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# Phenotypic characterization of domestic cavies (*Cavia porcellus*) in the agricultural zone of Haut-Katanga, Democratic Republic of Congo

**Mwangomb K D[1], Ntemunyi N C[2], Bilolwa B P[2], Tshimbangu M I[2], Ayagirwe R[3], Kampemba M F[2], Meutchieye F[4].**

*[1] : Centre de Recherche Agro-Alimentaire (CRAA) ; BP 54 Lubumbashi, DR Congo*

*[2] : Faculté des sciences Agronomiques, Université de Lubumbashi ; BP 1825 Lubumbashi, DR Congo.*

*[3] : Université Evangélique en Afrique, Bukavu-DRC, Department of Animal Production, Faculty of Agricultural and environmental sciences, Bukavu, DR Congo*

*[4] : Faculty of Agronomy and Agricultural Sciences, University of Dschang, Cameroon*

**Corresponding Author**: **Mwangomb K D**, *Centre de Recherche Agro-Alimentaire (CRAA); BP 54 Lubumbashi, DR Congo*; **Email**: *dominiquekapep@gmail.com*

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**Abstract**

This study was conducted with the aim of contributing to the characterization of zoo genetic resources for farm animals in the agricultural area of Haut Katanga. For this, 185 guinea pigs were sampled according to the snowball method from 117 households and whose weight parameter obtained from a balance and linear parameter obtained at the area of a measuring tape a description. The cavy was held immobile in a horizontal plane, and measurements were taken after locating landmarks on the surface of the animal's body. Qualitative parameters were collected by the visual method where the color of the coat was identified by direct observation under daylight (FAO, 2013; AU-IBAR, 2015). The main results showed that the location factor significantly influenced the majority of biometric characteristics while the sex factor had no significant effect on the measurements. The studied cavies had an angular conformation with the following average performances: weight 506.1 ± 149.9g; chest circumference 15.8 ± 3.0cm; body length 27.7 ± 3.2cm; thigh circumference 5.8 ± 0.9cm. Morphological characteristics indicate the presence of 6 main colors (white, cream, brown, grey, black and silver), from which several combinations are derived. The most frequent combinations are trichromic (White, black and brown) with 34.05%, followed by dichromic (White and brown: 18.38%). About 99.4% of the animals had black eyes. The hairs were soft (82.7%) and short (100%). PCA followed by an Ascending Hierarchical Classification (AHC) of these animals resulted in four genetic types; the first two types (type 1 and 2) have lower than average weights and resemble the guinea pigs of a (traditional) family farm, while the other two are semi-improved. Based on the coloring of the hair, these domestic cavies have a compound coat. These results show the existence of a great variability between the guinea pig populations as well as a diversity of rearing practices that requires monitoring for improvement, which constitutes an opportunity for genetic improvement of local guinea pigs.

**Keywords:** Characterization, Phenotype, *Cavia porcellus*, Democratic Republic of Congo

## Introduction

There is pressure on rodent biodiversity induced by the hunting of these group species. While it is possible to obtain them through controlled production (Kampemba, 2014). Their large-scale breeding could be likely to replace the methods of gathering and/or poaching currently practiced for rodents in general. The development of domestic cavy (rodent) production for economic purposes and on a rational technical basis should be a possibility in this respect (Ndébi et *al.*, 2015). For example, the study on the possibilities of developing cavy production in order to meet the growing demand for animal protein conducted by Ndebi et *al.* (2015) led to the results that the economic productivity of this animal species is relatively high but can be further improved and effectively meet the protein requirements for human consumption and, as a knock-on effect, reduce poverty and malnutrition.

This productivity evaluated in terms of the relative weight productivity index (IPPR) was for the variables observed by the authors more than 30%. At a time when the majority of people raise and consume these animals, the bulk of the work remains the development of sustainable strategies to improve the livestock production system for these animals (Metre, 2011).

Guinea pig breeding (domestic cavy farming) in the agricultural zone of Haut-Katanga is an activity that is poorly controlled, less practiced, and even endangered (Kampemba, 2011). Its breeding is of the family type of 8 guinea pigs on average per household surveyed; it is made for self-consumption of which only the surpluses are sold (Kampemba, 2014). There is no regulation that allows owners to promote the development of this type of farming and no genetic improvement and conservation program for local breeds being implemented. There is also a lack of data on the characterization of domestic cavies and therefore the phenotypic evaluation of this diversity has not yet been carried out. For a knowledge of native animal genetic resources, morpho-biometric characterization has been proposed as one of the strategies for analyzing domestic populations (Bouchel et *al.*, 1997; Daloum et *al.*, 2015; Defeu et *al.*, 2015). Hence the general objective is to have knowledge on the local animal genetic resources and specifically it was a question of phenotypically characterizing the guinea pigs bred in the agricultural zone of Haut-Katanga.

