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Comparative Study on Morphological and Morphometric Features of Village Chicken in Sri Lanka

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ABSTRACT: *A study was conducted in two selected sites (Anuradhapura and Puttlam districts) to phenotypic ally characterize various types of village chicken present in Sri Lanka. Qualitative traits such as characteristics of plumage, comb, shank, eye and earlobe, and body condition score were recorded with a full inventory of management conditions. Quantitative traits included body weight and linear morphometric measurements such as chest circumference, wing length, back length, breast width, keel length, pelvis width, shanklength and shank circumference. Seven distinct phenotypic groups could be identified as naked neck (NNC), long legged (LLC), crest/crown (CC), Giri raj (GRC), commercial crosses (ComC), frizzle feathered (FFC) and non-descript (NVC). NVC group included multiple crosses of other groups. Occurrence of different morphological features varied significantly ($p<0.05$) between study sites, sexes and among phenotypic groups as shown by chi square analysis. Analysis of variance procedure followed by Duncan's new Multiple Range test showed significant differences in linear measurements and body weight among groups, where GRC (exotic genotype of Indian origin) reporting to be the largest and FFC the smallest ($p<0.05$). Regression analysis performed showed significant relationships of body weight with every linear trait while chest circumference and shank length were the best predictors of live weight. The performance gap between village chicken and exotic breeds showed the potential for village chicken to be developedandsustainably utilized.*

Keywords*: Characterisation, morphometric traits, phenotypic diversity, Sri Lanka, village chicken*

INTRODUCTION

In most of the South-east Asian countries, poultry keeping has been practiced for centuries as a backyard operation using scavenging chicken among rural families (Ramlah, 1999). Sri Lanka too has no exception in this regards where around 43% of the village chicken products is consumed at household level, and backyard poultry contributes for various non-monetary benefits including, manure production, weed and pest control, waste and agricultural by-products recycling and conservation of valuable genetic resources (Wijayesena ***et al.,*** 2014). The local chickens, which are commonly classified world wide as non-descriptive types due to lack of information (FAO, 2012), vary widely in body size, body conformation, plumage colour and many other phenotypic characteristics, which is important in livelihood and household food security in rural farm families (Cabarles ***et al***., 2012).

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The most significant threats to the village poultry are indiscriminate crossbreeding and breed replacement, changes of production systems and degradation of the environment (Cabarles ***et al***., 2012). Since a loss or extinction is an irreversible phenomenon, it is always better not to be too late to take precautionary actions to curb further losses or erosions of indigenous animal genetic erosion.

Characterization information is essential to design livestock conservation, development and breeding programmes in management of Animal Genetic Resources (AnGR) at local, national, regional and global levels (FAO, 2012). Many efforts have begun to characterize animals in developing countries to provide a foundation for developing sustainable genetic improvement approaches. Chief among these efforts is the program by the Food and Agricultural Organization (FAO) of the United Nations to develop a Global Strategy for the Management of Farm Animal Genetic Resources or FAnGR (Gibson ***et al***., 2006).

In Sri Lanka, limited attention has been paid to the characterization and classification of indigenous non-descriptive chicken types, and research studies are at preliminary stage for the identification, description and evaluation of these genetic resources. A genetic characterization study of village chicken completed very recently revealed that Sri Lankan chicken is a very diverse and unique group of birds, which has close genetic relationship with Red Jungle Fowl (***Gallus gallus***) and Gray Jungle Fowl (***Gallus sonneratii***) (Silva ***et al***., 2008). It indicates that Sri Lankan indigenous chicken may have originated from either Red Jungle fowl or Gray Jungle Fowl and not from the Ceylon Jungle Fowl (***Gallus lafayettii)*** that is endemic to the country. Hence, the origin of the village chicken in Sri Lanka is yet not known.

There are several village chicken types already identified but not phenotypic ally characterized in detail. Among those are Naked neck, Giant, Deep brown, Orange tan, Black, Black with yellow silver, White, Light brown and White brown varieties (see The baseline survey report on the status, trends and utilization of FAnGR available at http://fangrsl.org). In any conservation effort a proper evaluation of the existing species/breeds/lines and the trends in population dynamics are the key information that decides the success and the appropriateness of the effort (Silva ***et al***., 2010).

Therefore, objective of the present study was to identify, characterize and describe the phenotypic variation of village chicken populations found in North Central and North Western provinces following standard FAO guidelines. Lastly, it was also aimed at developing a prediction formula for determining body weight of birds based on linear morphometric measurements.

