

*Full Length Research Paper*

# Phenotypic characterization (qualitative traits) of various strains of indigenous Tswana chickens in Kweneng and Southern districts of Botswana

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Received 11 October, 2020; Accepted 27 January, 2021

The aim of this study was to identify and describe qualitative traits of indigenous Tswana chicken populations in Kweneng and Southern districts of Botswana. The qualitative traits involved in the study included tail colour, breast colour, back colour, neck colour, comb type, shank colour, earlobe colour and head shape. Data were subjected to frequency and cross tabulation procedures of descriptive statistics in Statistical Package for Social Sciences (SPSS) to compute frequencies of occurrence of each qualitative trait. The five strains of indigenous Tswana chickens under scavenging management system showed distinct physical variations for most of the qualitative traits. Black was the most predominant tail colour across the strains (51.6%) followed by brown (27.9%). The frequency of brown breast colour and brown back colour were significantly higher in those respective regions. Brown and black were the predominant neck colours across the strains. The single comb type (81.7%), featherless shank (65.4%), red ear lobes (67.6%) and grey shank colour (32.9%) were the most predominant phenotypes across the strains. Plain and crested head shapes occurred at similar frequencies of 56.4 and 43.6%, respectively, in Tswana chickens in Southern part of Botswana.

**Key words:** Botswana, morphological characterization, phenotypic variation, qualitative traits, Tswana chickens.

## INTRODUCTION

In Africa, rural households have kept indigenous chickens for many years on free running or scavenging management (Ndidde et al., 2014). Indigenous chickens

of Botswana are known as Tswana chickens and are the most widely spread domestic animal, which almost every rural family owns.

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Indigenous Tswana chicken contributes enormously to supply of meat and eggs to the rural communities of Botswana (Badubi et al., 2006). According to Badubi et al. (2006) on average, households keep flocks of between 5 and 30 chickens of mixed ages and sex with very few households keeping over 50 chickens.

Indigenous chickens have different morphological identities, carrying genes which have adaptive values to their environment and local diseases (Aklilu et al., 2013). Local chicken populations are often described and grouped according to geographical location or phenotypic characteristics, while their classification into breeds or types is limited (Manyelo et al., 2020). They also exhibit great variation in performance in various qualitative and quantitative traits of economic importance (Faruque et al., 2010). Indigenous Tswana chicken exhibits numerous observable attributes including plumage, shank and earlobe colour, comb type, head shape and other qualitative traits. The possible existence of several genetically distinct subpopulations within a large population has called for the need to identify and define the subpopulations in order to determine genes which might be in danger of becoming extinct and therefore need conservation (Guni and Katule, 2013).

However, genetic resources identification and phenotypic characterization of different strains of Tswana chickens have not been done. Therefore, the objective of this study was to identify and describe the phenotypic variations (qualitative traits) of Tswana chicken populations in Southern and Kweneng districts of Botswana.

## MATERIALS AND METHODS

### Location of study area

The study was carried out in Kweneng and Southern districts of Botswana from January to June 2014. Six remote villages were selected from each district (Figure 1) and within a district; villages were selected such that there was uniformity in the chicken production system. Large villages and villages near towns were avoided due to their high populations of exotic chicken breeds and to minimize the influence of urban-affiliated farming systems on typical rural village-based traditional free running system (Desta et al., 2013). A total of 98 households within each district comprising six villages each, rearing only indigenous Tswana chicken participated in the study. Households with exotic chickens or with a history of keeping exotic chicken breeds and those near such households did not participate in the study to ascertain the genetic purity of indigenous Tswana chicken participating in the study. This, however, limited the number of households and the total number of chickens of various strains that participated in the study.

### Data collection

A total of 618 indigenous Tswana chickens, comprising 246 normal-feathered (54 males and 192 females), 123 naked-neck (18 males and 105 females), 129 dwarf (45 males and 84 females), 57 rumpless (27 males and 30 females) and 63 frizzled (18 males and 45 females) chickens, kept under traditional free running management system were used in the study (Figures 2 to 6). There

were generally more females than males of various strains of Tswana chicken per household as a result of the inherent breeding system; hence more females than males participated in the study. Some households selected against naked-neck, dwarf, rumpless and frizzled chickens, which results in low frequency of such strains in the general Tswana chicken population, hence their lower sample size compared to the normal-feathered strain. Rumpless and frizzled strains did not exist at all in some selected villages. The chickens used were approximately six months of age or older as per the information provided by the owners. Qualitative morphological traits such as plumage colour, shank colour, comb type, earlobe colour, spur colour and head shape were obtained by visual observation following FAO recommended descriptors for chicken genetic resources (FAO, 2011).