## Methodology

### *Study area*

This study was carried out in the agricultural zone of Haut-Katanga which covers the district of Kolwezi (now Lualaba Province) and the administrative territories of: Kasenga, Kipushi, Kambove and Sakania, in the district of Haut-Katanga (current province of Haut-Katanga), in the Democratic Republic of Congo (Mukalay, 2016) (Figure 3).

The study area belongs to climate type $Cw_6$ of the Köppen classification (FAO, 2005). This type defines warm temperate rainy climates where the average temperature of the coldest month is around 18°C (Kidinda *et al*., 2015). The zone has only one cropping season per year, unlike the three other agricultural zones of the former Katanga Province, which have two per year (Mukalay, 2016).

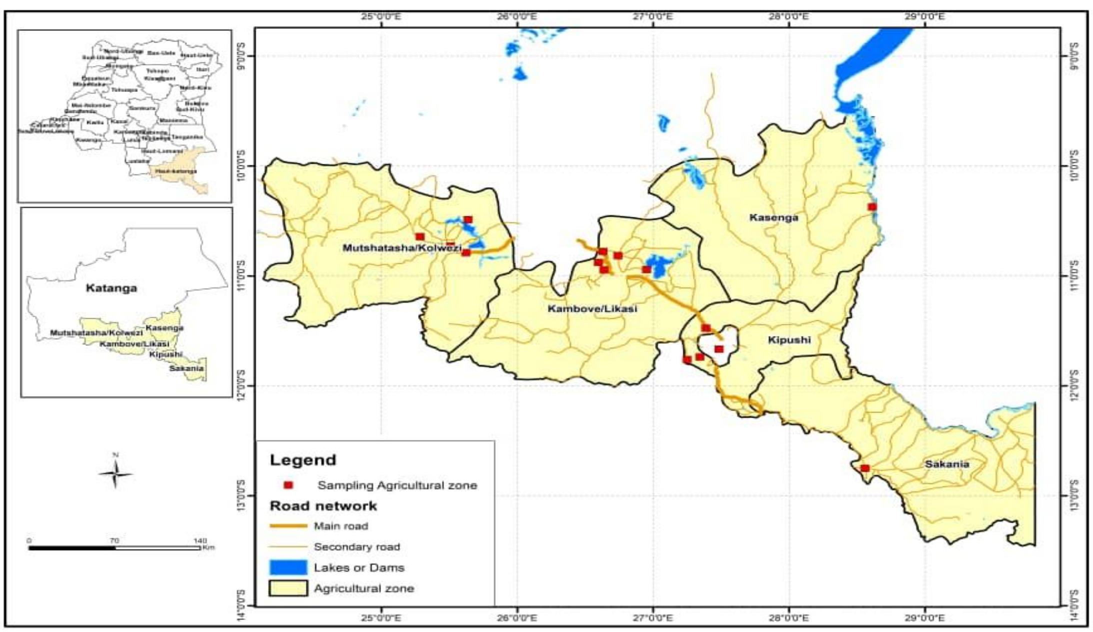


**Figure 1:** Study location sites

***Sampling and data collection***

The surveys were conducted between April 2015 and November 2016, following the non-probability sample known as the snowball in the agricultural zone of upper Katanga, which was subdivided into six sites: Kambove, Kipushi, Kolwezi, Lubumbashi, Kasenga, Sakania. The first breeders selected were used to identify other guinea pig breeders (Salganik and Heckathorn, 2004, Ayagirwe, 2014). For the whole study area, a total of 117 keepers were surveyed. The appropriate sample size of animals at each study site depended of the variability in the sample population. Thus, given the low number of guinea pigs in the study area (Kampemba, 2011; 2014), the animals were chosen according to their phenotypic variability as advised by Takashi and Anthony (1989), among others, the age and the distribution of colors. And numbers from 1 to 5 were considered in this study. Only adult animals were selected for data collection; and the age was given by the keepers themselves (about 6 months). Sampling for the morphometric study was carried out on 185 cavy individuals which were each photographed. And for the collection of data relating to livestock management, a survey was conducted following a semi-structured interview based on a questionnaire.