METHODOLOGY

A total of six villages, rich in phenotypic diversity of village chicken, were selected from Anuradhapura (North Central province site) and Puttalam (North Western province site) districts following baseline studies done on village chicken population distribution countrywide as a part a multi-country project (www.fangrasia.org, GEF-UNEP-ILRI-FAnGR Asia project). Forty households per village that practice village chicken rearing were selected representing all available local ecotypes, by using stratified random sampling technique to record morphological characters and linear measurements. All the birds above 6 months old were sampled and altogether 820 birds were measured and recorded along with the

household code and GPS position. A full inventory of the birds according to the age class and the ecotype according to the local description were also recorded following FAO guidelines on genetic characterization of animals (FAO, 2012). The wing bands with reference numbers were applied for all the birds sampled for future reference.

Qualitative and quantitative traits

Visual observations of the general features of the birds such as feather patterns, body morphology and specific traits such as naked- neck, frizzled feather and crested head were recorded as qualitative (categorical) traits (Table 1) according to the FAO (2012) guidelines. In addition body condition score was also measured according to Assan (2013). Quantitative traits (FAO, 2012) are generally the dimensions of different body parts and live weight which are directly related to production parameters. Those traits vary with the age of the animal and the production environment. Therefore, measurements were taken only from birds of ages 6 months or above. These birds were kept in similar management conditions. Grouping of the birds into breed/type categories was performed based on farmer perceptions and, distinct phenotypic differences between and similarities within the groups. Nomenclature of the breed/type categories was partly based on the popular usage of particular name by the farmers of the study sites.

Table 1. Morphological traits recorded in village chicken

Type of trait	Morphological features
Qualitative traits	Comb type, colour/ colours of plumage , shank and foot, skin, eye, comb, earlobe, presence of feathers in neck and foot, body condition score
Quantitative traits	Chest circumference, wing length, back length, shank length and shank circumference, breast width, keel length and pelvis width, body weight

Statistical Analysis

Chi-square analysis was performed to find out the differences in frequency distributions among various categories such as sexes, study sites, and phenotypic groups with respect to each qualitative trait using PROC FREQ procedure in SAS software. Analysis of variance procedure was carried out using PROC GLM in SAS software based on the following statistical model:

$$\mathbf{Y_{ijlk} = \mu + Lc_i + gp_j + sx_k + Lc_i*gp_j + Lc_i*sx_k + gp_j*sx_k + Lc_i*gp_j*sx_k + error_{ijkl}}$$

where,

Y_{ijlk} = live weight of k^{th} bird in i^{th} site, j^{th} group and k^{th} sex;
μ = overall mean;
Lc_i = effect of i^{th} study site (1= Tirappane, 2= Karuwalagaswewa);
gp_j = effect of j^{th} phenotypic group (j= 1,2, …, 7);
sx_k = effect of k^{th} sex of bird (1=male and 2=female);
$error_{ijkl}$ = residual effect.

Relevant means were compared using Duncan's New Multiple Range (DNMRT) test. Prediction formulas for body weight based on linear morphometric traits were derived by linear regression analysis using PROC REG procedure in SAS software.

RESULTS AND DISCUSSION

Phenotypic diversity

According to the morphological and morphometric characteristics recorded from 820 birds, seven clearly different phenotypic categories of chicken could be identified. The first group was the Naked Neck chicken (NNC) which could be easily distinguishable among other birds due to lack of presence of feathers in their neck area (Fig. 1). The second group called Long Legged Chicken (LLC) carried disproportionately long legs compared to the rest of their regular size body (Fig. 2). Crest or Crown Chicken (CC) exhibited a crest or crown shaped feather arrangement on their heads (Fig. 3). Some farmers carried birds that belonged to Giri raj chicken (GRC) which was a village chicken based improved breed developed in India specifically for better performance under tropical extensive rearing conditions (Fig. 4). A group called commercial crosses (ComC) represented the crossbreds of improved commercial birds and village chicken (Fig. 5). Another pure village chicken group (Fig. 6) exhibited easily distinguishable frizzle feathers (a feather related gene mutation), hence called Frizzle Feathered Chicken (FFC). Lastly all other pure village chicken that had no peculiar feature were classified into Normal Village Chicken (NVC) which included a variety of common plumage colours occurring due to segregation of alleles from random mating among birds of different plumage patterns (Fig. 7).

