Frequencies of different phenotypes and body parameters of mature indigenous chicken in deciduous rainforest zone of Nigeria

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Abstract

The study was conducted using 800 adult local chickens comprising 355 males and 445 females, which were obtained from 2 major markets in Ado Ekiti, the capital city of Ekiti state, Nigeria. Convenience sampling technique was employed in selecting animals for observation. The birds were individually observed for phenotypic expression of shank colour, feather morphology, feather structure, polydactyly, ptylopody and comb types. The number in each group was expressed as a percentage of the total number of birds. The body size parameters measured include body weight, body girth, body length, shank length, wing length, toe length, keel length and shank diameter. The result revealed that the phenotypic frequencies of birds with dominant genes for feather morphology (FF, Ff), feather structure (NaNa + Nana), poly dactyl (PoPo + Popo) and ptylopods (FshFsh + Fshfsh) were 0.033, 0.037, 0.042 and 0.046 respectively, while that of the recessive gene carriers were 0.967, 0.963, 0.958 and 0.954 respectively. The calculated gene frequencies for frizzled (F), Naked neck (Na), Polydactyly (Po) and ptylopods (Fsh) were 0.035, 0.024, 0.034 and 0.035 respectively. The local chicken showed different plumage coloration with black, brown and pink predominating. The male birds were superior to their female counterparts with significant differences (P<0.05) in all the parameters measured except weight.

Key words: phenotypic, polydactyly, ptylopods, frizzle, naked neck, normal

Introduction

The local chicken is owned by most households in rural areas (personal observation). It is therefore safe to say that the local chicken is among the many local resources of resource poor people living in rural areas which could be harnessed and utilized for poverty reduction or alleviation. In recent time, efforts had been more than ever before geared towards improving the productive potentials of the local chickens by researching into health and nutritional status of the birds, its management and social economic potentials but less attention had been focused on its genetics. The rudiment of its genetics should begin with characterization and to accomplish this, understanding the roles of genes influencing major characteristics of the animal species, its relative frequencies and importance is of paramount importance. Relevant in this regard is the occurrence of some adaptive features such as frizzling, naked neck, polydactyly, ptylopody and comb types found in the local chickens. These genes have been reported to be important in the adaptation and productivity of the breed in its native, hot environment, influencing either the meat characters or its eggs (Sonaiya, 2000). Frizzling is caused by a single incompletely dominant autosomal gene, restricted by autosomal recessive modifier (Hutt, 1949). Unmodified homozygotes have the rachis extremely reserved in all feathers. The feathers are easily broken and they therefore appear quite bare. The modifying gene lessens the extreme

aspects of the homozygotes so that they appear less woolly. Unmodified homozygotes have the feather shafts and barbs of contour feathers recurved, to a much less extent than the homozygotes. The action of the frizzle gene has been shown to be localized in the feather follicle and does not result from a metabolic disorder (Njenga, 2005).

Naked neck gene is a single autosomal dominant gene. It is incompletely dominant with the heterozygote individual showing an isolated tuft of feathers on the ventral side of the neck above the crop while the homozygote individuals either lack this tuft or it is reduced to just a few pinfeathers or small feathers. The important feature of the naked neck birds is the reduction in feather coverage which is expected to facilitate better heat dissipation

Polydactyly, a mutant developmental defect (Pisenti *et al.* 1999) can be defined as a condition in which instead of the normal 4 toes in a chicken, the bird has 5 toes. Shoffner *et al.* (1993) observed that lines with polydactyly and ptylopody had better body weight and egg production.

Ptylopody according to Hutt (1949) is a condition where hair is present at the hock, tarso-metatarsus and the outer toe. This had been reported to have a negative selection effect on birds with such condition as they are unattractive; hence, negative social preference and high heat load as the extremities of the shank are covered with feathers (Sonaiya, 2000).

Several comb types had been reported in chickens but four, namely, pea, rose, single and walnut had been reported in local chicken (Oluyemi and Roberts, 2000). Comb is known as an important medium for heat loss in birds (Van Kampen, 1974, Sonaiya, 2000) and so, it will play a significant role as an adaptive feature in local chicken in hot, humid environment. The aim and objective of this study is, therefore, to observe the frequencies of these major and modifier genes for the purpose of documentation and utilization in improvement programme of local chickens.

