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Qualitative Diversity of Northeastern Nigerian Indigenous Chicken Populations.

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Target audience: Animal Scientist; Researcher in science; and Industrialist.

Abstract

A total of 600 adult indigenous chickens of central and southern parts of Borno state were examined for qualitative characteristics which consisted of 322 (53.67%) males and 278 (46.33%) females. The qualitative traits considered included plumage colour, comb type, feather characteristics and earlobe, shank and eye colours. Data collected on the qualitative parameters were analyzed using descriptive statistics (means, percentage and frequency) using SPSS (2011), v. 20. There were abundant chickens with brown red (27%) and white birds (17%) in the central while black birds dominated (17.4%) the southern part. Chickens with multicolour plumage were most frequent (31.3%). More hens were multicoloured and cocks were mostly white. Normal feathered chickens abound (59.7%), naked neck (16%) and frizzle (24.3%) feathered chickens were scanty. Cocks of normal feathered (59.9%) and naked neck (21.4%) were more prevalent. Reverse was the case for frizzle feathered (31.7%). Seventy eight percent (78%) of the chickens was normal headed (with no crest). Crestedness was more frequent with birds from the southern part (37.7%). Single comb chickens were in abundant (75.2%). Chickens with white shank (30.3%) were predominant. Chickens with yellow shank colour dominated the southern part (29%). Cocks were more of white shank (31%) and hens were varied in shank colour. Chickens with orange eye colour were predominant (39.2%). Most chickens possessed white earlobe (36.7%). The multiple variants in qualitative characteristics revealed in this study provided essential tools for designing an effective selection and conservation programme for improvement of qualitative potentials inherent in these chickens.

Keywords: Indigenous chickens; diversity; naked neck; frizzle feathered; normal feathered; qualitative traits.

1. Description of problem

The population of Nigerian poultry are estimated at 180 million with 90% being the native fowls that were harbored in the rural areas under primitive free-range system (1). The rapid increase in Nigerian population has

resulted to high demand for protein in our daily diets (2). This by consequence geared the production of poultry products in form of eggs and meat (3). The potential for producing meat and eggs inherent in these chickens could meet up with dietary protein requirements of man (4). The role played by the indigenous fowls in shaping the socio-economy of rural communities has been documented. Among others, the chickens provide the rural with animal protein, extra cash incomes as well as provision of cultural and religious-related utilities (5). These birds possess several valuable characters that are not found in their exotic counterparts yet they attract only appreciable low input farming system (6). They were known to providing nutrition for the family, a small cash flow reserve for times of celebrations or need in the developing countries. Additionally, they have good adaptability for climate and resistance against diseases; wide variability with respect to performance and they remain important reservoirs of useful genes (7). Although these chickens are characterized with lower body weights and dimensions in comparison with exotic counterparts (8), their utility is enormous.

According to (9), the indigenous chickens were characterized with a wide range of phenotypic and genetic diversity and their significance in describing genetic variation, adaptive attributes and qualitative morphological traits, raised the economic value of these chickens. In general, qualitative traits are governed by just few gene pairs, each of which segregates independently of others during gamete formation (9). More importantly, the expression of these characters is not usually affected by the environment as is the case with quantitative characters (10). Qualitative traits such as plumage pigmentation, comb type and a host of others in chickens were reported to have had significant effect on most quantitative traits including body weight (11; 12 and (13). This therefore, suggested these traits as useful tools in Traits Assisted Selection (TAS) for breeding, selection and improvement programmes. While viewing from the perspective of global world, there are specific choices for plumage and skin colours that influence preferences of different geographic markets (14).

Unlike in most countries, plumage colour is seen as been second in importance to live weight in affecting market preference for chickens in some part of the world. This is in addition to its cultural and religious functions (9). In some part of Africa for instance (northern part of Ethiopia), both producer sellers and intermediary traders of chickens attach the strongest market preference to plumage colour, feather distribution and comb type (15). Such believes of the society on the phenotypic appearances of the chickens create influences on the market values of mature birds (16). The presence of diversified phenotypic appearances of indigenous chickens therefore showed the extent of genetic potential for improvement in these birds (6) and (16). Before attempting any genetic improvement however, animals must first be characterized (17). Characterization of the chicken genetic resources requires information on population, adaptation to specific environment, possession of traits of current and future value as well as socio-cultural importance, which are crucial inputs to decisions on conservation and utilization (18). Although there have been reports on the phenotypic characterization of indigenous chickens in Nigeria, lots of such were

however not have been on record for indigenous chickens of Borno State, northeast Nigeria. This research work therefore was geared to explore the qualitative profiles of indigenous chickens of Borno state which could be an important ingredient in developing breeding strategies for genetic improvement and conservation of these chickens.