Fig. 1. Naked neck chicken

Fig. 2. Long legged chicken

Fig. 3. Crown chicken

Fig. 4. Giri raj chicken

Fig. 5. Commercial cross

Fig. 6. Frizzle feathered

Fig. 7. Normal village chicken

Table 2 presents the population details of the identified phenotypic categories of village chicken in the two sampling sites. Majority (~69%) of village chicken belonged to the broad phenotypic group of NVC as it included multiple crosses of birds carrying a variety of feather pattern and body morphology. The next most abundant category (17.9%) was Naked Neck Chicken. All the other phenotypic categories represented only 13.3% of the population.

Table 2. Village chicken population description in two study sites

Phenotypic group	Breed code	No. of birds	% of birds	Site 1*	Site 2*	No. of males	No. of Females	Male : Female
Normal Village chicken	NVC	564	68.78	69.88	67.94	94	470	1:5
Naked neck chicken	NNC	147	17.92	15.90	19.44	29	118	1:4.1
Long leg chicken	LLC	58	7.07	3.69	9.61	35	23	1:0.7
Crest/crown chicken	CC	9	1.09	2.55	-	2	7	1:3.5
Giri raj chicken	GRC	6	0.73	1.70	-	2	4	1:2
Commercial cross	ComC	30	3.65	5.11	2.56	3	27	1:9
Frizzle feather chicken	FFC	6	0.73	1.13	0.04	2	4	1:2
Total		820	100	100	100	167	653	1:3.9

[§]Frequency distributions of phenotypic groups between sites and between sexes were significantly different according to Chi square analysis ($P<0.05$).

*Site 1: Thirappane (Anuradhapura district), Site 2: Karuwalagaswewa (Puttalam district).

Horst (1989) has indicated that indigenous chicks have the most important traits that are genetically conserved for their special utility in tropical environment, one of which being the naked neck character. The feather restriction NNC carries is considered to be a favourable character for tropics (Duguma, 2006) and the NNC phenotypic group found in the current study seems to be rapidly expanding in the area since their phenotype is favoured by the tropical environment. In addition, the reduction of plumage cover considerably reduces the need for dietary nutrition to supply protein input for feather production (Duguma, 2006).

Male to female ratio of the total population was approximately 1:4 (Table 2) which is high compared to the required ratio for breeding. Reason for the majority of birds (79.6%) being females was that the main purpose of keeping backyard poultry is egg production for home consumption and also for selling. However, more males were observed in LLC as those were kept primarily for cock fighting.

Qualitative trait distribution in locations

Between the two sites considered in the study, site 1 was more diverse and represented by all seven phenotypic categories of birds. However, some of the categories, i.e. CC, GRC, and FFC, were rare in both sites. A variety of comb types, and colour variations in body parts could be seen in the two sites studied (Table 3). According to Chi-square analysis, the frequency distributions between sites were significantly different with respect to all qualitative traits ($P<0.05$). The most frequent characteristics in both sites were red single combs, black plumages, yellow colour shanks, pink skins, orange and black eyes, red earlobes, and non descript plumage patterns.

Table 3. Qualitative variation among sexes and locations of village chicken

Qualitative trait (%)	Percentage of birds				
	All birds (n= 820)	Male (n=167)	Female (n=653)	Site 1 (n=352)	Site 2 (n= 468)
Comb type					
Single	62.7	53.3	65.1	67.3	59.7
Pea	14.0	13.2	14.2	13.9	14.1
Rose	11.7	13.2	11.3	10.8	12.4
Cushion	5.6	7.8	5.1	3.7	8.8
Strawberry	3.4	6.0	2.8	2.0	4.5
Buttercup	1.6	5.4	0.0	2.3	1.7
Plumage colour					
Black	21.8	8.4	25.3	20.5	22.9
Brown + black	16.5	9.6	18.2	16.8	16.2
Brown + white	15.7	4.8	18.5	16.5	15.2
Multi colour	12.2	51.5	2.1	10.2	13.7
Brown	8.5	0.00	10.7	9.1	8.1
Gray/ash	8.4	3.0	9.8	9.9	7.3
Golden mix	5.9	15.6	3.4	5.4	6.2
White	6.3	5.4	6.6	8.5	4.7
White + black	4.5	1.8	5.2	2.8	5.8
Shank and foot colour					
Yellow	51.0	62.3	48.1	67.9	42.5
Black	11.3	7.2	12.4	19.0	6.2
Gray/ash	8.8	3.0	10.3	2.0	14.1
Pink	9.8	16.2	10.6	9.7	17.5
Greenish mix	7.0	3.6	7.8	0.1	13.7
Skin colour					
Pink	77.1	64.1	80.4	58.2	91.2
Yellow	12.0	22.2	9.3	20.5	9.4
White	7.7	10.8	6.9	21.3	1.9
Eye colour					
Orange + black	41.7	54.5	38.4	24.1	54.7
Yellow + black	35.0	29.3	36.6	35.7	34.2
Brown + black	9.3	4.8	10.4	12.0	7.7
Comb colour					
Red	86.2	92.2	84.2	98.86	79.3