Materials and Methods

Study site

The study was conducted in Ekiti state, a deciduous forest zone of western Nigeria.

Origin of the study animals

The indigenous chickens included in this study were those brought by village producers and/or middle men and resell them in markets of big cities like those in Ado Ekiti, Ekiti state, Nigeria. Ado Ekiti is the capital city of Ekiti State, Nigeria. The market was chosen because of the availability of high populations of local chickens at the place at all times

Study design and data collection

The study was conducted on 800 (eight hundred) adult local chickens comprising 355 males and 445 females, which were obtained from two major markets in Ado Ekiti, Nigeria. Convenience sampling technique was employed in selecting animals for observation. The birds were individually observed for phenotypic expression of shank colour, plumage colour, feather morphology, feather structure, polydactyly (more than 4 toes) and ptylopody (feathered shank). The number in each group was expressed as a percentage of the total number of birds.

The body size parameters measured include body weight, body girth, body length, shank length, wing length, toe length, keel length and shank diameter.

*Live body weight was measured in kilograms on a top loading weighing scale.

Table 1: Plumage and shank colourations of local chickens of the deciduous rain forest zone of Nigeria.

	Plumage colour		shank colour	
	Number observed	Proportion (%)	Number observed	Proportion (%)
Black	292	36.50	292	36.50
Pink	162	20.25	-	-
White	85	10.63	77	9.63
Brown	215	26.88	-	-
Purple	15	1.88	-	-
Ash	8	1.00	-	-
Red	15	1.88	-	-
Dark	8	1.00	131	16.38
Yellow	-	-	285	35.63
Grey	-	-	15	1.88

*Body length was taken as the distance from the tip of the beak over the neck, through the body trunk to the tail.
*Body girth was determined as the circumference of the breast region
*Keel length was taken as the length of the keel bone from the V-joint to the end of the sternum.
*The wing length was taken as the length of the wing from the scapula joint to the last digit of the wing.
*Shank length was taken as the length of the tarso-metatarsus from the hock joint to the metatarsal pad.
*Toe length was taken as the length of the third toe measured from the metatarsal fold to the last phalange on the toe.

*The body length, body girth, keel length, wing length, shank length and toe length were measured in centimeters on a tape
***Shank diameter was determined as the diameter (in mm) of the tarso-metatarsus just below the spur using a pair of vernier caliper.**
Data analysis
Mean values of the body size parameters were subjected to a two-way analysis of variance to determine the effects of genotype (Naked neck and frizzle feather, polydactyly, ptylopody) and sex (Steel and Torrie 1980) on bodyweight and body size parameters of the local chickens. Where statistical differences occurred, mean values were separated by means of the Duncan Multiple Range Test (Duncan, 1955). The frequencies of the dominant alleles (Na, F, Po and Fsh) and the recessive alleles (na, f, po and fsh) were calculated using the Hardy - Weinberg approach (Falconer 1989) as follows:

$q = vm/t$

where: q = frequency of the recessive gene na, f, po or fsh
m = observed number of birds with recessive trait under consideration
t = total number of birds examined

The frequencies of the dominant alleles (Na, F, Po and Fsh) were calculated from $p = 1 - q$ where p is the frequency for the dominant alleles and q is the frequency

of the recessive allele.

The observed genotypic frequencies were tested against the expected Mendelian values of 0.75 for the dominant allele and 0.25 for the recessive allele using the chi-square test (Thompson 1941) with the assumption of zero value for artificial selection. Calculated chi-square value (x^2) was obtained as follows:

$$x^2 = \sum \frac{(O - E)^2}{E}$$

Where:

O = Observed frequencies

E = Expected frequencies

The statistical model used to analyze the fixed effect of sex and genotype is as follows: $Y_{ijk} = \mu + g_i + s_j + e_{ijk}$

Where

Y_{ijk} = phenotypically expressed trait y (e.g. body weight) taken on the k^{th} individual, of the j^{th} sex, belonging to the i^{th} genotype

μ = overall mean

g_i = fixed effect of the i^{th} genotype

s_j = fixed effect of the j^{th} sex

e_{ijk} = error residual with expectation is being equal to zero.