Information on body weight (g) was collected using a 5kg scale (accuracy 1g) and linear measurements (cm) using a tape measure (Essien and Adesope, 2003; Egena et al., 2010a; Anye et al., 2010) and was as follows (Figure 2) :

*Body length* (BL) which is the total length of the body measured from m to b; *thoracic perimeter* (ThP) measured just behind the shoulders (n); *ear length* (EL) measured from the base of the ear to the apex of the pinna; the *Ear Width* (EW) measured at the widest ear width (the middle of the ear); the *Face Length* (FL) measured between the nasal apex (m) and the middle of two ear bases (a) ; the *the forearm Length* (FAL) measured from point h to l; the *shoulder Length* (SL) measured from point c to h; the *back Length* (BcL) measured on the median line of the body, between point a to b while following the profile of the spine ; the *Front Leg Length* (FLL) measured from point c to l; the *Hind Leg Length* (HLL) measured in the interval from point d to g; the *Thigh Length* (TL) measured from point d to e; the *Thigh Circumference* (TC) measured on the contour of the thigh (o).

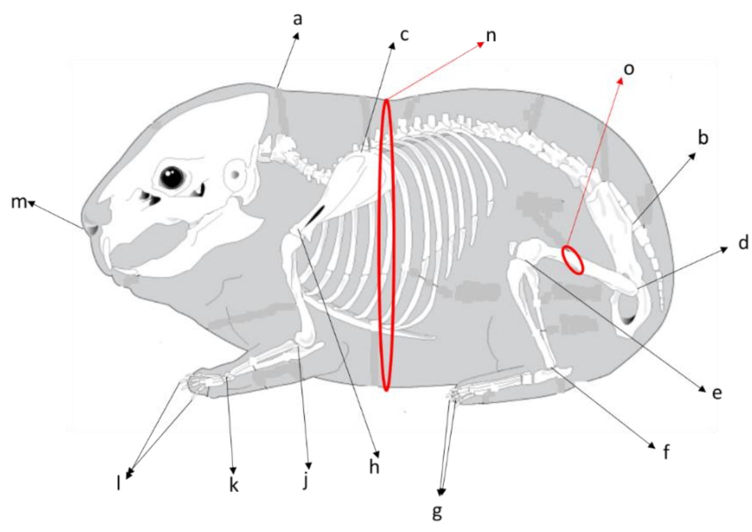


**Figure 2.** Diagram on the different measurements of the guinea pig

The cavy was held immobile in a horizontal plane, and measurements were taken after locating landmarks on the surface of the animal's body.

Qualitative parameters were collected by the visual method where the color of the coat was identified by direct observation under daylight (FAO, 2013; AU-IBAR, 2015).

To classify the breeds in a preliminary manner, the breed description method proposed by Boucher (2009) considered as a dichotomous key was used. This method describes the color patterns of the breeds but also those that may appear in cross-breeding. This key conforms to the publications of Boucher (2009).

### *Statistical analysis*

After collection, the data were entered into the computer using the Excel program. Software R Version 3.3.0 and SAS were used for descriptive statistical analysis and typological analysis of the data. Qualitative variables were described in terms of numbers and percentages; and quantitative data were described in terms of means more or less standard deviation. Data from guinea pig measurements were subjected to a two-factor (area and sex) analysis of variance and Tukey's test was performed to separate the means from each other at the 5% significance level.

To highlight the typology of guinea pigs, a grouping analysis of individuals was carried out and it consisted of a Principal Component Analysis (PCA) followed by the Ascending Hierarchical Classification (AHC) to group the types of guinea pigs reared in the agricultural zone of Haut-Katanga. The classification is ascending because it starts from individual observations; it is hierarchical because it produces larger and larger classes or groups, including subgroups within them. This PCA was carried out on 13 quantitative variables. After the PCA, a standard variable was created in the database to allow the quantitative data to be compared with the phenotypic data of the guinea pigs.

## Results

### *Quantitative characteristics*

The mean weight of the animals was 506.1g in the study area (Table 4). These results show significant differences ($p \leq 0.05$) between sites for all parameters observed except face length and thigh circumference which were similar. Between the sex of the animals and their interaction with the sites, the results were similar ($p \geq 0.05$). Animals from Kambove and Lubumbashi had significantly higher weights than the site remnants and the lowest weight was observed in Kipushi cavies.

The animals from Kasenga were significantly superior to the animals from the other sites with respect to the length of: ear (EL), forearm (FAL), shoulder (LEP), thigh (TL), back (BcL), front leg (FLL). Whereas in Kambove the animals had a large Thoracic Perimeter (ThP) and the particularity of the Lubumbashi animals was to be long. For the animals in Kipushi and Kolwezi, the length of the hind legs was high compared to that of the other sites.