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White + red	4.4	2.4	4.9	-	9.4
Pink	3.3	1.8	3.7	0.02	8.8
Earlobe colour					
Red	61.7	70.7	59.1	86.1	43.4
White + red	17.3	16.8	17.5	2.6	35.9
White	5.7	1.8	6.7	10.6	5.1
Red + yellow	4.4	5.4	4.1	0.1	8.5
Plumage type and colour pattern	72.4	86.2	68.2	77.5	68.6
Non-descript	18.7	0.6	23.2	16.2	20.5
Muffed/ beared	8.2	11.9	7.1	5.1	10.5
Mottled	0.7	1.1	0.6	1.1	0.1
Frizzled					
Body condition score					
1	26.8	15.5	29.7	33.8	21.6
2	68.1	68.8	67.9	59.7	74.6
3	4.9	15.5	2.20	6.5	4.8

[§]Every qualitative trait is significantly associated with sex of bird and location according to Chi square analysis ($p<0.05$).

Comb type

Single comb was the highest occurring comb type among phenotypic groups except for LLC which commonly carried pea and rose comb types as well (Table 4). Strawberry and butter cup combs were absent in CC and ComC groups. Given the small number of samples available in other phenotypic categories, the real level of variation of comb type was hard to be speculated. The results on the trends of distribution of single comb were quite similar to the findings of Egahi ***et al.*** (2010) in Markudi, Nigeria but different from those reported by Dana ***et al.*** (2011). The dissimilarity in the occurrences of comb types may be attributed to differences in frequencies of alleles responsible for the comb types and interactions of different genes responsible for its expression. Banarjee (2012) and Cabarles ***et al.*** (2012) showed that single comb is the most common comb type in tropical regions such as India and Philippines regions. This could be because of the fact that the presence of single comb helps to reduce 40% of body heat, hence advantages in tropical conditions (Duguma, 2006). Red was the only comb colour present in CC, GRC, ComC and males of FF (Table 4). As the intensity of the red colouration is an indication of the quality of sperm in the case of male birds (Navara ***et al.***, 2012), this study shows good fertility indicative characteristics in the birds investigated.

Plumage characteristics

According to Table 4, majority of the NVC, NNC and LLC males (47.8%, 51.7%, 65.7%, respectively) had multiple colours in their plumage. In the case of female birds, brown plumage followed by black, gray/ash, multiple, white, and white with black colouration was observed for all phenotypic categories. About 72.4% of the whole chicken population exhibited a complex mixture of colours without a standard pattern classified as non-descript. This could be due to non discriminate random mating occurs in those populations. Presence of frizzled feather type in NNC males could be due to the cross between the birds carrying naked neck allele and those with frizzle feathers allele, as necked neck and frizzle characters are controlled by two separate single genes. Varying plumage colour is a form of adaptation to the living environment such as camouflage against predators as well as strategy for

breeding. In order to understand those traits which carry signals in adaptive context, it is important to determine how each character is interpreted and utilized by birds for their survival in their respective environments.

Skin and shank

Yellow is the most common shank colour across all the groups and both sexes (Table 4). Similar studies done elsewhere have also reported that there was a predominant occurrence of yellow colour shank among indigenous birds (Cabarles *et al.*, 2012). Characteristically ComC males had only pink skins (showing dominance of pink in the cross) while no pink colour was observed in GRC. Duguma (2006) reported that white and red colouration of the skin dominates in the indigenous chicken ecotypes in Ethiopia. This might have some implication on the origin of different phenotypic groups as the literature show that the yellow skin colour was inherited from Grey jungle fowl (*G. sonneratii*) and Ceylon jungle fowl (*G. lafayettii*) which hybridized with Red jungle fowl (*G. gallus*) (Cabarles *et al*., 2012).

