



QUALITATIVE TRAITS CHARACTERIZATION OF FULANI ECOTYPE CHICKEN IN NIGERIA

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The present study was conducted to characterize the qualitative traits of Fulani ecotype chickens in Nigeria. A total of 300 matured Fulani ecotype chickens (152 males and 148 females) were used for this study. The birds were obtained from 30 randomly selected households in two villages of the Lafia, Doma, Obi, Keana, and Awe Local Government areas, Nasarawa State, Nigeria. The qualitative morphological traits (plumage colour and pattern, skin colour, eye colour, earlobe colour and shank colour and, feather morphology and distribution, comb type and comb size), of the Fulani ecotype chicken were analyzed for descriptive statistics using frequency procedures and cross-tabulation. The Kruskal-Wallis Test option of the non-parametric tests was employed to determine the effects of location and sex of the Fulani ecotype chickens on the proportion of each qualitative morphological trait. The association between locations and the qualitative traits were assessed using Correspondence Analysis, CHAID and Exhaustive CHAID algorithms. Diverse colours of plumage, eye, skin, comb, shank, and earlobe, as well as body shape, head shape, feather morphology, feather distribution, comb size, and types of local Fulani chickens, were observed. The most common plumage colour across the locations was ash (37.5%), followed by white (32.3%), multicolored (27.3%), black (27.0%), red (25.5%), and brown (24.0%). Significant variations among qualitative traits suggest underlying genetic diversity and environmental adaptation. These findings, combined with biometric and production traits, offer valuable insights for designing targeted genetic improvement programs aimed at enhancing the Fulani ecotype's productivity and resilience in Nasarawa State's varied environments.

Keywords: Characterization, Chicken, Fulani ecotype, Qualitative traits

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INTRODUCTION

In the diverse landscape of Nigerian poultry farming, the Fulani ecotype chicken stands as an emblem of resilience, adaptability, and cultural significance. Originating from the ancient nomadic Fulani people, this indigenous ecotype has traversed generations (FAYEYE *et al.*, 2005). Village/backyard poultry farming makes an important contribution to poverty alleviation in many countries around the world (BERREZOUG *et al.*, 2019). It produces mainly food for domestic consumption, in the form of meat or egg. It produces mainly food for domestic consumption, in the form of meat or eggs, and generates income through the sale of these products (BERREZOUG *et al.*, 2019).

The Fulani ecotype chicken has long been associated and preserved by the Fulani tribe of Northern part of Nigeria and raise these chickens in Fulani settlements and villages under extensive or semi-intensive production systems where the Fulani chicken serves as a veritable source of proteins for meat and eggs, and as a means of livelihoods (SANUSI and OSENI, 2020). ADELEKE *et al.* (2022) stated that morphological variations in qualitative and quantitative traits of Fulani ecotype chickens emphasize the importance of understanding their potentials for future breeding programmes. GWAZA *et al.* (2018) explored the distribution of qualitative traits within and between two populations of Nigerian local chickens' ecotypes, providing insights into how these traits vary and adapt to climatic challenges. The Fulani ecotype is native to the drier parts of Nigeria, found in the Savannahs (Guinea and Sahel Savannah), Montane regions, and cattle kraals of the North and South West. These chickens weigh about 1.75–2.5 kg at maturity (AJAYI, 2010) and are usually managed under an extensive system of animal husbandry. The Fulani ecotype chicken is characterized as hardy, tolerant to diseases and adverse climatic conditions, and has great potential for genetic improvement for both meat and egg production. Distinctive characteristics of Fulani ecotype chickens in Nigeria including plumage colors, comb types, and other qualitative traits play a crucial role in their adaptation and survival in different environments. External appearance (morphology) remains commonly used by researchers and practitioners for the identification, characterization, and selection of farm animals (YAKUBU *et al.*, 2022).

Despite its widespread presence, a comprehensive understanding of the qualitative characteristics defining the Fulani ecotype chicken remains largely unexplored within scientific literature, thus; the need for this present study.

The objective of this study was to evaluate the qualitative traits of Fulani ecotype chicken characterization in Nigeria.

MATERIALS AND METHODS

Study area

The experiment was conducted at Lafia, Doma, Obi, Keana and Awe Local Government Areas of Nasarawa State from November to December 2022. The mean monthly maximum and minimum temperatures ranges from 35.06°C and 20.16°C, respectively while the mean monthly relative humidity is 74%. Annual rainfall is about 168.90 mm in the Guinea Savanna zone of North Central Nigeria (NIMET, 2023).

Experimental birds and management

A total of 300 matured Fulani ecotypes chicken (152 males and 148 females) were used for this study. The birds were obtained from 30 randomly selected households in two villages of Lafia (Wakwa and Agyragu), Doma (Saman laraba and Alwaza), Obi (Daddare and Angwanatashi), Keana (Giza and Kadarko) and Awe (Azara and Ribbi) local government areas. The birds in this study were simply selected by identifying 30 households randomly across multiple villages within the five local government areas: Lafia, Doma, Obi, Keana, and Awe.

The 30 households in the specified villages were chosen using random sampling methods, which involved systematic random sampling to avoid bias and ensure each household had an equal chance of being selected. By sampling across several villages and LGAs was to capture a representative sample of the Fulani ecotype chicken population in the region, reducing geographic or management bias. The sample consisted almost evenly of males and females, which supports random and representative sex distribution. This approach minimizes selection bias by avoiding convenience or purposive sampling and increases the representativeness of the sample for generalizing findings about the Fulani ecotype chickens in the study area.

The birds were raised on deep litter in half walls wire-netting houses. Routine medication and sanitation were provided. The birds were fed formulated concentrate feed *ad libitum*. The distribution of qualitative traits was measured on the parent stock. The abundance of each qualitative trait was measured as a ratio of their frequencies to the total number of birds.