### Statistical analysis

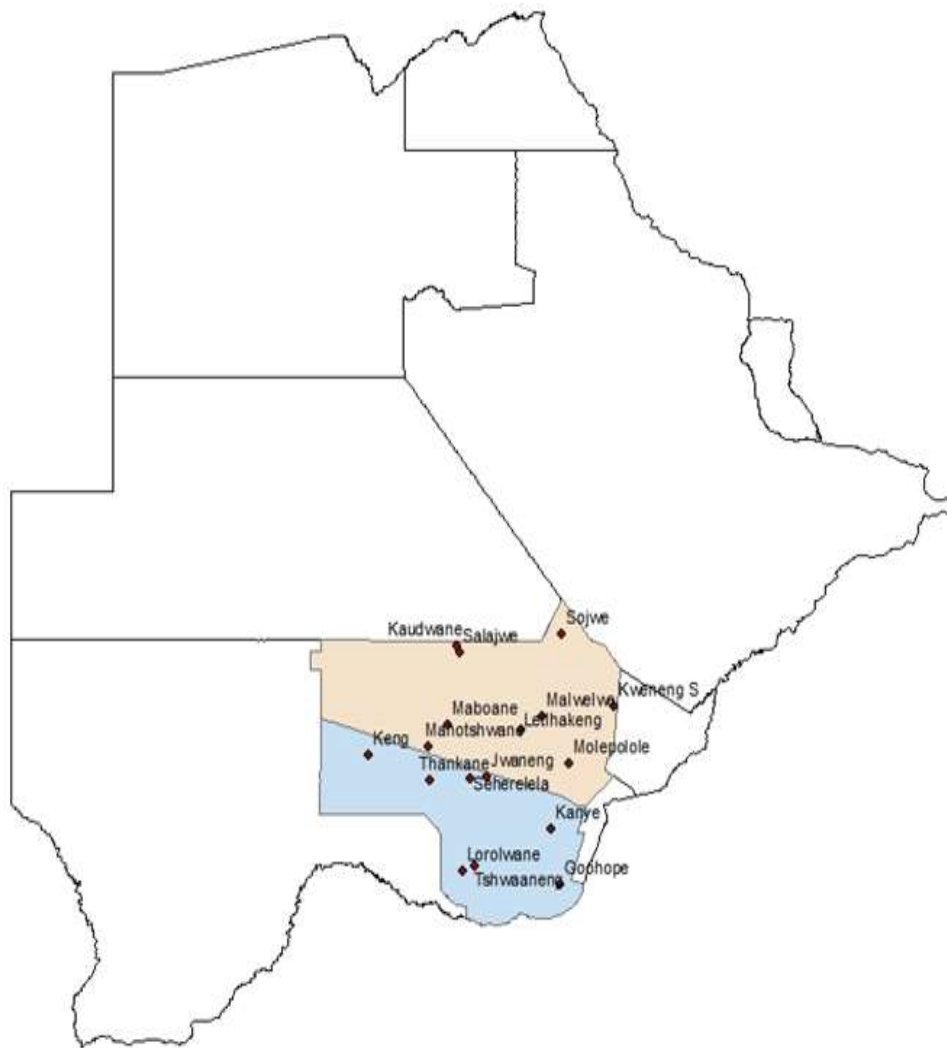
The qualitative variables were analyzed using descriptive statistics and compared as percentages using the Statistical Package for Social Science (SPSS, 2013; version 22.0). T-test analysis was carried out to find out the differences in frequency distributions among different phenotypic classes with respect to each qualitative trait using SAS (2012).