Earlobe colour

The colour of the earlobe was red in majority of birds except for ComC males where white was the most frequent (Table 4). The fact that most commercial layers originated from Mediterranean class bear white ear lobes could be the reason for ComC to exhibit a higher frequency of white earlobes. Cabarles *et al.* (2012) reported the presence of red (37.53%), white with red (57.41%) and white (1.85%) earlobes in indigenous chicken in Philippines. According to Duguma (2006), 67% of Ethiopian chicken had white earlobes while 17.9% and 18.6% had white with red, and red earlobes, respectively. A similar trend was observed by Faruque *et al.* (2010) for Bangladesh village chicken. The differences of earlobe colours are a result of adaptability of chickens for local conditions (Cabarles *et al*., 2012). Accordingly, the Sri Lankan chicken has probably been differently adapted to other village chicken populations reported in above studies. Body condition score values (Table 4) showed that very few birds were in excellent form, many being average or below, indicating the insufficient feeding and management conditions commonly prevailing in the sites.

Table 4. Qualitative trait variation among phenotypic groups of village chicken

Qualitative trait (%)	NVC (n=564)		NNC (n=147)		LLC (n=58)		CC (n=9)		GRC (n=6)		ComC (n=30)		FFC (n=6)	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Comb type														
-Single	60.6	64.0	55.1	70.3	28.5	26.0	100	71.4	-	100	100	85.1	100	75.0
- Pea	6.3	12.9	24.1	17.7	28.5	30.4	-	14.2	-	-	-	11.1	-	-
- rose	18.8	13.4	-	3.3	11.4	26.0	-	-	50.0	-	-	3.7	-	-
- cushion	5.3	6.1	10.3	2.5	14.3	17.3	-	14.2	-	-	-	-	-	-
- strawberry	4.2	-	3.4	2.5	14.3	-	-	-	-	-	-	-	-	25.0
- buttercup	5.3	0.2	6.8	2.5	2.8	-	-	-	50.0	-	-	-	-	-
Plumage														
colour	11.7	26.6	10.3	30.5	-	4.3	-	14.2	-	-	-	-	-	50.0
- Black	5.3	19.1	13.7	17.7	17.1	21.7	-	14.2	-	-	-	3.7	50.0	20.0
- Brown +	4.2	18.7	6.8	16.1	2.8	4.3	-	28.5	-	-	33.3	40.7	-	-
black	47.8	1.2	51.7	1.6	65.7	26.1	50.0	-	50	-	-	-	50.0	-
- Brown +	-	7.6	-	14.4	-	4.3	-	14.2	-	25	-	51.8	-	-
white	1.1	10.0	10.3	10.1	-	8.6	-	-	50	75	-	-	-	-
- Multi	22.3	3.6	-	-	11.4	17.3	50.0	-	-	-	-	-	-	25.0
colour	5.3	7.0	3.4	5.9	2.8	4.3	-	28.5	-	-	66.6	-	-	-
- Brown	2.1	5.7	3.4	3.3	-	8.6	-	-	-	-	-	3.7	-	-
- Gray/ash														
- Golden														
mix														

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- White														
- White + black														
Shank/ foot colour	57.4	44.4	620	50.8	1.4	65.2	100	71.4	100	100	100	70.3	-	50.0
- Yellow	10.6	12.3	-	14.4	-	4.3	-	14.2	-	-	-	11.1	100	25.0
- Black	5.3	10.6	6.8	14.4	-	-	-	14.2	-	-	-	-	-	-
- Gray/ash	19.1	17.0	24.1	9.3	11.4	13.0	-	-	-	-	-	18.5	-	-
- Pink	4.2	8.5	10.3	7.6	8.5	8.6	-	-	-	-	-	-	-	25.0
- Greenish mix														
Skin colour														
- Pink	65.9	79.5	58.6	86.4	62.8	86.9	100	57.1	-	-	100	85.1	50.0	50.0
- Yellow	21.2	8.7	24.1	11.8	22.8	13.0	-	14.2	50.0	50.0	-	7.4	50.0	25.0
- White	12.7	7.8	6.8	1.6	8.5	-	-	14.2	50.0	50.0	-	7.4	-	25.0
Eye colour														
- orange + black	59.5	38.1	48.2	42.3	45.7	21.7	100	14.1	-	25.0	100	55.5	-	50.0
- yellow + black	28.7	36.0	24.1	36.4	37.1	56.5	-	57.1	100	75.0	-	22.2	-	25.0
- brown + black	6.3	11.2	8.4	10.1	6.2	8.6	-	14.1	-	-	-	14.8	100	25.0
Comb colour														
- red	97.8	84.1	86.2	87.2	80.0	60.8	100	100	100	100	100	100	100	75.0
- white + red	2.1	5.1	3.4	4.2	17.1	26.0	-	-	-	-	-	-	-	-
- pink	-	4.6	3.4	3.3	2.8	-	-	-	-	-	-	-	-	25.0
Earlobe colour	71.2	59.5	79.3	50.0	60.0	43.4	100	85.7	100	100	33.3	92.5	100	100
- red	22.3	15.9	13.7	26.2	11.4	30.4	-	-	-	-	-	3.7	-	-
- white + red	3.19	8.2	-	3.3	2.8	-	-	-	-	-	66.6	3.7	-	-
- white	3.19	7.8	6.8	10.1	25.7	21.7	-	14.2	-	-	-	-	-	-
- red + yellow														
Plumage pattern	87.2	66.5	82.7	67.7	88.5	8.2	100	100	100	100	100	100	-	-
- non descript	1.1	25.3	-	25.4	-	13.0	-	-	-	-	-	-	-	-
- muffed/ barred	11.7	8.1	-	6.7	11.4	4.3	-	-	-	-	-	-	-	-
- mottled	-	-	17.2	-	-	-	-	-	-	-	-	-	100	100
- frizzled														
Body cond. score	14.8	31.0	6.8	23.7	17.1	34.7	50.0	42.8	-	-	3.3	2.9	50.0	50.0
- 1	68.1	66.5	86.2	76.2	65.7	60.87	-	42.8	50.0	50.0	33.3	74.0	50.0	50.0
- 2	17.0	2.3	6.8	-	17.1	4.3	50.0	14.2	50.0	50.0	33.3	-	-	-
- 3														