Data collection

Visual appraisal of the appearance (observation of qualitative traits) of Fulani ecotypes chicken was done and recorded, using a structured format for morphological description, following standard phenotypic characterization of Animal Genetic Resource as described by DANA *et al.* (2010). A total of 300 matured chickens were observed for phenotype expression of qualitative or discrete traits (presence of spur, plumage color and pattern, skin color, eye color, earlobe color and shank color, feather morphology and distribution, comb type and comb size).

Statistical analysis

The qualitative morphological traits (plumage color and pattern, skin color, eye color, earlobe color and shank color and, feather morphology and distribution, comb type and comb size), of the Fulani ecotype chickens were analyzed for descriptive statistics using frequency procedures and cross-tabulation of SPSS version (2020). The Kruskal-Wallis Test option of the non-parametric tests of SPSS were employed to test the effects of location and sex (independent factors) of Fulani ecotypes chicken on the proportion of each dependent traits (Comb type, comb size, body shape, head shape, presence of spur, presence of polydactyl, feather distribution, presence of shank feather). Association between locations and sex and the qualitative traits were assessed using Correspondence Analysis and Exhaustive CHAID algorithms (DÍAZ-PÉREZ *et al.*, 2020) and the significance threshold in this study was at 0.05.

Ethical

The study ‘‘ Qualitative traits characterization of Fulani ecotype chicken in Nigeria’ ’ was reviewed and approved by Committee for Ethical and Responsible Conduct of Research of

National Animal Production Research Institute (NAPRI), Zaria (Approval number, ABUACAUC/2017/004).

RESULTS

Frequency (%) of colour traits of Nigerian indigenous Fulani chickens based on location is presented in Table 1. The proportions of plumage colour attributes differed greatly between Fulani chickens and locations. The most common plumage colour in all the Fulani chickens was ash (37.5%), followed by white (32.3%), multicolored (27.3%), black (27.0%), red (25.5%), and brown (24.0%). Significant differences in the proportion of breast feather colour were found among chicken ecotypes in the study area (Table 1). Overall, the most common breast feather colour was white (36.8%), followed by black (32.6%), ash (28.8%), red (26.9%), and multicolored (21.9%). The most common skin color in the studied chicken populations was red (35.0%), followed by white (33.3%) and yellow (32.5%), with pink being the least common. Awe had the highest occurrence of red chicken ecotype (35.0%), while Lafia and Obi had the highest occurrence of white chicken (33.3 and 33.33%, respectively). There were significant differences ($P < 0.05$) in shank colour proportions among chicken ecotypes supported by Kruskal-Wallis. Grey-blue shank colour were the most common (61.5%), followed by Greenish (50.0%), white (34.1%), black (31.0%), pink (26.2%), and yellow (22.5%). Grey-blue and greenish shank colour predominated in Keana chicken ecotypes (61.5 and 50.0%, respectively), whereas greenish (50%), white and pink (34.1 and 26.2%), and black and yellow (31.0 and 22.5%) shank colour predominated in Lafia, Doma, and Awe, respectively.

Four eye colours (red, brown, orange, and black) were observed, with marked differences between chicken ecotypes. The majority of chickens (66.7%) had orange eyes, followed by black (52.0%), brown (32.6%), and red (21.6%). Orange and black occurrences were higher in Lafia and Awe chicken ecotypes than in Doma and Keana chicken ecotypes. Significant differences in earlobe colours were found among chicken ecotypes in all locations. The majority (40.0%) of the chickens had bluish earlobes, followed by pink (31.9%), white (27.8%), black (25.0%), and red (24.4%). Doma chicken ecotypes had more bluish earlobe colours than Keana, Obi, or Awe chicken ecotypes. In this study, two comb colours (red and pale) were observed, with no difference between chicken ecotypes. The majority of the chickens (27.4%) had pale combs, while the rest (23.3%) had red combs. In this study, Awe ecotype had a higher proportion of pale combed chicken (27.4%) than Keana (23.3%).

Table 2 shows the frequency (%) of colour traits of Nigerian indigenous Fulani chickens based on sex. Female Fulani chickens had the most ash plumage colours (93.7%), while male (91.5%) chicken ecotypes had more red. Males had a higher proportion of plumage colour ecotypes, with red (91.5%), multicolored (69.3%), and white (54.8%), while females had ash (93.7%), black (86.5%), and brown (84.0%). There were significant differences in breast feather color between chicken ecotypes. In this study, males had the most (59.6%) white breast feather color, red (76.9%), and multi-coloured (53.1%) feathers, while females had (67.4%) black and (75.0%) ash feathers. Four skin colours (white, yellow, red, and pink) were observed, with marked differences between chicken ecotypes. The skin colour of male and female chicken ecotypes were yellow and white (67.5 and 58.3%), respectively, and red and pink (70.0 and 54.5%). There were significant differences in the proportion of shank colour between chicken

ecotypes based on sex. White, yellow, and pink (53.7, 56.3, and 59.5%, respectively) were the most common shank colours observed in males, while black and pink (78.6 and 61.5%, respectively) were more common in females, with greenish having similar proportions (50.0%) in both male and female chicken ecotypes. In this study, four eye colors (red, brown, orange, and black) were observed, with significant differences between chicken ecotypes based on sex. The majority of male chickens had orange or red eyes (66.7 and 52.4%, respectively), whereas female ecotypes had black or brown eyes (64.0 and 58.1%). Every chicken had earlobes. There were significant differences between chicken ecotypes based on sex.