### *Correlation between weights and linear body measurements*

The correlation between the different body measurements of the sampled cavies and their weights (shown in Table 5) shows significant relationships between parameters ($p<0.05$). Nevertheless, the strongest relationships were obtained between the length of the hind legs and the front legs (0.81). On the other hand, weight was significantly ($p<0.01$) correlated with body length (0.76), thoracic perimeter (ThP) (0.69), back length (BcL) (0.63), thigh length (TL) (0.60), face length (FL) (0.51). In addition, body length (BL) was strongly ($p<0.01$) correlated with back length (BcL) (0.72) and thigh length (TL) (0.62). Also, back length (BcL) was significantly ($p<0.01$) correlated with thigh length (TL) (0.66). Thoracic perimeter (ThP) was also correlated with thigh length (TL) (0.59).

**Table 4.** Metric characteristics of the local guinea pig population in the Agricultural zone of Haut - Katanga according to zone and sex

| **Features** | **Sites** | | | | | | **Average** | **Statistical test** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Kambove | Kipushi | Kolwezi | Lubumbashi | Kasenga | Sakania | | Sites | S | Sites*S |
| Weight (g) | 585.1±27.5a | 433.94±25.8c | 535.52±24.5ab | 584.87±16.9a | 447.59±36.8bc | 449.75±83.6abc | 506.1±149.9 | s | ns | ns |
| ThP/cm | 19.44±0.4a | 13.03±0.4c | 16.85±0.4b | 17.17±0.2b | 18.00±0.6ab | 10.35±1.3c | 15.8±3.0 | s | ns | ns |
| EW/cm | 2.90±0.1a | 2.90±0.1a | 2.97±0.1a | 2.62±0.04b | 2.90±0.1a | 2.65±0.2ab | 2.8±0.3 | s | ns | ns |
| EL/cm | 2.74±0.07cd | 2.48±0.07d | 2.86±0.06c | 3.12±0.04b | 3.85±0.1a | 2.52±0.2bcd | 2.9±0.5 | s | ns | ns |
| FL/cm | 6.33±0.2 | 6.07±0.1 | 6.43±0.1 | 6.63±0.1 | 6.40±0.2 | 6.05±0.6 | 6.3±1.0 | ns | ns | ns |
| BL/cm | 28.28±0.5b | 25.28±0.5c | 27.93±0.5b | 30.16±0.3a | 29.17±0.7ab | 25.72±1.7abc | 27.7±3.2 | s | ns | ns |
| FAL/cm | 3.98±0.1c | 3.88±0.1c | 4.06±0.1c | 5.15±0.1b | 6.16±0.1a | 3.87±0.4c | 4.5±1.0 | s | ns | ns |
| SL/cm | 4.43±0.1bc | 4.37±0.1c | 4.72±0.1bc | 4.82±0.1b | 5.63±0.1a | 4.70±0.4abc | 4.7±0.7 | s | ns | ns |
| HLL/cm | 11.11±0.2ab | 11.65±0.2a | 12.12±0.2a | 10.22±0.1b | 10.95±0.3ab | 11.80±0.8ab | 11.3±1.6 | s | ns | ns |
| TW/cm | 5.79±0.1ab | 4.79±0.1c | 5.78±0.1ab | 5.74±0.1ab | 6.20±0.2a | 4.85±0.4bc | 5.5±0.6 | s | ns | ns |
| WC/cm | 6.26±0.1 | 5.92±0.1 | 5.97±0.1 | 5.69±0.1 | 5.97±0.2 | 5.25±0.6 | 5.8±0.9 | ns | ns | ns |
| BcL/cm | 20.16±0.5b | 18.07±0.4c | 21.89±0.4ab | 21.80±0.3ab | 23.46±0.6a | 18.97±1.5bc | 20.7±2.9 | s | ns | ns |
| FLL/cm | 8.73±0.3b | 9.86±0.3ab | 9.70±0.3ab | 8.97±0.2b | 10.37±0.5a | 10.30±1.1ab | 9.6±1.9 | s | ns | ns |

**EL:** Ear length; **FAL:** Forearm length; **SL:** Shoulder length; **HLL:** Hind leg length; **TL:** Thigh length; **CT:** Circumference of the thigh; **ThP:** Thoracic perimeter; **EW:** Ear width; **FL:** Face length; **BL:** Body length; **Z:** Zone; **BcL:** Back length; **FLL:** Foreleg length;; **S:** Sex; **s:** Significant; **ns:** Not significant;