[§]Distributions of qualitative trait among groups are significantly different according to Chi square analysis ($p<0.05$).

Morphometric characteristics

The morphometric information (Table 5) for a particular species or breed is important for breed or species identification and economic valuation in its utilization. The traits that show less variability within breeds/types indicate homogeneity and identity of those categories. However, traits showing wider variation could be used for prediction purposes such as live weight prediction (Assan, 2013).

Table 5. Quantitative variation among phenotypic groups of village chicken

Breed		Means of linear measurements[§] (mm)								
		Body circ.	Wing length	Back lengh	Breast width	Keel lengh	Pelvis width	Shank length	Shank circ.	Weight (g)
NVC (n= 564)	M	349 ^{bc}	166 ^{bc}	302 ^{ab}	85 ^{bc}	116 ^{a}	10 ^{cd}	150 ^{ab}	76 ^{bcd}	1759 ^{bcde}
	F	309 ^{cd}	148 ^{cd}	266 ^{bc}	76 ^{cd}	100 ^{b}	21 ^{bc}	127 ^{c}	65 ^{d}	1299 ^{ef}
NNC (n= 147)	M	345 ^{bc}	167 ^{bc}	283 ^{abc}	81 ^{abcd}	112 ^{ab}	12 ^{cd}	153 ^{ab}	79 ^{abcd}	1672 ^{cde}
	F	300 ^{cd}	149 ^{cd}	253 ^{c}	76 ^{cd}	99 ^{b}	20 ^{bc}	129 ^{c}	66 ^{d}	1272 ^{ef}
LLC (n= 58)	M	350 ^{bc}	168 ^{bc}	294 ^{abc}	83 ^{abcd}	118 ^{a}	8 ^{d}	155 ^{ab}	84 ^{abc}	1851 ^{bcd}
	F	308 ^{cd}	156 ^{bc}	272 ^{bc}	76 ^{cd}	104 ^{ab}	14 ^{bcd}	140 ^{bc}	71 ^{cd}	1430 ^{def}
CC (n= 9)	M	350 ^{bc}	178 ^{b}	278 ^{bc}	78 ^{bcd}	103 ^{ab}	10 ^{cd}	143 ^{abc}	77 ^{abcd}	1720 ^{cde}
	F	315 ^{cd}	1456 ^{cd}	268 ^{bc}	79 ^{abcd}	98 ^{b}	19 ^{bcd}	133 ^{c}	63 ^{d}	1321 ^{def}
GRC (n= 6)	M	434 ^{a}	205 ^{a}	323 ^{a}	92 ^{a}	118 ^{a}	20 ^{bcd}	155 ^{ab}	89 ^{ab}	2645 ^{a}
	F	380 ^{b}	165 ^{bc}	288 ^{abc}	91 ^{ab}	117 ^{a}	33 ^{a}	151 ^{ab}	74 ^{bcd}	2255 ^{ab}
ComC (n= 30)	M	395 ^{ab}	181 ^{ab}	289 ^{abc}	89 ^{abc}	117 ^{a}	10 ^{cd}	157 ^{a}	93 ^{a}	2177 ^{abc}
	F	324 ^{cd}	156 ^{bcd}	264 ^{bc}	77 ^{bcd}	104 ^{ab}	24 ^{ab}	129 ^{c}	65 ^{d}	1489 ^{def}
FFC (n= 6)	M	308 ^{cd}	183 ^{ab}	300 ^{ab}	76 ^{cd}	104 ^{ab}	9 ^{cd}	143 ^{abc}	62 ^{d}	1575 ^{def}
	F	292 ^{d}	131 ^{d}	267 ^{bc}	69 ^{d}	98 ^{b}	17 ^{bcd}	127 ^{c}	67 ^{d}	1102 ^{f}

