., 14(3).

Muchadeyi FC, Sibanda S, Kusina NT, Kusina J, Makuza S (2007). Village Chicken Flock Dynamics and the Contribution of Chickens to Household Livelihoods in a Smallholder Farming Area in Zimbabwe. Trop. Anim. Health Prod., 39(6): 459-466.

Okeno TO, Kahi AK, Peters KJ (2012). Breed Selection and Breeding Strategies for Indigenous Chicken in Kenya: Current Status and Future Outlook. World's Poult. Sci. J., 68(1): 1-12. https://doi.org/10.1017/S0043933912000128

Padhi MK (2016). Importance of Indigenous Breeds of Chicken for Rural Economy and Their Improvements for Higher Production Performance. Sci. Rep., 6: 27909. https://doi.org/10.1155/2016/2604685

Salman KAA, Al-Saeedi MKI, Al-Jebory HH (2024a). Impact of ova injection with zinc methionine on some blood parameters and glycogen level of broiler chickens exposed to feed fasting. Adv. Anim. Vet. Sci., 12(8):1532-1538. https://doi.org/10.17582/journal.aavs/2024/12.8.1532.1538

Salman KAA, Al-Saeedi MKI, Al-Jebory HH, Al-Jebory RF (2024b). Effect of neem (Azadirachta indica) leaf powder supplementation on some blood parameters in broiler chickens exposed to heat stress. Punjab Univ. J. Zool., 39(2): 177-183. https://doi.org/10.17582/journal.pujz/2024/39.2.177.183

Tadelle D, Alemu Y, Peters KJ (2013). Village Chicken Production Systems in Ethiopia: 1. Flock Characteristics and Performance. Livestock Res. Rural Dev., 12(1): 1-10.

Tixier-Boichard M, Bed'hom B, Rognon X (2011). Chicken Domestication: From Archeology to Genomics. Proceedings of the 11th European Poultry Conference, World's Poult. Sci. J., 67(1): 1-15.

Yakubu A, Salako AE, Ige AO (2009). Effects of Genotype and Housing System on the Laying Performance of Chickens in Different Agro-Climatic Zones in Nigeria. Trop. Anim. Health Prod., 41(6): 1033-1039.