Materials and Methods

Study area

By geographical co-ordinates, Borno State lies between Latitudes 10^0-13^0 N and Longitudes 12^0 – 15^0 E of the Equator with a greater part lies on the Chad Formation. This state is divided into broad relief regions; hilly/mountainous area of generally over 600 m above sea level, which cover the south and southeastern parts of the state; and plains of generally less than 600 m above sea level which dominate much of the central and northern parts of the State. Consequently, the rainfall varies from 700 to 1000 mm in the southern part and 300 to 500 mm in the north (19), the annual rainfall of the central part lies in between this range. Three seasons were identified in the State: the cool dry (harmattan) season (October to March); the hot dry season (April - June); and rainy season (July - September). The temperatures are high all year round, with hot season mean temperatures ranging between 39^0 and 40^0 C. Agriculture of both crops and animals is the mainstay of the economy (20).

Experimental birds and data collection

Six hundred (600) adult (above six months of age) **indigenous** chickens were collected from six local government areas selected from the Central (Jere, Maiduguri and Konduga) and Southern (Dambua, Biu and Chibok) parts of Borno State. Data were collected on plumage colour, comb type, feather characteristics, shank, ear lobe and eye colours. Colour variations and other qualitative characteristics of the chickens were determined by visual appraisal (28).

Statistical analysis

Data collected on the qualitative parameters were analyzed using descriptive statistics (means, percentage and frequency) of Statistical Package for Social Sciences (SPSS) version 20.0 (2011) Chi-square was adopted to determine the variation between the observed and expected frequencies using the same software.

Results and discussion

Frequency distribution of plumage colours of indigenous chickens

Plumage colour frequency distribution of indigenous chickens in Borno State is highly variable (Table 1). There were significant colour differences ($P<0.001$) among chickens in the central and southern parts of the state. Out of the 600 birds investigated, chickens with multicolour plumage had highest population (31.3%). This is followed by those with white (12.5%). Other birds with distinct colours of black-with- white strips (BWS), brown and ash were 8.2%, 7.5% and 6.8%, respectively. In both the central and southern parts, birds with multicolour abound (34.3% and 28.35%, respectively). However, there were more of brown red (27%) and white (17%) chickens in the central part. Conversely, birds with black (14.7%) and black-with-white strips (13%) colours were in abundant in the southern part. By percentage, there were almost equal numbers for brown colour birds (8% and 7%) in the two zones, respectively.

However, no significant (P>0.05) colour differences were observed among the sexes (cocks and hens), though hens were more of multicolour (32%) than the cocks while population of chickens with white (13.4%) colour was in favour of the cocks.

Table 1: Frequency distribution of plumage colour of indigenous chickens in the central and southern parts of Borno State

				Sex	
LGA	**Central**	**Southern**	**Total**	**Cock**	**Hen**
Observation	300	300	600	322	278
Plumage		**X^2=113.9*** **		**X^2=6.93^{ns}**	
Ash	12(4)	29(9.7)	41(6.8)	19(5.9)	22(7.9)
Black	20(6.7)	44(14.7)	64(10.7)	28(8.7)	36(12.9)
BWS	10(3.3)	39(13)	49(8.2)	27(8.4)	22(7.9)
Brown	24(8)	21(7)	45(7.5)	24(7.5)	21(7.6)
Brown red	8(27)	15(5)	23(3.8)	14(4.3)	9(3.2)
Multicolour	103(34.3)	85(28.3)	188(31.3)	99(30.7)	89(32)
Red	17(5.7)	7(2.3)	24(4)	14(4.3)	10(3.6)
White	51(17)	24(8)	75(12.5)	43(13.4)	32(11.5)
WBS	13(4.3)	7(2.3)	20(3.3)	11(3.4)	9(3.2)
Yellow	9(3)	7(2.3)	16(2.7)	8(2.5)	8(2.9)
Others	33(11)	22(7.3)	55(9.2)	35(10.9)	20(7.2)

*****=P<0.001, X^2=Chi-square value, ns=not significant, Numbers in parenthesis are in percentages, BWS=Black with White Stripes, WBS= White with Black Stripes**

However, no significant (P>0.05) colour differences were observed among the sexes (cocks and hens), though hens were more of multicolour (32%) than the cocks while population of chickens with white (13.4%) colour was in favour of the cocks.