The effect of genotype on body size parameters was calculated as;

$$g = \ddot{Y}_i - \ddot{Y}.... = \underline{?i} - \underline{?....}$$

t bt

The sex effect on body sise parameters was calculated as;

$$S_i = \ddot{Y}_j - \ddot{Y}.... = \underline{?i} - \underline{?....}$$

t bt

where

$\ddot{Y}_j$ = mean of the i^{th} genotype

$\ddot{Y}$ = overall mean

$\ddot{Y}_j$ = mean of the j^{th}

b and t = number of sex and genotypes respectively.

Results

Table 1 revealed that the experimented birds had different shank and plumage colourations. Of the chickens studied, black plumage constituted 36.50 %, brown (26.88 %), pink (20.25 %) and white (10.63 %). Other colour variants observed in the plumage are purple and red (1.88 % each) and ash and dark (1 % each). The shank colours were black (36.50 %), yellow (35.63 %), dark (16.38 %), white (9.63 %) and grey (1.88 %) colourations.

The result presented in Table 2 showed the gene frequencies of naked neck, frizzled, polydactyl and ptylopod birds as 0.02, 0.01, 0.01 and 0.01 respectively. The corresponding gene frequencies for normal alleles in the table were 0.98, 0.99, 0.99 and 0.99 respectively. The expected phenotypic proportion and gene frequencies for the frizzle feathered birds in the table was calculated on the assumption that the frizzle feathered birds in its homozygous state is lethal (Haaren-kiso *et al.*, 1995). The chi-square analysis showed that the calculated gene frequency for naked neck versus normal, frizzle versus normal, polydactyly versus normal and ptylopody versus normal failed to conform to expectation for a Mendelian population.

Table 3 showed that 96.24 % of the 800 birds examined had single comb while each of pea and rose comb types recorded 1.88 % and the walnut 0.00 %. The gene frequencies of the R and P alleles in rose and pea comb types were both 0.05 while

Table 2: Proportion and frequencies of major gene in the local chickens of the deciduous rain forest zone of Nigeria

Conditions	Major gene	Expd.	obsd (%)	proportion freq	cal gene freq.	Exp. gene
Naked neck	Na	468	24	3.85	0.02**	0.75
Normal	na	156	600	96.15	0.98**	0.25
Frizzle	F	416	16	2.56	0.01**	0.67
Normal	f	208	608	97.44	0.99**	0.33
Polydactyly	Po	468	8	1.28	0.01**	0.75
Normal	po	156	616	98.72	0.99**	0.25
Ptylopody	Fsh	468	8	1.28	0.01**	0.75
Normal	fsh	156	616	98.72	0.99**	0.25

***Significantly different from expected Mendelian value (p<0.01)*

Table 3: Frequencies of comb type genes in the local chickens of the deciduous rain forest zone of Nigeria.

Comb types	Number observed	Proportion (%)	Gene	
			Incidence	Frequency
Pea	15	1.88	P	0.05**
Rose	15	1.88	R	0.05**
Single	770	96.24	r & p	0.99**
Walnut	-	-		-

-

***Significantly different from expected Mendelian value*

Table 4: Body weight and body size parameters of major gene carriers in the local chickens of the deciduous rain forest zone of Nigeria

Parameters	Naked neck	Frizzle	Polydactyly	Ptylopody	Normal
Body weight (kg)	1.24	1.38	1.56	1.42	1.39
Body length (cm)	37.92	38.97	40.39	39.32	39.12
Body girth (cm)	27.80	27.67	28.37	27.23	27.43
Wing length (cm)	18.08	18.37	18.86	18.83	8.42
Shank length (cm)	10.02	10.51	10.70	10.04	10.03
Drumstick length (cm)	10.80	10.70	11.12	10.75	10.70
Toe length (cm)	4.86	4.95	5.02	5.01	4.92
Keel length (cm)	13.45	14.40	14.85	13.95	13.95

Figures in same row are not significantly different (P>0.05)

that of the recessive alleles r and p (single comb type) was 0.99. The single comb type is the commonest in the local chickens found in the study area.