[§]Means not sharing a common superscript are significantly different (P<0.05).

Chest circumference and wing length, generally having less variability in poultry are used to characterize different phenotypic groups (Momoh and Kershima, 2008). The present study showed males always have a larger values for body circumference, wing length and breast width than females in all the chicken types, though the differences were not statistically significant (p>0.05) due to large variation within groups and fewer observations in certain groups (Table 5). As GRC were specifically bred to produce large market weights, they showed the largest mean values for chest circumference, wing length, back length and breast width in each sex group. Frizzled feathered group showed the lowest mean body circumference values for both males and females.

Though not significantly different (p>0.05), NVC, NNC and LLC showed comparatively shorter wings. More observations and less variation (if conducted under controlled environments) would have depicted more significant differences among the phenotypic categories. Mean female breast width was significantly smaller (P<0.05) than that of males in all phenotypic categories except for GRC.

Exhibiting the potential for egg production, GRC recorded the highest pelvis width for females. Male birds carried smaller pelvis width than females in all phenotypic categories but the difference was significant only in GRC group. Among the native phenotypic groups, LLC reported the longest shanks, keels and shank circumference values though the differences were not significant (p>0.05). However, the GRC and ComC birds which are having exotic genes also showed similarly long shanks.

Body weight

Because of its strong correlation with meat yield, body weight is used as a proxy indicator of production (FAO, 2012). The highest mean weight for male was recorded by GRC (2645 g) and it was significantly higher than others except for ComC ($P<0.05$). This shows the superiority of the exotic breed (GRC) over the unimproved village chicken. Mean weight of the most common chicken type (NVC) was 1759 g in males and 1299 g in females (Table 5). Momoh and Kershima (2008) also reported that males were significantly heavier than females in Nigerian village chicken. Given the fact that the GRC was developed based on village chicken in India, the large difference between GRC and NVC shows the potential to genetically improve NVC through a planned directional selection programme. FFC showed the minimum mean weight for both males (1575 g) and females (1102 g).

Live weight prediction

Practical difficulties to measure live weight at field level have led scientists to develop prediction models to estimate live weight using linear body measurements (Assan, 2013; Ige *et al*., 2006 & Momoh and Kershima, 2008). When all breed groups were combined (overall), every linear parameter had a significantly positive ($p<0.05$) association with body weight (detailed results were published elsewhere). Among them the following formula was found to be the best predictor of body weight with coefficient of determination value of 65 percent:

Predicted body weight = -1690.4 + 5.53*Chest circ. + 10.11*Shank length

These results are in agreement with those of Ige *et al*. (2006) and Momoh and Kershima (2008) that showed higher muscle deposition in breast and thigh create a strong relationship between chest circumference or shank length with live weight.

CONCLUSIONS

The present study describes seven different phenotypic categories of chicken found in the two study sites using the distinctly predominant morphological characters presence in each category. These phenotypic categories carried multiple variants of nine different morphological traits considered where some of the traits reflect the adaptive fitness of birds under backyard scavenging type environments. The attributes important in breeding for backyard farming in tropical conditions were identified. The morphometric parameters of different phenotypic categories suggested that the predominant categories such as normal village chicken and naked neck exhibit the linear body measurements related to medium level of production performances. The phenotypic categories which are exotic or crosses of exotic genotypes showed the linear body measurements related to comparatively high level of production performances. Body circumference was identified as a suitable predictor trait of live weight.

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REFERENCES

Assan, N. (2013). Bio prediction of body weight and carcass parameters from morphometric measurements in livestock and poultry. Scientific J. of Review, *2(6),* 140 - 150.

Banarjee, S. (2012). Morphological characterization of indigenous chicken of Sikkim and West Bengal, India. Animal Genetic Resources, FAO., *51,* 57-71.