Table 1. Frequency (%) of colour traits of Nigerian indigenous Fulani chickens based on location

Traits	Class	Location					Chi-square	Cramer's V
		Lafia n = 60	Keana n = 60	Doma n = 60	Awe n = 60	Obi n = 60		
Plumage colour	White	12 (19.4) ^{ab}	9 (14.5) ^b	10 (16.1) ^b	11 (17.7) ^{ab}	20 (32.3) ^a	36.84*	0.18*
	Black	7 (18.9) ^{ab}	8 (21.6) ^a	10 (27.0) ^a	10 (27.0) ^a	2 (5.4) ^b		
	Red	5 (10.6) ^a	12 (25.5) ^a	11 (23.4) ^a	12 (25.5) ^a	7 (14.9) ^a		
	Brown	12 (24.0) ^a	6 (12.0) ^a	10 (20.0) ^a	12 (24.0) ^a	10 (20.0) ^a		
	Ash	0 (0.0) ^b	6 (37.5) ^a	5 (31.3) ^a	5 (31.3) ^a	0 (0.0) ^b		
Breast feather colour	Multicoloured	24 (27.3) ^a	19 (21.6) ^{abc}	14 (15.9) ^{bc}	10 (11.4) ^c	21 (23.9) ^{ab}	34.58**	0.17**
	White	10 (17.5) ^b	9 (15.8) ^b	12 (21.1) ^{ab}	5 (8.8) ^b	21 (36.8) ^a		
	Black	9 (20.9) ^{ab}	7 (16.3) ^{ab}	14 (32.6) ^a	8 (18.6) ^{ab}	5 (11.6) ^b		
	Red	11 (21.2) ^a	14 (26.9) ^a	7 (13.5) ^a	12 (23.1) ^a	8 (15.4) ^a		
	Ash	13 (25.0) ^a	5 (9.6) ^b	14 (26.9) ^a	15 (28.8) ^a	5 (9.6) ^b		
Skin colour	Multicoloured	17 (17.7) ^{ab}	25 (26.0) ^a	13 (13.5) ^b	20 (20.8) ^{ab}	21 (21.9) ^{ab}	24.34*	0.16*
	White	4 (33.3) ^a	0 (0.0) ^c	3 (25.0) ^{ab}	1 (8.3) ^{ab}	4 (33.3) ^a		
	Yellow	11 (14.3) ^{bc}	25 (32.5) ^a	20 (26.0) ^{ab}	8 (10.4) ^c	13 (16.9) ^{bc}		
	Red	4 (20.0) ^a	4 (20.0) ^a	2 (10.0) ^a	7 (35.0) ^a	3 (15.0) ^a		
	Pink	41 (21.5) ^{ab}	31 (16.2) ^b	35 (18.3) ^{ab}	44 (23.0) ^a	40 (20.9) ^{ab}		
Shank Colour	White	6 (14.6) ^{ab}	5 (12.2) ^b	14 (34.1) ^a	6 (14.6) ^{ab}	10 (24.4) ^{ab}	39.34**	0.18**
	Black	12 (28.6) ^{abc}	5 (11.9) ^c	7 (16.7) ^{abc}	13 (31.0) ^a	5 (11.9) ^c		
	Yellow	30 (18.8) ^{ab}	34 (21.3) ^{ab}	25 (15.6) ^b	36 (22.5) ^a	35 (21.9) ^{ab}		
	Grey-blue	1 (7.7) ^b	8 (61.5) ^a	3 (23.1) ^{ab}	1 (7.7) ^b	0 (0.0) ^c		
	Greenish	1 (50.0) ^a	1 (50.0) ^a	0 (0.0) ^b	0 (0.0) ^b	0 (0.0) ^b		
Eye colour	Pink	10 (23.8) ^a	7 (16.7) ^a	11 (26.2) ^a	4 (9.5) ^a	10 (23.8) ^a	67.37**	0.27**
	Red	41 (19.7) ^a	45 (21.6) ^a	39 (18.8) ^a	42 (20.2) ^a	41 (19.7) ^a		
	Brown	3 (7.0) ^b	11 (25.6) ^a	14 (32.6) ^a	2 (4.7) ^b	13 (30.2) ^a		
	Orange	16 (66.7) ^a	1 (4.2) ^b	2 (8.3) ^b	3 (12.5) ^b	2 (8.3) ^b		
	Black	0 (0.0) ^c	3 (12.0) ^b	5 (20.0) ^b	13 (52.0) ^a	4 (16.0) ^b		
Earlobe colour	White	19 (21.1) ^a	9 (10.0) ^b	18 (20.0) ^a	19 (21.1) ^a	25 (27.8) ^a	29.01*	0.16*
	Bluish	6 (30.0) ^a	1 (5.0) ^b	8 (40.0) ^a	1 (5.0) ^b	4 (20.0) ^a		
	Red	20 (23.3) ^a	21 (24.4) ^a	14 (16.3) ^a	15 (17.4) ^a	16 (18.6) ^a		
	Black	6 (18.8) ^a	6 (18.8) ^a	7 (21.9) ^a	8 (25.0) ^a	5 (15.6) ^a		
	Pink	9 (12.5) ^b	23 (31.9) ^a	13 (18.1) ^b	17 (23.6) ^{ab}	10 (13.9) ^b		
Comb colour	Red	38 (21.6) ^a	41 (23.3) ^a	34 (19.3) ^a	26 (14.8) ^a	37 (21.0) ^a	8.99 ^{ns}	0.17 ^{ns}
	Pale	22 (17.7) ^a	19 (15.3) ^a	26 (21.0) ^a	34 (27.4) ^a	23 (18.5) ^a		

n = No. of birds observed; * = Significant at $P < 0.05$ and ** = Significant at $P < 0.01$, ns = Not significant
Means within rows having different superscripts are significantly different.