According to (21), the plumage colour is only second in importance to live weight in affecting market preference of indigenous chickens. In Northern Ethiopia for instance, both product sellers and intermediary traders attached the highest preference for plumage colours (16). The presence of multiple variants of plumage colours within a population is a typical feature characterizing indigenous chickens in some part of Africa (22) and Asia (23). Such large variation in feather colours revealed that much genetic dilutions have occurred with the indigenous chickens. *Oluyemi and Roberts* (24) reported that the fact that indigenous chickens have not been artificially selected may be the possible reason while (25) added that the most probable explanation for this is that a number of genes interact to determine plumage colours and pattern. Multicolour is most likely an adaptive and survival feature.

The highly variable shades of plumage colour observed in this study had earlier been reported by a number of authors (26) and (27). The predominance of multicoloured birds reported in this study is in line with the reports of (27) and (22) in Nigeria and Botswana, respectively. This result is however contrary to the report of (28) who reported black (18%) as the predominant plumage colour for indigenous chickens in the Sudan and Sahel Savannah of Borno state, Nigeria. The relative larger number of white colour birds in the central than in the

southern part of the study area may be due to higher productivity, more resistance to harsh environment because while colour usually repel heat thus, a potential for higher rate of survivability in the central zone as presented in Table 1. Nigussie *et al.* (21) reported white as the most predominant plumage colour in chicken. In contrast, abundance of black glossy birds in the southern part suggests adaptive mechanism to absorb heat and warm the bird's body. However, (29) attributed low occurrence of black plumage in southern Nigeria to negative thermoregulation which adversely affects adaptation. This correlates with that of (28) who worked with indigenous chickens of the Sahel and Sudan Savanna Agro ecological zones of Borno State. The differences in the result of this study and those of other authors may be attributed to genetics and geographical locations.

Distribution of feather characteristics of indigenous chickens

The frequency distribution of feather characteristics of indigenous chickens in Borno state is presented in Table 2. Normal feathered birds were most predominant (59.7%) and then frizzle feathered (24.3%) and naked neck (16%), in that order. Although, the central zone had significantly ($P<0.001$) more normal birds (65.6%) than southern (53.7%) part, more naked neck (18.3%) and frizzle (28%) were observed in the southern part than their respective values in the central part (13.7% and 20.7%, respectively). Though frizzle feathered hens were more than cocks (31.0% and 18.6%), the reverse was observed for naked neck birds (21.4%, 9.7%). With regards to crestedness (Table 2), larger percentage of the birds (78%) were normal (without crest) against those with crest (22%). In both zones, birds without crest abound with central

Table 2: Frequency distribution of plumage characteristics of indigenous chickens in the central and southern parts of Borno State

				Sex	
LGA	**Central**	**Southern**	**Total**	**Cock**	**Hen**
Observation	300	300	600	322	278
Feather characteristics	X^2=152.9**			X^2=22.13***	
Normal	197(65.6)	161(53.7)	358(59.7)	193(59.9)	165(59.3)
Naked neck	41(13.7)	55(18.3)	96(16)	69(21.4)	27(9.7)
Frizzle	62(20.7)	84(28)	146(24.3)	60(18.6)	88(31.0)
Crestedness	X^2=66.94***			X^2=87.54***	
Normal	272(90.7)	196(65.3)	468(78)	299(92.9)	69(60.8)
Crested	28(9.3)	104(34.7)	132(22)	23(7.1)	109(39.2)

***=P<0.001, **=0.01, X^2=Chi-square value, Numbers in parenthesis are in percentages

having higher value (90.7% and 75.3%, respectively). However, the observed value for crested birds was more in the southern part (34.7%) than in the central part (9.3%). Among the sexes, there were more crestless cocks (92.9%) than hens (60.8%). The crestedness however was in favour of the hens (39.2% vs 7.1%).

The predominant population of normal feathered birds over other feather characteristics observed in this study had earlier been reported by other authors (9). The naked neck (*Na*) gene is described as one of the major genes in local chickens of the Tropics that have desirable effects on heat tolerance and adult fitness which consequently aids appetite (7). However, the percentage of chickens that expressed the gene in this study was quite low (16%) compared with normal feathered (59.7%). An important reason for this low frequency may be that the farmers did not prefer naked neck chickens because of its unthrifty appearance (15) and this led to selection against this valuable gene. Consequently, the future of the naked neck chicken is endangered unless measures are taken towards its conservation (9). The total frequency of chickens carrying the *Na* gene in the population studied was higher than 6% reported in Nigeria by (30) and 3.6% by (22) in Botswana.