Cabarles, Jr., J.C., Lambio, A.L., Vega, S.A., Captain, S.S. and Mendioro, M.S. (2012). Distinct morphological features of traditional chickens (*Gallus gallusdomesticus*L.) in Western Visyas, Philippines. Animal Genetic Resources, FAO., *51,* 73 - 87.

Dana, N., Dessie, T., van der Waaj, L.H. and van Arendonk, J.A.M. (2011). Morphological features of indigenous chicken population of Ethiopia. Animal Genetic Resources, FAO., *46,* 11 - 23.

Duguma, R. (2006). Phenotypic characterization of some indigenous chicken ecotypes of Ethiopia. Livestock Research and Rural Development.18(9) [on line]. [Accessed on 25.05.2014]. Available at http://www.Irrd.org/Irrd18/9/dugu18131.htm

Egahi, J.O., Dim, N.L., Momoh, O.M. and Gwasa, D.S. (2010).Variations in qualitative traits in the Nigerian local chicken. J. Poul. Sci., *9(10),* 978 - 979.

FAO (2012). Phenotypic characterization of animal genetic resources. FAO Animal Production and Health Guidelines No.11. Rome. [on line]. [Accessed on 25.05.2014]. Available athttp://www.fao.org/docrep/015/i2686e/i2686e00.pdf

Faruque, S., Siddiquee, N.U., Afroz, M.A. and Islam, M.S. (2010). Phenotypic characterization of native chicken reared under intensive management system. J. Bangladesh Agri. Univ., *8(1),* 79 - 82.

Gibson J., Gamage, S., Hanotte, O., Iniguez L., Maillard, J.C., Rischkowsky, B., Semambo, D. and Toll, J. (2006). Option and strategies for the conservation of farm animal genetic resources: CGIAR System-wide Genetic Resources Programme (SGRO)[on line]. [Accessed on 22.08.2012].Available at http://www.fao.org/ag/cgrfa/AnGR.htm

Horst, P. (1989). Native fowls as reservoir for genomes and major genes with direct and indirect effect on the adaptability and their potential for tropically oriented breeding plans. Arch. Geflugel., *53(3),* 93 - 101.

Ige, A.O., Akinlade, J.A., Ojedapo, L.O., Oladunjoye, I.O., Amao, S.R. and Animashaun, A.O. (2006). Effect of sex on interrelationship between body weight and linear body measurements of commercial broilers in a derived savannah environment of Nigeria.Proc.

11th Annual Conf. of the Anim. Sci. Ass. of Nigeria. 18- 21 Sept 2006, Ibadan, Oyo State,Nigeria., pp. 231-3.

Momoh, O.M. andKershima, D, E. (2008). Linear body measurements as predictors of body weight in Nigerian local chickens. ASSET Series A, *8(2),* 206 - 212.

Navara, K.J., Anderson, E.M. and Edwards, M.L. (2012). Comb size and colour relate to sperm quality: a test of the phenotype-linked fertility hypothesis. J. Behavioural Ecology, *23(5),* 1036 - 1041.

Ramlah, A.H. (1999). Production aspects of village chicken in the South-East Asian region. First INFPD/FAO Electronic Conference on Family Poultry (1999) [on line]. [Accessed on 20.08.2012].Available at http://www.fao.org/ag/againfo/subjects/en/infpd/documents/econf_scope/paper5.html.

Silva, P.,Guan, X., Ho-shing, O., Jones, J., Xu, J., Hui, D., Notter, D. and Smith, E. (2008). Mitochondrial DNA-based analysis of genetic variation and relatedness among Sri Lankan indigenous chickens and the Ceylon Jungle Fowl (*Gallus lafayetti*). Animal Genetics., *40(1),* 1 - 9.

Silva, P., Dematawewa, M. and Chandrasiri, N.(2010). Farm animal genetic resources. pp. 1-46. In: Silva, P. (Ed) Indigenous Animal Genetic Resources in Sri Lanka – Status, Potential and Opportunities. UNEP-GEF-ILRI FAnGR Asia Project Publication. Sri Lanka.

Wijayasena, A.M.P.S.S., De Alwis, D.J., Silva, G.L.L.P. and Abeykoon, M.N.D.F. (2014). Cost benefit analysis of village chicken production in Puttalam district of Sri Lanka: a case study. Proc. Peradeniya University International Research Sessions, Peradeniya, Sri Lanka, July 4-5, 2014., p 224.