## RESULTS AND DISCUSSION

### Phenotypic diversity

The morphology of Tswana chickens indicated five clear phenotypic groups: Normal (Figure 2), Naked-Neck (Figure 3), Dwarf (Figure 4), Frizzled (Figure 5) and Rumpless (Figure 6). Normal strain does not have any special feature, but it is characterized by different plumage colours occurring as a result of separation of alleles from random mating between birds of variable colour patterns (Liyanage et al., 2015) (Figure 2). The Naked-Neck strain is easily identifiable among other strains of Tswana chickens because of absence of feathers in their neck region. The Dwarf strain is easily distinguishable from other strains by their short legs. The Dwarf strain is also known as creeper fowl in some areas because the shorter shank length contributes to the shorter legs (Banarjee, 2012). Machete et al. (2017) reported shank length of 8.35 and 5.60 cm for female Normal and Dwarf strains of Tswana chicken, respectively. Frizzled strain of Tswana chicken is characterized by curled feathers throughout the body caused by feather related gene mutation (Liyanage et al., 2015). The Rumpless strain of Tswana chicken is characterized by the absence of tail feathers in both males and females. Of all the five strains of Tswana chicken the Normal strain was by far the most popular (39.81%), followed by Dwarf and Naked Neck at frequencies of 20.87 and 19.90%, respectively, in the study. Frizzled and Rumpless strains of Tswana chicken were the least popular at frequencies of 10.19 and 9.22%, respectively, in the Southern part of Botswana.

The variations in plumage colour in different regions of Tswana chicken body are shown in Table 1. The qualitative traits involved in the study included tail colour,



**Figure 1.** Map of Botswana showing Southern and Kweneng districts in blue and orange colours, respectively.

breast colour, back colour and neck colour. Black was the most predominant tail colour across the strains (51.6%) followed by brown (27.9%), grey (15.7%), white (2.8%) and lastly khakhi (2.0%). There were significant differences in the frequencies of black, brown and grey tail colours, while the white and khakhi tail colours occurred at similar and significantly lower frequencies than black, brown and grey tail colours. Brown and black were the most predominant breast colours across the strains at frequencies of 54.4 and 36.3%, respectively. The frequency of brown breast colour was significantly higher than that of black breast colour. White, grey and khakhi breast colours occurred at similar and significantly lower frequencies than brown and black breast colours. Brown and black were by far the most predominant back colours across the strains at frequencies of 56.7 and 29.6%, respectively. The frequency of brown back colour was significantly higher than that of black back colour.

White, grey and khakhi back colours occurred at similar and significantly lower frequencies than brown and black back colours. Brown and black were the predominant neck colours across the strains and there were no significant differences in their frequencies (49.0 vs. 36.7%). Plumage diversity, including the main phenotypes, was higher in both studied districts. Eskindir et al. (2013) stated that the plumage colour diversity is maintained as indications of random mating and many genes controlling the trait with respect to plumage colour. In the general population of Tswana chicken in the Southern part of Botswana, white and grey neck colour occurred at similar and significantly lower frequencies than brown and black neck colour.

The single comb type was by far the most frequent comb type across the strains (81.7%) and occurred at significant higher frequency than walnut (12.9%), pea (2.9%) and rose (2.5%) comb type (Table 2). Walnut, pea



**Figure 2.** Normal strain.



**Figure 3.** Naked-Neck strain.



**Figure 4.** Frizzled strain.





**Figure 5.** Dwarf strain.



**Figure 6.** Rumpless strain.

**Table 1.** Frequency (%) of plumage colour variations of Tswana chickens in the Southern part of Botswana.

Trait	Strain					Overall mean
	Normal	Naked Neck	Frizzled	Rumpless	Dwarf	
<b>Tail colour</b>						
Black	60.5	46.7	63.6	40	47.4	51.6 <sup>a</sup>
Brown	23.3	26.7	18.2	40	31.6	27.9 <sup>b</sup>
Grey	11.6	26.7	9.1	10	21.1	15.7 <sup>c</sup>
White	4.7	0	9.1	0	0	2.8 <sup>d</sup>
Khakhi	0	0	0	10	0	2.0 <sup>d</sup>
<b>Breast colour</b>						
Brown	44.2	53.3	36.4	80	57.9	54.4 <sup>a</sup>
Black	41.9	33.3	54.5	20	31.6	36.3 <sup>b</sup>
Grey	7.0	13.3	0	0	5.3	5.1 <sup>c</sup>
White	4.7	0	9.1	0	0	2.8 <sup>c</sup>
Khakhi	2.3	0	0	0	5.3	1.5 <sup>c</sup>
<b>Back colour</b>						
Brown	46.5	60.0	54.5	70	52.6	56.7 <sup>a</sup>
Black	37.2	33.3	36.4	20	21.1	29.6 <sup>b</sup>
White	4.7	0	9.1	10	15.8	7.9 <sup>c</sup>
Grey	9.3	6.7	0	0	5.3	4.3 <sup>c</sup>
Khakhi	2.3	0	0	0	5.3	1.5 <sup>c</sup>
<b>Neck colour</b>						
Brown	22	9	5	6	7	49.0 <sup>a</sup>
Black	15	4.7	5	3	9	36.7 <sup>a</sup>
White	4	1	1.2	1	2	9.2 <sup>b</sup>
Grey	3.1	1	0	0	1	5.1 <sup>b</sup>