The frizzle feathered chickens being next to the normal feathered in proportion can be justified by the report of blood protein screening which revealed that frizzle and normal feathered chickens are closely related as they share a more recent common ancestor than either shares with any other strains on the phylogenetic tree (31). The reason that account for the low occurrence of frizzle feathered birds is the lethality of the frizzle gene (f) when in homozygous (32). In support of this, (33) reported that frizzle feathered birds have high rate of mortality. Most of the chickens in the population studied were identified with flat head (78%) while a few portions had crested head (22%). This report is in agreement with (28) with Northeastern Nigeria indigenous chickens (90 vs 10%) and (9) with Ethiopian indigenous chickens (46 vs 34%). According to (30), crestedness is a condition which renders chickens unattractive, most likely the scale of preference weighed heavily against chickens with this feature. This may be linked with the fact that the southern part is characterized with cooler weather conditions which favour crestedness in chickens. More proportion of crested birds observed in the southern part in this study (34.7%) against 9.3% in the central part, is in line with the result of (28) who observed 11% in the Sudan Savannah against 7% in the Sahel zones of Borno State, Nigeria. Conversely, (9) reported higher proportion of crested chickens (75%) in the northern population but flat heads were a characteristic feature of those in the south of Ethiopia (64%).

Distribution of comb type and shank colour of indigenous chickens

Table 3 presents the frequency distribution of comb type and shank colour of indigenous chickens in Borno State. Single comb had the highest value (75.2%) while double comb had the lowest (2%) value. Rose and pea had 18.2% and 4.7%, respectively. Across the zones, no significant difference ($P>0.05$) was observed with respect to comb type. Meanwhile, there was significant sex effect ($P<0.05$) on single (77%, 73%) and rose (18.9%, 17.3%, respectively) combed birds. Birds with white shank colour had the highest

percentage (30.3%) and this is followed by yellow (26.3%). The values for black, green and grey-blue were 20.8, 13.3 and 9.3%, respectively. There was significant difference between the values for shank colour in the central and southern parts. The central part had significant values (P<0.001) for white (39%) shank colours while values for southern part were significantly higher for yellow (29%) shank colours. No significant difference was observed between the sexes for shank colours.

According to (24), the most common comb type is single. Single comb in population is the most reliable evidence of homozygosity of any comb type. The highest value observed for single comb which is almost the largest in size (24) suggests a selection advantage and greater adaptability. Comb remains an important avenue for heat loss in birds especially in hot climates.

Since the study area is characterized with high temperature, large combs would play an efficient role in heat dissipation (34). The High proportion of single comb (75.2%) as observed in this study had been equally reported by a number of authors such as (6), (35) and (28), (36), (11). However, this is contrary to the reports of (21), (9) and (37) who reported pea as most predominant comb type. The variations in the reports could be due to differences in geographical locations as some comb types were more favoured in one environment than the other. Despite the fact that these qualitative traits have less economic values for other segment of the society, cultures and beliefs of most of rural communities of Ethiopia have been highly attracted by these variations (16). Some morphological appearances are significantly important for price variations of the marketable birds of various chicken ecotypes (38) and are influenced by genetics. The shank is yellow when lipochrome pigment is

Table 3: Frequency distribution of comb type and shank colour of indigenous chicken in the central and southern parts of Borno State

				Sex	
LGA	**Central**	**Southern**	**Mean**	**Cock**	**Hen**
Observation	300	300	600	322	278
Comb type	X^2=14.23^{ns}			X^2=8.14*	
V-shape	2(0.7)	10(3.33)	12(2)	3(0.9)	9(3.2)
Pea	15(5)	13(4.3)	28(4.7)	10(3.1)	18(6.5)
Rose	54(18)	55(18.3)	109(18.2)	61(18.9)	48(17.3)
Single	229(76.3)	222(74)	451(75.2)	248(77)	203(73)
Shank colour		X^2=48.31***			X^2=0.63^{ns}
Black	52(17.3)	73(24.3)	125(20.8)	68(21.1)	57(17.7)
Green	45(15)	35(11.6)	80(13.3)	43(13.4)	37(12.3)
Grey blue	15(5)	40(13.3)	55(9.2)	27(8.4)	28(9.3)
White	117(39)	69(21.6)	182(30.3)	100(31)	82(27.3)
Yellow	71(23.6)	87(29)	158(26.3)	84(28)	74(24.7)

*****=P<0.001, **=P<0.01, *=P<0.5, X^2=Chi-square value, Numbers in parenthesis are in percentages**

present and it is black when there is melanic pigment. Additionally, when there is yellow in the dermis and black in the epidermis, the shank appears greenish. If the two are absent, the shank is white. Meanwhile, the proportion of yellow colour depends largely on the amount of xanthophylls in the diet (24). Dominance of white shank colour as reported in this study could be explained by the fact that white is dominant to yellow, due to an autosomal dominant gene *W* which prevents yellow from developing in the skin but has much effect on black (24). However, not all shank colour inheritance can yet be explained. Yellow and black shank colours were dominant in the southern part. This is in line with (24) who concluded that most common shank colours are yellow and black. The higher percentage of white shank colour in this zone as reported in this study may be connected with the presence of gene *E* which is involved in controlling the extension of black pigment (24).