Table 2. Frequency (%) of colour traits of Nigerian indigenous Fulani chickens based on sex

Traits	Class	Sex		Chi-square	Cramer's V
		Male n= 152	Female n= 148		
Plumage colour	White	34 (54.8) ^a	28 (45.2) ^a	101.12**	0.58**
	Black	5 (13.5) ^b	32 (86.5) ^a		
	Red	43 (91.5) ^a	4 (8.5) ^b		
	Brown	8 (16.0) ^b	42 (84.0) ^a		
	Ash	1 (6.3) ^b	15 (93.7) ^a		
	Multi-colour	61 (69.3) ^a	27 (30.7) ^b		
Breast feather colour	White	34 (59.6) ^a	23 (40.4) ^a	35.76**	0.35**
	Black	14 (32.6) ^b	29 (67.4) ^a		
	Red	40 (76.9) ^a	12 (23.1) ^b		
	Ash	13 (25.0) ^b	39 (75.0) ^a		
	Multicoloured	51 (53.1) ^a	45 (46.9) ^a		
Skin colour	White	7 (58.3) ^a	5 (41.7) ^a	14.46**	0.22**
	Yellow	52 (67.5) ^a	25 (32.5) ^b		
	Red	6 (30.0) ^a	14 (70.0) ^a		
	Pink	87 (45.5) ^b	104 (54.5) ^a		
Shank Colour	White	22 (53.7) ^a	19 (46.3) ^a	18.60**	0.25**
	Black	9 (21.4) ^b	33 (78.6) ^a		
	Yellow	90 (56.3) ^a	70 (43.7) ^b		
	Grey-blue	5 (38.5) ^b	8 (61.5) ^a		
	Greenish	1 (50.0) ^a	1 (50.0) ^a		
	Pink	25 (59.5) ^a	17 (40.5) ^a		
Eye colour	Red	109 (52.4) ^a	99 (47.6) ^a	6.20 ^{ns}	0.14 ^{ns}
	Brown	18 (41.9) ^a	25 (58.1) ^a		
	Orange	16 (66.7) ^a	18 (33.3) ^a		
	Black	9 (36.0) ^a	16 (64.0) ^a		
Earlobe colour	White	45 (50.0) ^a	45 (50.0) ^a	11.80*	0.20*
	Bluish	3 (15.0) ^b	17 (85.0) ^a		
	Red	48 (55.8) ^a	38 (44.2) ^a		
	Black	16 (50.0) ^a	16 (50.0) ^a		
	Pink	40 (55.6) ^a	32 (44.4) ^a		
Comb colour	Red	125 (71.0)	51 (29.0)	70.59**	0.49**
	Pale	27 (21.8)	97 (78.2)		

n = No. of birds observed; * = Significant at $P < 0.05$, ** = Significant at $P < 0.01$, ns = Not significant
Means within rows having different superscripts are significantly different.

Male chicken ecotypes had the highest proportions of earlobes that were red or pink (55.8 and 55.6%), while females had a higher proportion of bluish (85) earlobes. Similarly, the proportion of white and black earlobes was the same (50.0%). Two comb colour (red and pale) were observed in this study. Red (71.0 %) comb colour was observed in male while pale (78.2 %) in female chicken ecotypes.

Table 3. Frequency (%) of body structure and feather distribution of Nigerian indigenous Fulani chickens based on location

Traits	Class	Location					Chi-square	Cramer's V
		Lafia n = 60	Keana n = 60	Doma n = 60	Awe n = 60	Obi n = 60		
Comb type	Rose	13 (26.5) ^a	8 (16.3) ^{ab}	15 (30.6) ^a	9 (18.4) ^{ab}	4 (8.2) ^b	34.70**	0.20**
	Single	42 (27.1) ^a	33 (21.3) ^{ab}	27 (17.4) ^{bc}	21 (13.5) ^c	32 (20.6) ^{ab}		
	Pea	3 (6.5) ^b	11 (23.9) ^a	8 (17.4) ^{ab}	14 (30.4) ^a	10 (21.7) ^a		
Comb size	Walnut	2 (4.0) ^b	8 (16.0) ^a	10 (20.0) ^a	16 (32.0) ^a	14 (28.0) ^a	15.80*	0.16*
	Large	26 (26.8) ^a	17 (17.5) ^{ab}	21 (21.6) ^{ab}	20 (20.6) ^{ab}	13 (13.4) ^b		
	Medium	12 (12.6) ^b	28 (29.5) ^a	17 (17.9) ^b	19 (20.0) ^{ab}	19 (20.0) ^{ab}		
Body shape	Small	22 (20.4) ^{ab}	15 (13.9) ^b	22 (20.4) ^{ab}	21 (19.4) ^{ab}	28 (25.9) ^a	11.31 ^{ns}	0.14 ^{ns}
	Blocky	43 (21.3) ^a	41 (20.3) ^a	41 (20.3) ^a	38 (18.8) ^a	39 (19.3) ^a		
	Triangular	11 (27.5) ^a	6 (15.0) ^a	3 (7.5) ^a	9 (22.5) ^a	11 (27.5) ^a		
Head shape	Wedge	6 (10.3) ^a	13 (22.4) ^a	16 (27.6) ^a	13 (22.4) ^a	10 (17.2) ^a	15.79**	0.23**
	Plain	55 (21.7) ^a	52 (20.6) ^a	51 (20.2) ^a	41 (16.2) ^b	54 (21.3) ^a		
	Crested	5 (10.6) ^b	8 (17.0) ^b	9 (19.1) ^b	19 (40.4) ^a	6 (12.8) ^b		
Presence of spur	Absent	37 (21.9)	30 (17.8)	35 (20.7)	34 (20.1)	33 (19.5)	1.82 ^{ns}	0.08 ^{ns}
Presence of polydactyl	Present	23 (17.6)	30 (22.9)	25 (19.1)	26 (19.8)	27 (20.6)	12.02*	0.20*
	Absent	49 (18.2) ^b	58 (21.6) ^a	53 (19.7) ^{ab}	51 (19.0) ^b	58 (21.6) ^a		
Feather distribution	Present	11 (35.5) ^a	2 (6.5) ^b	7 (22.6) ^{ab}	9 (29.0) ^a	2 (6.5) ^b	12.02 ^{ns}	0.14 ^{ns}
	Normal	51 (22.3) ^a	41 (17.9) ^b	42 (18.3) ^b	44 (19.2) ^{ab}	51 (22.3) ^a		
	Naked neck	6 (17.6) ^a	10 (29.4) ^a	8 (23.5) ^a	5 (14.7) ^a	5 (14.7) ^a		
Presence of shank feather	Frizzled	3 (8.1) ^a	9 (24.3) ^a	10 (27.0) ^a	11 (29.7) ^a	4 (10.8) ^a	5.27 ^{ns}	0.13 ^{ns}
	Absent	57 (19.5)	60 (20.5)	60 (20.5)	58 (19.8)	58 (19.8)		
	Present	3 (42.9) ^a	0 (0.0) ^a	0 (0.0) ^a	2 (28.6) ^a	2 (28.6) ^a		