Table 4 showed that there were no statistical significant differences in values obtained for all the genotypes examined in terms of body weight and body measurements.

Table 5 revealed that the effect of genotype on body parameters in this study was generally low especially for body weight, drumstick length and toe length. There was no genetic effect on the body weight, wing length, toe length and keel length of the normal birds and also for the keel length of the ptylopod birds. The polydactyly birds in all the parameters measured showed the highest and positive genetic effect. The genetic effects for most of the variables measured were positive in the ptylopod birds except body girth and shank length. In the frizzle there were equal positive and negative genetic effects on the traits while in the naked neck only the body girth and drumstick length had positive genetic effect.

Table 6 showed the mean values for body weight and body size parameters of male and female local chickens. The report show significant differences between male and female local chickens in all the parameters examined with the male showing consistent superiority.

Table 7 showed that the genetic effect of sex on body weight and body size parameters was as shown in Table 7. The effect were about the same in the two sexes except that they are positive in male and negative in females.

Table 5: Effect of genotype on body weight and body size parameters of major gene carriers in the local chickens of the deciduous rain forest zone of Nigeria

Parameters	Naked neck	Frizzle	Polydactyly	Ptylopody	Normal
Body weight	-0.15	-0.01	+0.17	+0.03	0.00
Body length	-1.17	-0.12	+1.30	+0.23	+0.03
Body girth	0.34	+0.21	+0.91	-0.23	-0.03
Wing length	-0.34	-0.05	+0.44	+0.41	0.00
Shank length	-0.03	+0.49	+0.68	-0.01	-0.02
Drumstick length	+0.09	-0.01	+0.41	+0.04	-0.01
Toe length	-0.06	+0.03	+0.10	+0.05	0.00
Keel length	-4.75	+0.45	+0.09	0.00	0.00

Table 6: Mean body weight and body size parameters of major gene carriers in the male and female local chickens of the deciduous rain forest zone of Nigeria

Parameters	Male (M)	Female (F)	M - F
Body weight (kg)	1.54^{a}	1.21^{b}	0.33
Body length (cm)	39.69^{a}	37.09^{b}	2.60
Body girth (cm)	28.42^{a}	26.12^{b}	2.30
Wing length (cm)	19.52^{a}	17.04^{b}	2.48
Shank length (cm)	11.02^{a}	8.83^{b}	2.19
Drumstick length (cm)	11.17^{a}	10.14^{b}	1.03
Toe length (cm)	5.25^{a}	4.51^{b}	0.74
Keel length (cm)	14.57^{a}	13.17^{b}	1.40

Figures in a row with different superscripts are significantly different (P<0.05)

Table 7: Effect of genotype on body weight and size parameters of major gene carriers in the male and female local chickens of the deciduous rain forest zone of Nigeria

Parameters	Male	Female
Body weight (kg)	+0.15	-0.18
Body length (cm)	+1.60	-2.00
Body girth (cm)	+0.96	-1.34
Wing length (cm)	+1.10	-1.38
Shank length (cm)	+0.97	-1.22
Drumstick length (cm)	+0.46	-0.57
Toe length (cm)	+0.33	-0.41
Keel length (cm)	+0.62	-0.78

Discussion

Local chickens could be described using phenotypic characteristics. These phenotypic characteristics (adult size, comb types, morphometric traits and plumage characteristics etc) are economically potent traits that are transferable from parents to their progenies via inheritance. These traits can be exploited, standardized and used as a basis for the transformation of local chickens to commercial breeds that are adaptive to native environment.

In the current study, diverse plumage and shank colouration were observed within the chickens examined. The postulated function of plumage colouration as a mean of camouflage (Ayeni, 1980) against predator become more evident in this study as revealed by the low proportion of white colour in the population.

Shank pigmentation, a function of nutrition, had been reported to depend on combination of pigments in the upper and lower layers of the skin that are particularly associated with the presence or absence of melanic pigments in dermis and epidermis of the skin (Duguma, 2006). Nesheim *et al.* (1979) observed empirically that yellow shank and skin colouration is currently more preferred by consumers of developed nations and such colour is associated with carotenoid pigments in the epidermis which is obtained through

dietary origin. In this study it was revealed that the food resource available for the local chicken to facilitate acceptability is significantly below average as revealed by 64.38 % of pigmentation of the shank not yellow. This finding was in agreement with the work of Oluyemi and Roberts (2000) who reported that common shank colours are yellow and black.