**Table 5:** Spearman's correlation on guinea pig weights and linear measurements

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W n=185 | 0.76*** | 0.69*** | 0.31*** | 0.15* | 0.30*** | 0.51*** | 0.46*** | 0.63*** | 0.20** | 0.19** | 0.60*** | 0.46*** |
| | BL n=185 | 0.62*** | 0.49*** | 0.05 | 0.56*** | 0.54*** | 0.53*** | 0.72*** | 0.14 | 0.04 | 0.62*** | 0.36*** |
| | | ThP n=185 | 0.39*** | 0.18* | 0.36*** | 0.28*** | 0.40*** | 0.53*** | 0.01 | 0.03 | 0.59*** | 0.39*** |
| | | | EL n=185 | 0.12 | 0.62*** | 0.20** | 0.44*** | 0.48*** | 0.02 | -0.07 | 0.46*** | 0.18* |
| | | | | EW n=185 | -0.10 | 0.27*** | 0.22** | 0.22** | 0.33*** | 0.40*** | 0.22** | 0.35*** |
| | | | | | FAL n=185 | 0.25*** | 0.40*** | 0.37*** | -0.09 | -0.30*** | 0.33*** | 0.12 |
| | | | | | | FL n=185 | 0.47*** | 0.47*** | 0.18* | 0.16* | 0.42*** | 0.39*** |
| | | | | | | | SL n=185 | 0.62*** | 0.37*** | 0.22** | 0.47*** | 0.32*** |
| | | | | | | | | BcL n=185 | 0.37*** | 0.27*** | 0.66*** | 0.38*** |
| | | | | | | | | | FLL n=185 | 0.81*** | 0.31*** | 0.38*** |
| | | | | | | | | | | HLL n=185 | 0.31*** | 0.36*** |
| | | | | | | | | | | | TL n=185 | 0.54*** |
| | | | | | | | | | | | | CT n=185 |

***W :** Weight; **BL :** Body length; **ThP:** Thoracic perimeter; **EL:** Ear length; **EW:** Ear width; **FAL:** Forearm length; **FL :** Face length; **SL:** Shoulder length; **BcL:** Back length; **FLL:** Foreleg length; **HLL:** Hind leg length; **TL:** Thigh length; **CT:** Circumference of the thigh*

***Description of qualitative characteristics of guinea pigs***

The results in Table 2 revealed 6 color patterns of the coat (white, cream, brown, grey, black and silver). These colors led to 17 color combinations. Thus, the trichromic color pattern (White, black and brown) was more represented (34.05%), followed by the dichromic pattern (White and brown: 18.38%), while the mono was weakly identified (white 2.16%), black (0.54%) and brown (1.62%). Generally, these domestic cavies were short-haired (185: 100%) regardless of sex, with a tender appearance (101: 89.73%) and black eyes (184: 99.46%).

**Photo 1 : Trichromic**

**photo 2 : Dichromic (brown-**

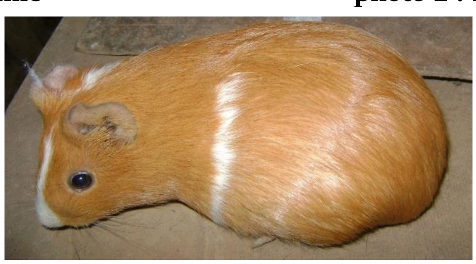

**Photo 3 : Black eye**

**Table 2.** Morphological characteristics of guinea pigs in Haut-Katanga according to sex

| Features | | Female | | Male | | Total | |
|---|---|---|---|---|---|---|---|
| | | **N** | **%** | **N** | **%** | **N** | **%** |
| Short hair | | 114 | 61.62 | 71 | 38.38 | 185 | 100 |
| ***Eye color*** | | | | | | | |
| Black | | 113 | 61.08 | 71 | 38.38 | 184 | 99.46 |
| Red | | 1 | 0.54 | 0 | 0 | 1 | 0.54 |
| ***Hair feature*** | | | | | | | |
| Hard | | 13 | 7.03 | 6 | 3.24 | 19 | 10.23 |
| Soft | | 101 | 54.59 | 65 | 35.13 | 166 | 89.73 |
| ***Coat color pattern*** | | | | | | | |
| W | Mono | 4 | 3.5 | 0 | 0 | 4 | 2.16 |
| WCr | Di | 6 | 5.3 | 6 | 8.5 | 12 | 6.49 |
| WCrBr | Tri | 1 | 0.9 | 0 | 0 | 1 | 0.54 |
| WBr | Di | 21 | 18.4 | 13 | 18.3 | 34 | 18.38 |
| WBrGr | Tri | 6 | 5.3 | 2 | 2.8 | 8 | 4.32 |
| WGr | Di | 1 | 0.9 | 0 | 0 | 1 | 0.54 |
| WB | Di | 3 | 2.6 | 3 | 4.2 | 6 | 3.24 |
| WBSi | Tri | 17 | 14.9 | 14 | 19.7 | 31 | 16.76 |
| WBBr | Tri | 41 | 36 | 22 | 31 | 63 | 34.05 |
| WBGr | Tri | 2 | 1.8 | 1 | 1.4 | 3 | 1.62 |
| Br | mono | 2 | 1.8 | 1 | 1.4 | 3 | 1.62 |
| BrCr | Di | 0 | 0 | 1 | 1.4 | 1 | 0.54 |
| BrGr | Di | 1 | 0.9 | 1 | 1.4 | 2 | 1.08 |
| B | mono | 1 | 0.9 | 0 | 0 | 1 | 0.54 |
| BCrSi | Tri | 1 | 0.9 | 1 | 1.4 | 2 | 1.08 |
| BBr | Tri | 5 | 4.4 | 6 | 8.5 | 11 | 5.95 |
| BBrGr | Tri | 2 | 1.8 | 0 | 0 | 2 | 1.08 |