n = No. of birds observed; *, **Significant at P<0.05 and P<0.01, respectively; ns = Not significant
Means within rows having different superscripts are significantly different.

Frequency (%) of body structure and feather distribution of Nigerian indigenous Fulani chickens based on location is shown in Table 3. Four comb types (rose, single, pea, and walnut), three comb sizes (large, medium, and small), three body shapes (blocky, triangular, and wedge), and two head shapes (plain and crested) were observed based on the location shown in 3. The highest proportion of rose (30.6%) comb type was found in Doma, followed by pea and walnut (30.4 and 32.0%) in Awe, and single (27.1%) in Lafia. Comb size was identified as medium in Keana (29.5%), large (26.8) in Lafia, and small (25.9%) in Obi. The body shape of chicken ecotypes does not differ significantly across locations. Doma and Obi were identified as having wedge and triangular body shapes, respectively, of the total chicken population, while Keana and Doma were identified as having blocky (20.3%). Awe had the highest proportion of crested heads (40.4%), followed by plain (21.7 and 21.3%) in Lafia and Obi. Presence of spur, polydactyl and shank feather were observed in this study. There was no significant difference in

respect of presence of spur and shank feather across all the locations. Keana had a higher percentage of spur presence (22.9%) than Lafia (21.9%). There was significant difference in the presence of polydactyl with significant differences across locations. Lafia had the highest proportion of polydactyls (35.5%), while Keana (21.6%) and Obi (21.6%) had the lowest. The presence of shank feather was most frequently observed in Lafia (42.9%), while the absence was observed in Doma (20.5%) and Keana (20.5%). Chicken ecotypes with frizzed and naked neck feather distribution were observed in Awe and Keana (29.7 and 29.4%, respectively), with the least proportion observed in Lafia and Obi (22.3%).

Table 4 presented the frequency (%) of body structure and feather distribution of Nigerian indigenous Fulani chickens based on sex. Four comb type (rose, single, pea and walnut), three comb size (large, medium and small), three body shape (blocky, triangular and wedge) and two head shape (plain and crested) were observed based on sex.

The results showed that females had the highest proportion of walnut and pea (94.0 and 67.4%) comb types, followed by single (68.1 %) males, and rose (57.0%) males had the lowest proportion. Comb size was identified as large and medium in males (73.2 and 65.3%), and small (82.4%) in females. There were significant differences in body shape based on gender. Female ecotypes were identified as wedge (79.3 %), while male ecotypes were identified as triangular and blocky (60.0 and 57.4 %), respectively. There was no significant difference in head shape between the sexes of the chicken ecotypes. Females had the highest proportion of plain head shapes (50.2%), while males had the highest proportion of crested heads (55.3%). Presence of spur, polydactyl and shank feather were also observed in this study. All sexes have significant differences in the presence of spurs and polydactyl. Males had higher percentages of spur presence (79.4%) than females (71.6%). Males had the highest proportion of polydactyl present (74.2%), while females had the lowest percentage (absence) (52.0%). Males were found to have a higher proportion of shank feathers (57.1%) than females (49.5%). There are no statistically significant differences in feather distribution between chicken ecotypes based on sexes. Female chickens had naked necks and frizzed feather distributions (64.7 and 56.8%, respectively), while males had normal feather distribution (54.1%).

Figure 1 is the biplot of the multiple correspondence analysis. The MCA revealed the association between the qualitative physical traits and local government areas in two dimensions (Fig 1). The first dimension was 37.3 % of the deviation from independence while the second dimension signified 28.1 % of the total variation based on the inertia. The local governments were not clustered perfectly (as revealed by the low inertia values of 0.029 and 0.022) considering the intermingling of some qualitative physical traits. This was more noticeable between qualitative traits in Lafia and Awe. Therefore, discrimination of the traits appears very weak. However, on the right top hand side of the biplot, black, crested, red, frizzled, pea and ash seemed to be more associated with Awe local government area.

The association between locations and the qualitative traits using Exhaustive CHAID is shown in figure 2. The model reflected eye colour, head shape, comb type, feather distribution, ear lobe and shank colour. There are 12 terminal nodes which include nodes 3, 6, 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18. The root node (node 0) showed the descriptive statistics of the chicken in the five local government areas. The Chi-squared base branch and node distribution revealed that the eye colour was the variable of utmost importance in assigning the chicken into their

respective local government areas followed by feather distribution. The eye colour only was significantly ($P < 0.01$) sufficient to discriminate between birds of the Lafia, Keana, Doma, Awe and Obi local government areas. The chicken from Obi are mostly brown eye colour while chicken of red, black and orange colour were mostly from Keana, Awe, and Lafia, respectively. The head shape, comb type and feather distribution were mostly predicted in Keana, Awe and Lafia, respectively. Meanwhile, earlobe and shank colour were mostly predicted in Doma and Keana.