The low calculated gene frequencies for the dominant gene carriers (naked neck, frizzle feathered, polydactyly and ptylopody) is a pointer to the fact that the genes are being drawn to extinction. The basic reasons for this situation could be as a result of the roles these birds play in rituals and sacrifices and the general belief that people who have such birds are either fetish or witches/wizards (personal interaction with sellers). Consequently, owners prefer to destroy them before their neighbours get to know that they have such birds and those who are bold to

keep them do so only to sell them for rituals most often before maturity. Additional reason in case of the frizzle feather could be the lethality of the gene in its homozygotic state (Haaren-kiso *et al.*, 1995). This situation requires scientific concern to ensure that these traits are preserved and available for utilization in future livestock improvement programme. This result is in tandem with the findings of Sonaiya and Olori (1990) and Fayeye *et al* (2006) who reported low frequencies of occurrence of these traits in local chickens of south western Nigeria and Nigeria local chickens respectively.

Three comb types (pea, rose and single) existed within the chickens examined. The gene frequencies of the comb types failed to conform to the 9:3:3:1 Mendelian mode of inheriting this character. The failure to conform is suspected to be due to possible interactions between the major genes which themselves may be pleitropic to quantitative traits. Pleitropic traits are capable of exerting threshold effects on other genes, preventing the latter from expressing their effects. On the other hand, it could be the involvement of comb and wattle in heat loss thus conferring better adaptive features for the largest comb type (single comb) which will facilitate more heat loss. This assertion was in tandem with the reports of Oluyemi and Roberts (2000) and Sonaiya (2000) and also corroborated the one made by Neisheim *et al.* (1979) that the size and colour of the comb and wattles are associated with gonad development and secretion of sex hormones and that large combs, large wattles and long legs are important morphological traits that allow better heat dissipation in the tropical hot environment. However, the gene frequencies for rose and pea obtained in this study were far lower than that of Sonaiya (2000) thus aggravating the fear that these comb types are already endangered.

Average body weight and body linear measurements of chickens in this study were low compared with the exotic chickens thus corroborating earlier reports (Oluyemi and Roberts, 2000 and Fayeye *et al.,* 2006) that indigenous chickens are relatively small in body size and other body measurements. The study also showed that, individuals with the dominant alleles, particularly the polydactyly birds, were superior to the recessive gene carriers in all the traits examined, though not statistically. This result was in tandem with the work of Fayeye *et al.* (2006) who reported that polydactyly and ptylopod birds were insignificantly higher in body weight when compared with their recessive gene carriers' counterpart. The superiority of the polydactyly birds particularly in body weight might be as a result of the balancing posture the five-toed birds is likely to give over and above the four-toed birds thus enabling it to support heavier weight.

The result further showed that the male birds were consistently superior to the female birds in all the parameters measured. This reason for this superiority could be ascribed to the endocrinal differences that exist between male and female animals which favour the male. Additionally, it could be as a result of the fact that female animals have more production pressure than the male thus dissipating more energy on maintenance and production with comparatively little left for growth. This report was in agreement with the work of Fayeye, *et al.* (2006) and Prado-Gonzalez *et al.* (2003) where the later reported that the male of

the native Creole chicken from South-Eastern Mexico were generally heavier than their female counterpart.

Conclusion

*Diverse phenotypic characters exist within the local chickens found in this region

*The investigated adaptive feather structure is at the brink of extinction going by the low frequencies of occurrence of these traits

*Research into the implication of these traits on economic traits should be undertaken for future rural oriented breeding programme.

Limitation of the study

Information on the age of the birds could not be obtained because indigenous chicken traders were ignorant of it, even most indigenous chicken keepers do not know the exact age of their birds, the average body weights of the indigenous chickens surveyed indicated that they were probably about 6 months of age because, Gueye *et al.* (1998) reported similar values for indigenous chickens at this age under extensive husbandry systems of villages.

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