W: White; Cr: Cream; Br: Brown; Gr: Grey; B: Black; Si: Silver

### *Typology of domestic cavies*

The Principal Component Analysis (PCA) was carried out on 13 quantitative variables and the contribution of the first two axes is 55.6%.

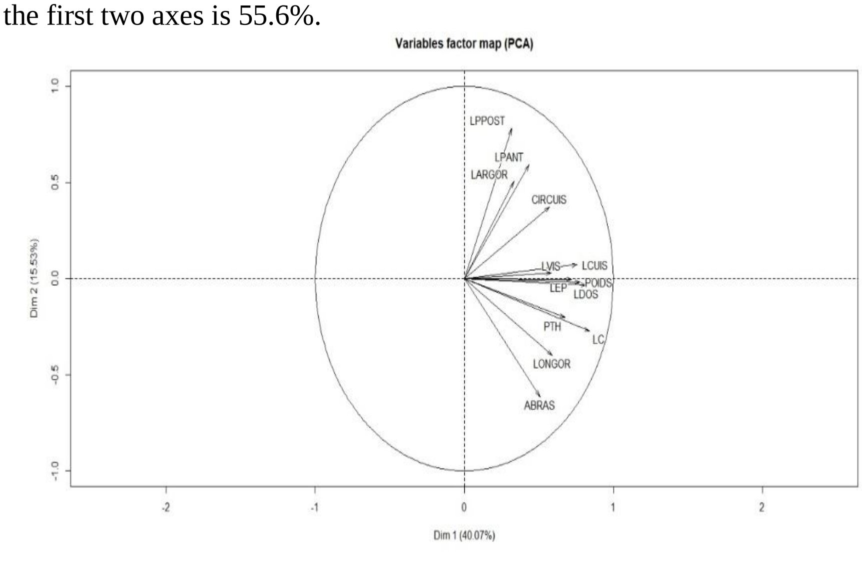


**Figure 4:** Graphical representation of the variables on axes 1 and 2

***BL (here LC) :*** *Body length;* ***ThP (here PTh):*** *Thoracic perimeter;* ***EL (here LONGOR):*** *Ear length;* ***EW (here LOR):*** *Ear width;* ***FAL (here ARBRAS):*** *Forearm length;* ***FL (here LVI):*** *Face length;* ***SL (here LEP):*** *Shoulder length;* ***BcL (here LDOS):*** *Back length;* ***FLL (LPANT):*** *Foreleg length;* ***HLL (here LPPOST):*** *Hind leg length;* ***TL (here LCU):*** *Thigh length;* ***CT (here CIRCUS):*** *Circumference of the thigh*

Figure 4 shows that, axis 1 accounts for 40.07% of the total variation. This first component represents the length of the body; it is formed by the lengths (of the back, thigh, shoulder, face, front and hind legs of the forearm), thoracic perimeter, thigh circumference and ear width which are positively correlated.

The second component accounts for 15.53% of the total variation and is characterized by the length of the hind legs and consists of the length of the front legs, ear width, thigh circumference that are positively correlated versus the thoracic perimeter, body length, ear length and forearm length (negatively correlated).