The white shank colour observed with higher percentage in this study had equally been reported by (6), (28), (11). However, it is contrary to (9), (37), (21) who reported yellow as the most common shank colour in their study. Large variations for indigenous chicken colours such as shank colour may be basically attributed to geographical situation of a place, isolation, natural and artificial selections as well as gene pool of a flock (16).

Distribution of eye and earlobe colours of indigenous chickens

Table 4 shows the frequency distribution of eye and earlobe colour of indigenous chickens. Orange eyed birds had highest distribution (39.2%) of a total of 600 birds sampled. The percentages for red, brown and pearl coloured eyed were 34.7%, 21% and 5.2%, respectively. The values were significantly different ($P<0.05$) among the birds. Orange (41.7%) and red (38.7%) eye coloured birds were significantly more in the central part than the south while brown colour (27.7%) was significantly higher in the southern part. Pearl eye colour was equally (5%, 5.3%) distributed in both the central and southern parts. No significant difference was observed between the sexes with respect to eye colour traits. Eye colour to a large extent depends on the proportion of carotenoid pigments and blood supply of a number of structures within the eye (25).

Chickens with white earlobe were most abundant (36.7%) while blue white was least in abundance (3.2%). The values for red white, red, blue and black were 22.8, 17.8, 16 and 3.5%, respectively. In both the central and southern parts, white earlobe colour was most abundant (41.7 and 31.7%). However, while central part had higher significant different values for white (41.7%), the southern part had significantly higher values for blue (20.7%). The two regions had equal values for red (17.7%, 17.7%) and red-white (23%, 23.1%) earlobes. No significant difference was observed for earlobe colours between the sexes.

Eye colour to a large extent depends on the proportion of carotenoid pigments and blood supply of a number of structures within the eye (25). Predominant white earlobe colour observed in this study is in line with (24) and (9) who reported white and red earlobe as being predominant.

Conclusion and Application

1. Chickens in central and southern parts of Borno state had abundant multicolour plumage, with abundant brown red and

Table 4: Frequency distribution of eye and ear lobe colour of indigenous chicken in the central and southern parts of Borno State

	Zone			Sex	
	Central	**Southern**	**Total**	**Cock**	**Hen**
Observation	300	300	600	322	278
Eye colour	X^2=26.12*			X^2=1.36^{ns}	
Brown	43(14.3)	83(27.7)	126(21)	66(20.5)	60(21.6)
Orange	125(41.7)	110(36.7)	235(39.2)	126(39.1)	109(39.2)
Pearl	16(5.3)	15(5)	31(5.2)	14(4.3)	17(6.1)
Red	116(38.7)	92(30.7)	208(34.7)	116(36)	92(33.1)
Ear lobe colour		X^2=51.87***		X^2=4.82^{ns}	
Black	13(4.3)	8(2.7)	21(3.5)	10(3.1)	11(3.9)
Blue	34(11.3)	62(20.7)	96(16)	47(14.6)	49(17.6)
Blue white	6(2)	13(4.3)	19(3.2)	19(5.9)	10(3.6)
Red	53(17.7)	54(17.7)	107(17.8)	53(16.5)	54(19.4)
Red white	69(23)	68(23.1)	137(22.8)	73(22.7)	64(23)
White	125(41.7)	95(31.7)	220(36.7)	130(40.4)	90(32.4)

*****=P<0.001, *=P<0.5, X^2=Chi-square value, ns=non significant, Numbers in parenthesis are in percentages**

white in the central parts and black birds in the southern.

2. Hens mostly multicolour while cocks were white. Normal feathered chickens abound with scanty naked neck and frizzle feathered. Cocks of naked neck birds were more frequent while reverse was the case for frizzle.
3. Chickens were mostly normal headed with scanty crested which were more frequent in the southern.
4. Single comb chickens were in abundant with many having white shank. Yellow shank colour dominated the southern part.
5. Cocks were more of white shank and hens were varied in shank colour.
6. Chickens with orange eye colour were most frequent. Most chickens possessed white earlobe. These variations in genetic resources of these chicken populations are an attestation that the birds are reservoir for genetic improvement and subsequent conservation. Therefore, these genetic resources in these chickens should be conserved for improvement.

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