Table 4. Frequency (%) of body structure and feather distribution of Nigerian indigenous Fulani chickens based on sex.

Traits	Class	Sex		Chi-square	Cramer's V
		Male n= 152	Female n= 148		
Comb type	Rose	28 (57.1) ^a	21 (42.9) ^a	66.21**	0.47**
	Single	106 (68.4) ^a	49 (31.6) ^b		
	Pea	15 (32.6) ^b	31 (67.4) ^a		
	Walnut	3 (6.0) ^b	47 (94.0) ^a		
Comb size	Large	71 (73.2) ^a	26 (26.8) ^b	75.10**	0.50**
	Medium	62 (65.3) ^a	33 (34.7) ^b		
	Small	19 (17.6) ^b	89 (82.4) ^a		
Body shape	Blocky	116 (57.4) ^a	86 (42.6) ^b	25.94**	0.29**
	Triangular	24 (60.0) ^a	16 (40.0) ^a		
	Wedge	12 (20.7) ^b	46 (79.3) ^a		
Head shape	Plain	126 (49.8) ^a	127 (50.2) ^a	0.48 ^{ns}	0.04 ^{ns}
	Crested	26 (55.3) ^a	21 (44.7) ^a		
Presence of spur	Absent	48 (28.4) ^b	121 (71.6) ^a	76.75**	0.51**
	Present	104 (79.4) ^a	27 (20.6) ^b		
Presence of polydactyl	Absent	129 (48.0) ^b	140 (52.0) ^a	7.66**	0.16**
	Present	23 (74.2) ^a	8 (25.8) ^b		
Feather distribution	Normal	124 (54.1) ^a	105 (45.9) ^a	5.14 ^{ns}	0.13 ^{ns}
	Naked neck	12 (35.3) ^a	22 (64.7) ^a		
	Frizzled	16 (43.2) ^a	21 (56.8) ^a		
Presence of shank feather	Absent	148 (50.5) ^a	145 (49.5) ^a	0.12 ^{ns}	0.02 ^{ns}
	Present	4 (57.1) ^a	3 (42.9) ^a		

n = No. of birds observed; * = Significant at $P < 0.05$, ** = Significant at $P < 0.01$, ns = Not significant, Means within rows having different superscripts are significantly different

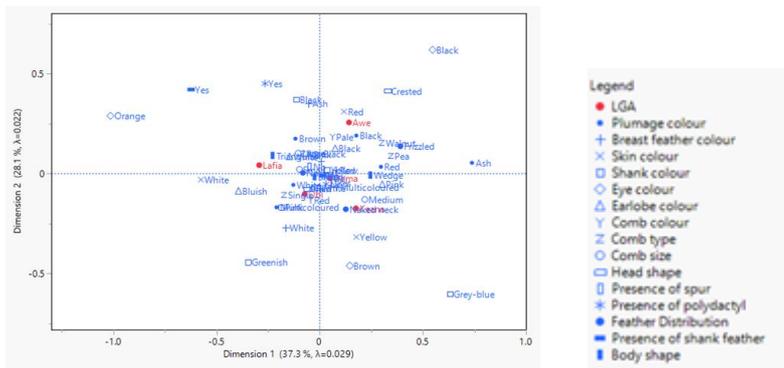


Figure 1.: A biplot showing the relationship between the qualitative physical traits and locations in Nasarawa State

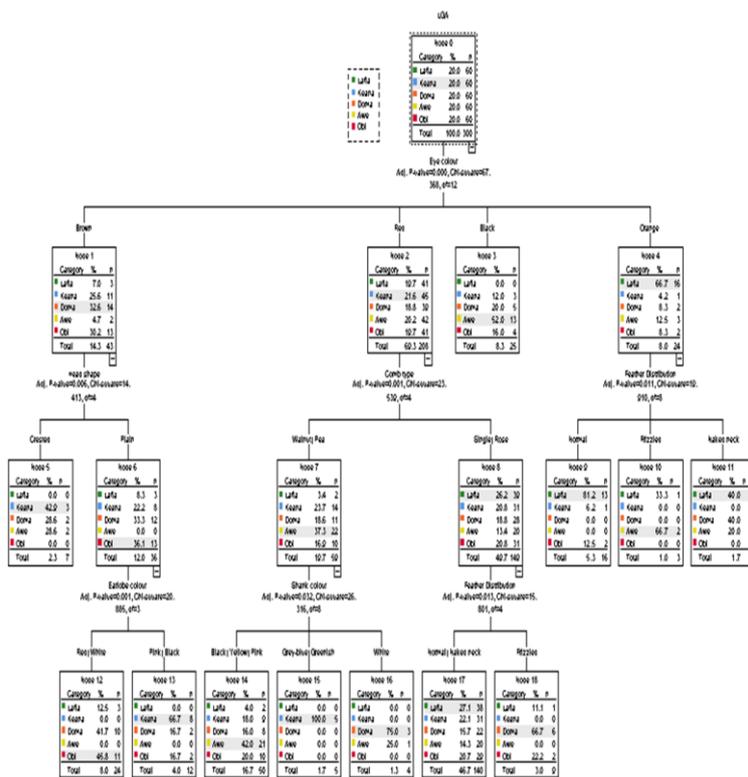


Figure 2. Association between locations and the qualitative traits using Exhaustive CHAID

DISCUSSION

The differences in plumage colour, breast feather colour among others in different locations is similar with the findings of ADELEKE *et al.* (2022) who reported brown and dark brown plumage colours were dominant and had an occurrence of 48.34% and 33.33%, respectively. The comb type in Fulani chickens was predominantly single (85%), and 46.67% had spurs. Significant variation in qualitative traits across locations aligns with prior findings (EGAHI *et al.*, 2010), reflecting environmental heterogeneity and divergent selection pressures.