***The Ascending Hierarchical Classification (AHC) and the description of the groups***

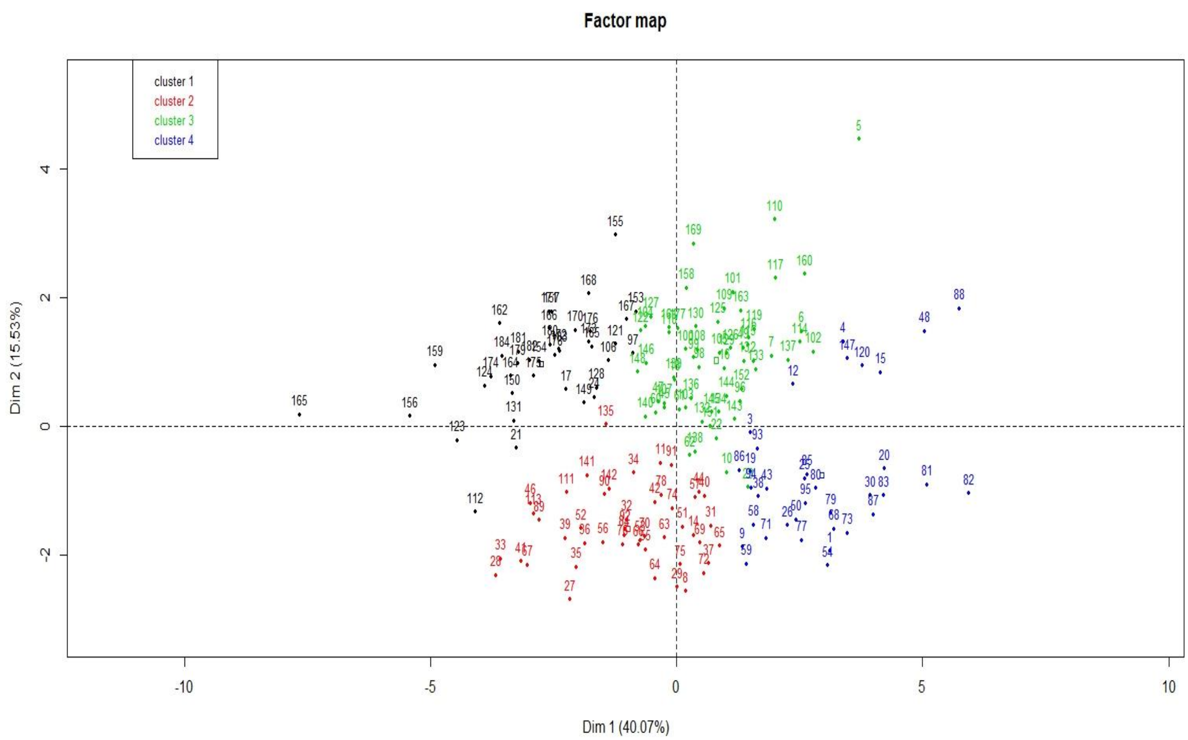


**Figure 5:** Graphical representation of domestic cavy's groups

The Hierarchical Ascending Classification was performed on 13 quantitative variables. Four groups of guinea pigs were identified, maintaining a variance between groups of 55.6% of the total variability. Figure 5 shows the 4 groups of cavies found in the agricultural zone of Haut-Katanga. These types are described in Table 3.

The description in Table 3 shows that the animals of types 1 and 2 are those with mean values of the parameters that are lower than the average observed in the zone. The exception is made for the length of the ear and forearm for type 2 animals that have values higher than the average for the zone. As for type 3 and 4 animals, the average measurements of the parameters are higher than the average measurements for the zone. The difference in weight between types is about 100g from one type to another. This means that type 4 is about 300g heavier than type 1 guinea pigs. Analysis of variance between the types revealed significant differences in the means. Thus type 4 had the values of all variables significantly higher than the values of the other types except for the length of the hind legs that were lower (p=0.000). Weight, Thoracic Perimeter (ThP), Face Length (FL), Back Length (BcL), Thigh Length (TL) were the variables that differed significantly from one type to another.

An observation in Table 3 shows that weight, body length, back length and chest perimeter are parameters that distinguish guinea pigs by their marked variability between types. According to these parameters, the value increases from type 1 to type 4.