<sup>a,b,c,d</sup>Means with different superscripts within trait differed significantly ( $P < 0.05$ ).

and rose comb types occurred at similar frequencies in Tswana chicken in the Southern part of Botswana. The predominance of single comb type found in the current study agrees with that observed by Moreda et al. (2014) in Ethiopian indigenous chickens, and Liyanage et al. (2015) in indigenous chickens of Sri Lanka. Banerjee (2012) also reported the predominance of single comb type in indigenous chickens of India. The single comb type also dominated in several indigenous chicken populations from different countries (Cabarles et al., 2012; Egahi et al., 2010; El-Safty, 2012; Apuno et al., 2011). According to Duguma (2006), the presence of single comb helps to reduce body heat by 40% and it is therefore advantageous in tropical conditions. The single comb type might therefore play a crucial thermoregulatory role under Botswana's hot and dry climatic conditions.

Plain and crested head shapes occurred at similar frequencies of 56.4 and 43.6%, respectively, in Tswana chickens in the Southern part of Botswana. Head shape is one the vital morphological features that can be used to separate variations between breeds or strains of indigenous chickens. All the strains of Tswana chickens

had a higher frequency of plain head shape compared to crested head shape. Our results are consistent with those of Moreda et al. (2014) who observed 72.8% plain head shape and 27.2% crested head shape in indigenous chickens of South and South West parts of Ethiopia. Addis et al. (2013) also reported similar results in indigenous chickens of North Gondor zone of Ethiopia.

Red ear lobes were by far the most frequent (67.6%) and were significantly higher than red-black, red-yellow and red-white ear lobes, which occurred at similar frequencies of 11.8, 11.1 and 9.6%, respectively (Figure 7). Variations in ear lobe colour in Tswana chickens is consistent with Faruque et al. (2010) and Moreda et al. (2014), who found similar results in indigenous chickens of Bangladesh and Ethiopia, respectively. The predominance of red earlobes in Tswana chickens is consistent with Moreda et al. (2014) and Liyanage et al. (2015), who reported similar results in indigenous chickens of Ethiopia and Sri Lanka, respectively. To the contrary, Cabarles et al. (2012) reported predominance of red-white (57.41%) earlobes over red earlobes (37.53%) in indigenous chickens of Philippines. Duguma (2006)

**Table 2.** Frequency (%) of qualitative morphological traits of the head region of Tswana chicken in the Southern part of Botswana.

Trait	Strain					Overall mean
	Normal	Naked Neck	Frizzled	Rumpless	Dwarf	
<b>Comb types</b>						
Single	74.4	86.7	72.7	80	94.7	81.7 <sup>a</sup>
Walnut	23.3	13.3	18.2	10	0	12.9 <sup>b</sup>
Pea	0	0	9.1	0	5.3	2.9 <sup>b</sup>
Rose	2.3	0	0	10	0	2.5 <sup>b</sup>
<b>Head shape</b>						
Plain	65.1	60.0	54.5	50	52.6	56.4 <sup>a</sup>
Crest	34.9	40.0	45.5	50	47.4	43.6 <sup>a</sup>
<b>Ear lobes colour</b>						
Red	78	66.7	54.6	75	63.5	67.6 <sup>a</sup>
Black	2.3	16.4	27.3	0	12.8	11.8 <sup>b</sup>
Yellow	9.3	3.40	9.1	15	18.4	11.1 <sup>b</sup>
White	10.4	13.40	9.10	10	5.3	9.6 <sup>b</sup>

<sup>a,b</sup>Means with different superscripts within trait differed significantly ( $P < 0.05$ ).