These differences highlight the genetic and phenotypic diversity useful for designing targeted, demand-driven genetic improvement programs. Such programs aim to enhance breed development, performance, conservation, and sustainable use of local chicken resources. The morphological variation across locations results from complex interactions of genetics, environment, selection, cultural, and historical factors, all crucial for effective breed management and conservation strategies.

However, contrary reports claimed that 100 % of the chickens in Ethiopia's Debrezeit Agricultural Research Center were black-eyed. According to the findings, 87.84 and 9.01, 72.48 and 24.31 % of chickens in the Horro and Jarso districts of Ethiopia have orange and red eyes, respectively. Orange eyes (73.4 %) and brown eyes (16.3 %) were found to be the most common eye colors in Tanzanian chicken populations (GUNI and KATULE, 2013).

For the sex differences, the greater occurrence of larger combs, darker shanks, and more colorful feathers in male Fulani chickens than in females results from sexual dimorphism influenced by hormonal variations and sexual selection. Genetic differences between the sexes also contribute to the observed variation in qualitative traits (IGE *et al.*, 2012). As observed in the current study, comb size is more pronounced in males than females and this is because comb is a secondary sexual characteristic that develops more in males due to higher testosterone levels (IGE *et al.*, 2012). Feather color patterns can vary between sexes. For example, males may have more vibrant or iridescent feathers to attract mates, while females have more camouflaged colors for protection during nesting (IGE *et al.*, 2012). Shank color is often darker in males. Shank color is influenced by carotenoid pigments, which are deposited more in males. This could be because the genetic differences between male and female chickens also contribute to trait variation. This genetic difference leads to differential gene expression and development of sex-specific traits. The pigmentation (carotenoid pigments) and blood supply to a number of structures within the eye may play a role in the variation in eye colors (AKILU, 2013).

Variations in physical traits such as skin color among chicken ecotypes are often influenced by geographic and biological factors. Significant differences in skin color were observed between chicken ecotypes base on location and sexes is contrary to the findings of MARKOS *et al.* (2016) who reported that 99.0 % and 4 % of the chickens in the lowland, midland and highland of Ethiopia were white and pink, respectively. Similar findings were reported in Tanzania, where white skin appeared to be more common (51.2%) than yellow (48.8%). The differences in skin color observed among chicken ecotypes could be attributed to differences in chicken feedstuff availability in the respective agro-ecologies. White skin color results from the absence of carotenoid pigments, whereas yellow skin color results from the presence of carotenoid pigments (Xanthophylls) consumed through feeds and deposited under skin. This could also be due to different genetic influences. Even if chickens are fed carotenoid-rich diets,

some may be unable to deposit the pigment under the skin. CABARLES *et al.* (2012) stated that the yellow skin color was inherited from Grey jungle fowl (*G. sonneratii*) and Ceylon jungle fowl (*G. lafayettii*). The most common plumage colour in all chicken ecotypes in all sexes was multicoloured and ash, respectively. Similar findings have been reported that red plumage color appeared to be more common (39, 20.8, and 26.9%, respectively) than others (ISIDAHOMEN *et al.*, 2012). The proportion of identified diversified shank colors varied significantly between the Fulani chickens and sexes. The observed results for yellow shank colour which is most common and the least greenish shank color is similar with the findings of FARUQUE *et al.* (2010) who reported that yellow shank colours were the most common shank colors in male and female chickens, respectively.

The differences in body structure and feather distribution among Nigerian indigenous Fulani chickens across locations suggest that populations have adapted to local environmental conditions such as climate, altitude, and available resources. Over time, geographic isolation, breeding practices, and natural selection have likely led to the development of unique genetic traits in these regional populations (ADELEKE *et al.*, 2022).

In chickens, this can manifest as differences in body size, comb size and shape, coloration, and feathering patterns. In many bird species, males and females have different reproductive roles, which can lead to physical adaptations (EGAHI *et al.*, 2010). The differences in comb type, comb size, body shape among others as observed in this study in both sexes agreed and similar with the findings of BOGALE (2008) who reported variation between male and female chickens for qualitative traits. The higher proportion of blocking-bodied local chickens reported in the current study disagrees with the findings of BOGALE (2008) who reported for the majority of the Fogera chicken population with wedge (88%) and few blocky (12%) body shapes. It is, however, agrees with the work of DANA *et al.* (2010) who reported that the presence of blocky, triangular, and wedge of local male (76.4, 14.4, and 9.2%, respectively) and female chickens (95.4, 4.4, and 0.2%), respectively in the indigenous chicken populations of Ethiopia. The proportions of the identified comb types differed significantly across locations and chicken sexes. The single comb type (45.0 %) was the most popular in male while the walnut comb type in female (63.5 %). The observed results in the present study for frequency of body structure and feather distribution of Nigerian indigenous Fulani chickens based on sex confirmed previous findings that 54.5, 29.6, and 15.9% of Tanzanian chicken populations were small, medium, and large comb sized chickens (MARKOS *et al.*, 2020).

Most local chickens in this study had spurs, consistent with reports showing high spur frequency in Nigerian indigenous chickens (MARKOS *et al.*, 2024). However, this contrasts with findings from other regions where non-spurred chickens predominate. Plain-headed chickens were more common than crested-headed, likely due to farmer preference leading to negative selection against crested heads, supporting previous findings (MARKOS *et al.*, 2020). All local ecotypes had normal feathers, with naked neck chickens rare overall but more frequent in females than male.

The clustering pattern of the traits based on MCA analysis especially in Doma, Keana and Obi chickens showed high level of admixture, although the chicken populations to an extent could be distinguished using eye colour, head shape, comb type, feather distribution, ear lobe

and shank colour. Generally, it could be said that the chicken from the five local governments showed less diversity in the qualitative traits measured.

Despite observable variations in qualitative traits across different geographic locations, genetic studies often reveal significant overlap and homogeneity within these populations. The trends observed in this study are similar with the report of YAKUBU *et al.* (2022) on indigenous helmeted Guinea fowl (*Numida meleagris*) in Nigeria. Therefore, in order to ascertain the genetic purity of the chickens in different local governments' areas, the MCA result did not give a perfect clustering of the chickens as phenotypic homogeneity of the populations despite differences in locations. This means that qualitative traits alone might not be sufficient to differentiate between the chickens in the five local governments. Similarly, TRAORE *et al.* (2018) reported that in spite of the enormous environmental differences, there was morphological homogeneity in qualitative traits in Guinea fowls in Burkina Faso. BROWN *et al.* (2017) observed limited phenotypic and genetic diversity in local Guinea fowls in Northern Ghana.

The decision tree results showed that the Chicken from the five local governments' areas to some extent be separated using eye colour, head shape, comb type, feather distribution, ear lobe and shank colour. However, there is a form of intermixing of the chicken in the different local governments areas. Phenotypic differences of local animal resources show a genetic diversity that may be worth conserving for future uses while better understanding of the qualitative traits helps to facilitate the implementation of conservation policies aimed to ensure local resources survival (SZTANDARSKI *et al.*, 2021).

The observable variations in qualitative traits such as eye color, head shape, and feather distribution among chickens across the five local government areas reflect a lack of selective breeding, resulting in mixed genotypes within the indigenous populations. The differences in qualitative traits observed in this study is similar with the findings of FAJEMILEHIN (2010); EBEGBULEM and ASUQUO (2018) who reported that Guinea fowl colour patterns were somehow different from the dominant Pearl, Lavender, Black and White variations. The three different eyes colours (brown, red and black) recorded in this study is similar with the observation of SOARA *et al.* (2020) in Nigeria where Nigerian birds shared brown eye colour (57.0%) with those of Atakora (Mountainous) dry savannah zone in Togo and Sudanian and Sudano Guinean zones in Benin (OROUNLADJI *et al.*, 2021). The present variant phenotypes may be due to polymorphism (BIRTEEB *et al.*, 2020) and might have evolved in local birds as adaptive measures for survival under varied environmental conditions. According to GETACHEW *et al.* (2021), sustainable livestock production in the tropics requires adaptive genotypes which can withstand the undesirable effects of climate change and ensure optimal performance of the birds. In another study on a different species, NIGENDA-MORALES *et al.* (2018) reported that the general fitness of individuals in their environments may be affected by colour while GONG *et al.* (2021) considered colour differences as an environmental indicator, which provides guides for the study of population genetics and biogeography.

CONCLUSIONS

It can be concluded that diverse colours of plumage, eye, skin, comb, shank, and earlobe, as well as body shape, head shape, feather morphology, feather distribution, comb size, and types of local Fulani chickens, were observed. The occurrence of different attributes of the majority of

the investigated qualitative traits varied significantly among the Fulani chickens. Significant differences in qualitative traits among local Fulani chickens indicate genetic variation and environmental heterogeneity. Therefore, the significant morphological diversity reflects rich genetic variability and environmental influences, offering potential for selective breeding, breed improvement, and sustainable utilization of Fulani chickens.

Recommendation

Use the phenotypic variation data as a foundation to design demand-driven, holistic genetic improvement strategies. These should aim to develop improved breeds, enhance performance traits, and conserve the unique genetic resources of Fulani chickens, ensuring their adaptability and productivity in diverse environments

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KARAKTERIZACIJA FULANI EKOTIPOVA KOKOŠKI NA OSNOVU KVALITATIVNIH OSOBINA U NIGERIJU

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Izvod

Ova studija je sprovedena radi karakterizacije kvalitativnih osobina kokošaka ekotipa Fulani u Nigeriji. Za ovu studiju je korišćeno ukupno 300 zrelih kokošaka ekotipa Fulani (152 mužjaka i 148 ženki). Ptice su dobijene iz 30 nasumično odabranih domaćinstava u dva sela u oblastima lokalne samouprave Lafija, Doma, Obi, Keana i Ave, država Nasarawa, Nigerija. Kvalitativne morfološke osobine (boja i šara perja, boja kože, boja očiju, boja ušnih resica i boja buba i morfologija i raspodela perja, tip i veličina češlja) kokošaka ekotipa Fulani analizirane su deskriptivnom statistikom korišćenjem frekventnih procedura i unakrsnog tabelarnog prikaza. Opcija Kruskal-Volisonovog testa neparametarskih testova korišćena je za određivanje uticaja lokacije i pola kokošaka ekotipa Fulani na udeo svake kvalitativne morfološke osobine. Veza između lokacija i kvalitativnih osobina procenjena je korišćenjem analize korespondencije, CHAID i iscrpnih CHAID algoritama. Primećene su različite boje perja, očiju, kože, češlja, drške i ušne reznje, kao i oblik tela, oblik glave, morfologija perja, raspodela perja, veličina češlja i tipovi lokalnih kokošaka Fulani. Najčešća boja perja na lokacijama bila je pepeljasta (37,5%), zatim bela (32,3%), višebojna (27,3%), crna (27,0%), crvena (25,5%) i smeđa (24,0%). Značajne varijacije među kvalitativnim osobinama ukazuju na osnovnu genetsku raznolikost i adaptaciju na životnu sredinu. Ovi nalazi, u kombinaciji sa biometrijskim i proizvodnim osobinama, nude vredne uvide za dizajniranje ciljanih programa genetskog poboljšanja usmerenih na povećanje produktivnosti i otpornosti ekotipa Fulani u različitim okruženjima države Nasarawa.

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