**Figure 7.** A yellow earlobe. Yellow.

reported the predominance of white earlobes (67%) over red (18.6%) and red-white (17.9%) earlobes in Ethiopian indigenous chickens. According to Cabarles et al. (2012), the differences in earlobe colour are the results of adaptability to local conditions.

The featherless shank occurred at significantly higher frequency (65.4%) than the feathered shank, which occurred at a frequency of 34.6%. Badubi et al. (2006)

also reported a high frequency (77.8%) of featherless shanks compared to feathered shanks (22.2%) in indigenous Tswana chickens. The current results are also in agreement with those of Moreda et al. (2014), who reported a higher frequency (98.48%) of featherless shanks relative to feathered shanks (1.56%) in indigenous chickens of Ethiopia. A significantly higher percentage of Tswana chickens had spur on their shanks (94.7%) as

**Table 3.** Frequency (%) of qualitative morphological traits of the leg region of Tswana chicken in the Southern part of Botswana.

Trait	Strain					Overall mean
	Normal	Naked Neck	Frizzled	Rumpless	Dwarf	
<b>Feathers on shank</b>						
feathered	32.6	26.7	36.4	30	47.4	34.6 <sup>a</sup>
featherless	67.4	73.3	63.6	70	52.6	65.4 <sup>b</sup>
<b>Spur</b>						
Present	90.7	93.3	100	100	89.5	94.7 <sup>a</sup>
Absent	9.3	6.7	0	0	10.5	5.3 <sup>b</sup>
<b>Shank colour</b>						
Grey	2.3	46.7	27.3	20	68.4	32.9 <sup>a</sup>
Blue	55.8	13.3	27.3	20	5.3	24.3 <sup>ab</sup>
Khakhi	34.9	13.3	27.3	30	15.8	24.26 <sup>ab</sup>
Yellow	7.0	13.3	18.2	10	10.5	11.8 <sup>ab</sup>
Green	0	13.3	0	20	0	6.7 <sup>b</sup>

<sup>a,b</sup>Means with different superscripts within trait differed significantly ( $P < 0.05$ ).

compared to 5.3% that did not have spur on their shanks.

Grey was the most predominant shank colour (32.9%) followed by blue (24.3%), khakhi (24.26%), yellow (11.8%) and lastly green (6.7%) (Table 3). A significant difference occurred only between the frequency of grey and green shank colours. Variations in shank colour, including yellow (32.48%), white (33.73%), brown (11.4%) and black (7.75%), were also reported by Moreda et al. (2014) in Ethiopian indigenous chickens. Contrary to our findings, Guni and Katule (2013) and Moreda et al. (2014) observed predominantly yellow and white shanks in indigenous chickens of Tanzania and Ethiopia, respectively. Variations in shank colour are due to variations in the production of carotenoid, dermal melanin and epidermal melanin controlled by *W+* and *W*; *Id* and *id+*; and *E* and *e+* genes, respectively (Petrus, 2011). Some studies have indicated that combinations of pigment controlling genes responsible of colour determination seemed to influence the occurrence of different types of shank colour (Guni and Katule, 2013) in indigenous chickens.

In view of these greater variations in plumage colours, it was noted that none or little of the genetic selection and desired mating were done with indigenous Tswana chickens. Indigenous Tswana chicken populations in the study areas compare various populations with different plumage colours (tail colour, breast colour, back colour, neck colour, earlobe colour and shank colour) and forms that differ in frequency of occurrence from one strain to another or from one location to another based on the qualitative characters observed.

The single comb type and red ear lobes were by far the most frequent qualitative traits across the strains. However, in some strains such as Normal, Naked-Neck

and Dwarf, the absence of spurs on the shank were observed particularly in females and young individuals. There is generally considerable diversity in various qualitative traits in different strains of Tswana chickens. High responses to selection can therefore be expected owing to the variations in various qualitative traits in different strains of Tswana chickens. Further research is required to genetically characterize the different strains of Tswana chickens for conservation purposes and better management approaches.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

## REFERENCES

- Addis G, Kefyalew A, Zewdu W (2013). Phenotypic characterization of indigenous chicken ecotypes in North Gondar Zone, Ethiopia. *American Eurasian Journal of Scientific Research* 8(6):248-255.
- Aklilu E, Kefelegn K, Taddelle D, Banerjee AK (2013). Phenotypic characterization of indigenous chicken population in Ethiopia. *International Journal of Interdisciplinary and Multidisciplinary Studies* 1(1):24-32.
- Apuno AA, Mbap ST, Ibrahim T (2011). Characterization of local chickens (*Gallus gallus domesticus*) in Shelleng and Song Local Government Areas of Adamawa State, Nigeria. *Agricultural and Biological Journal of North America* 1:6-14.
- Badubi SS, Rakereng M, Marumo M (2006). Morphological characteristics and feed resources available for indigenous chickens in Botswana. *Livestock Research for Rural Development* 18(1):205-211. <http://www.lrrd.org/lrrd18/1badu18003.htm>
- Banarjee S (2012). Morphological characterization of indigenous chickens of Sikkim and West Bengal, India. *Animal Genetic Resource* 51:57-71.
- Cabarles Jr. JC, Lambio AL, Vega SA, Capitan SS, Mendioro MS



- (2012). Distinct morphological features of traditional chickens (*Gallus gallus domesticus* L.) in Western Visayas, Philippines. *Animal Genetic Resource* 51:73-87.
- Desta TT, Dessie T, Bettridge J, Lynch SE, Melese K, Collins M, Christley RM, Wigley P, Kaiser P, Terfa Z, Mwacharo JM, Hanotte O (2013). Signature of artificial selection and ecological landscape on morphological structures of Ethiopian village chickens. *Animal Genetic Resource* 52:17-29.
- Duguma R (2012). Phenotypic characterization of some indigenous chicken ecotypes of Ethiopia. *Livestock Research for Rural Development* 18(9): [www.cipav.org.co/1rrd/1rrd18/9/dugu18131.htm](http://www.cipav.org.co/1rrd/1rrd18/9/dugu18131.htm).
- Egahi JO, Dim NI, Momoh OM, Gwaza DS (2010). Variations in qualitative traits in the Nigerian local chicken. *International Journal of Poultry Science* 9:78-989.
- El-Safty SA (2012). Determination of some quantitative and qualitative traits in Libyan native fowls. *Egyptian Poultry Science Journal* 32(11):247-258.
- Faruque S, Siddiquee NU, Afroz MA, Islam MS (2010). Phenotypic characterization of Native chicken reared under intensive management system. *Journal of Bangladesh Agricultural University* 8(1):79-82.
- Food and Agriculture Organization (FAO) (2011). Draft guidelines on phenotypic characterization of animal genetic resources. Food and Agriculture Organization of the United Nations (FAO). *Chicken descriptors* pp. 63-66.
- Guni FS, Katule AM (2013). Characterisation of local chickens in selected districts of the Southern Highlands of Tanzania: Qualitative characters. *Livestock Research for Rural Development* 25(9): <http://www.lrrd.org/lrrd25/9/guni25153.htm>
- Liyanage RP, Dematawewa CMB, Silva GLLP (2015). Comparative study on morphological and morphometric features of village chicken in Sri Lanka. *Tropical Agriculture Research* 26(2):261-273.
- Machete JB, Nsoso SJ, Kgwatalala PM, Moreki JC, Aganga AO (2017). Phenotypic characterization of Tswana chickens based on quantitative traits in Kweneng and Southern Districts, Botswana. *Livestock Research for Rural Development* 29(7): <http://www.lrrd.org/lrrd29/7/jmsm29132.html>.
- Manyelo TG, Selaledi L, Hassan ZM, Mabelebele M (2020). Local chicken breeds of Africa: Their description, uses and conservation methods: A Review. *Animals* 10:1-18.
- Moreda E, Singh H, Sisaye T, Johansson AM (2014). Phenotypic characterization of indigenous chicken population in South West and South part of Ethiopia. *British Journal of Poultry Sciences* 3(1):15-19.
- Ndidde Y, Akullo J, Zirintunda G, Ekou J (2014). Postmortem incidence and trends of Newcastle disease lesions among chicken presented for diagnosis at Makerere University Central Veterinary Laboratory: A retrospective study. *Journal of Veterinary Medicine and Animal Health* 6(8):217-221.
- Petrus NP (2011). Characterization and production performance of indigenous chickens in Northern Namibia regions [dissertation]. University of Namibia.
- SAS (2012). SAS Institute Inc. SAS/STAT user's guide. NC-SAS Institute Inc Cary USA.
- Statistical Procedures for Social Sciences (SPSS) (2013). SPSS User's guide version 22.0. SPSS Institute Inc: Cary NC.