**Table 3.** Description of domestic cavy's types

| Parameters | Type1 | | | Type2 | | | Type3 | | | Type4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Mean** | Min | Max | **Mean** | Min | Max | **Mean** | Min | Max | **Men** | Min | Max |
| Weight (g) | **405.9d** | 156 | 519 | **489.7c** | 224 | 729 | **594.1b** | 397 | 841 | **687.8a** | 323 | 990 |
| BL (cm) | **24.9c** | 17.5 | 27.5 | **28.3b** | 23 | 32.5 | **29.1b** | 24 | 34 | **32.4a** | 29 | 36 |
| ThP (cm) | **13.01d** | 9.9 | 18 | **16.4c** | 7.5 | 21 | **17.9b** | 13.1 | 24 | **19.3a** | 16 | 22.5 |
| EL (cm) | **2.4d** | 2 | 3 | **3.1c** | 2.5 | 4 | **2.9b** | 2 | 3.5 | **3.6a** | 2.5 | 4.5 |
| EW (cm) | **2.78a** | 2 | 3.9 | **2.5b** | 2 | 3 | **2.9a** | 2 | 3.8 | **2.9a** | 2.5 | 4 |
| FAL (cm) | **3.8d** | 3 | 4.5 | **5.23b** | 3 | 7 | **4.1c** | 3 | 5.2 | **5.8a** | 4 | 8 |
| FL (cm) | **5.9d** | 4 | 8.5 | **6.0c** | 5 | 8 | **6.5b** | 6 | 9 | **7.4a** | 6 | 11 |
| SL (cm) | **4.2c** | 2.5 | 5.4 | **4.5c** | 2 | 6 | **4.9b** | 4 | 7 | **5.4a** | 4.5 | 7 |
| BcL (cm) | **18.1d** | 10.7 | 21 | **19.8c** | 9 | 23 | **22.3b** | 18.2 | 27 | **24.0a** | 20 | 29 |
| FEL (cm) | **9.3a** | 5 | 11.5 | **7.9b** | 5.5 | 9.5 | **10.1a** | 7 | 22 | **9.9a** | 7 | 24 |
| HLL (cm) | **11.2b** | 6.5 | 13.2 | **9.3c** | 7 | 11 | **12.2a** | 9 | 16 | **10.9b** | 8 | 13 |
| TL (cm) | **4.8d** | 3.3 | 6 | **5.4c** | 4 | 6 | **5.9b** | 5 | 8 | **6.3a** | 5 | 11.5 |
| TC (cm) | **5.4b** | 3 | 7 | **5.4b** | 4 | 6.5 | **6.3a** | 5 | 9 | **6.4a** | 5 | 11 |

**EL:** Ear length; **FAL:** Forearm length; **SL:** Shoulder length; **HLL:** Hind leg length; **TL:** Thigh length; **CT:** Circumference of the thigh; **Mean±E:** Average plus at least Standard deviation; **S:** Sex; **s:** Significant; **ns:** Not significant; **ThP:** Thoracic perimeter; **EW:** Ear width; **FL:** Face length; **BL:** Body length; **Z:** Zone; **BcL:** Back length; **FLL:** Foreleg length;

## Discussion

Observation of morphometric data from the domestic cavies (also called guinea pigs) did not report any sexual dimorphism. However, females and males had similar growth patterns. This lack of sex dimorphism suggests that a breeding program on growth traits would be possible using both sexes without problems. It has been shown that the sexual dimorphism of guinea pigs can present situations where the male performs better than the female; the opposite or a lack of total dimorphism; these variations could be explained by a resemblance of growth trajectories, a mechanism explained by the constitution of anatomical regions (Równiak, 2013). These amounts to saying that the animals in the area would follow the same growth trajectory as explained by Równiak (2013).

The weight obtained in this study is within the range of weights reported in African farms. The live weight of local adult animals ranged from 352 to 1200 grams (Meter, 2012; Yiva et *al.,* 2014; Ayagirwe et *al.,* 2015; Umba et *al.,* 2017). These weights are also higher than those documented in traditional South American animals (459 g), but are significantly lower than those of improved breeds (1091 g) at 13 weeks of age (Chauca de Zaldívar, 1995). Compared to Ayagirwe et *al.* (2015), the weights of individuals in this study are lower than those of the agricultural zones (monomodal, bimodal and the western highlands) of Cameroon by 569g and individuals from the western region plus (626g). These authors indicated a high variability in weight growth in the different regions. This variation has already been recorded by Manjeli et *al.* (1998). It is thought to be due to the different animal management practices between the different regions but also to genetic differences between animals. Indeed, genetic characterization studies conducted by Ayagirwe (2014) and Wikondi (2014) revealed that there was a high genetic variability within the cavy population in each region but also between regions, suggesting possibilities for improvement.

Considering our adult animals, their weights are lower than those of other traditional and commercial farms; this difference could probably be due to the genetic types bred and the farming conditions.

According to Clement (1981), the weight of an animal is influenced by exogenous factors related to the animal's environment and by endogenous factors specific to the animal. The growth curve of an animal is also influenced by the farming system. This sigmoidal curve in an intensive production system becomes highly variable in an extensive production system due to the variable availability of feed (McDonald et *al.,* 2010). The growth rate is also a function of the type of breed used.

Linear body measurements provide good information on performance, productivity and carcass characteristics of animals (Ige et *al.*, 2006). These measurements have been in poultry by Oni et *al.* (2001), goats by Ozoje and Mbere (2002), sheep by Salako and Ngere (2002) and Salako (2004), cattle by Mbap and Bawa (2001) and Olutogun et *al.* (2003). For cavies, there is a shortage of reported work on linear body measurements of domestic cavies (Egena et *al.*, 2010). Some body dimensions have been useful in assessing the pattern of skeletal framework development (Berg and Butterfield, 1976; Berg, 1978). Objective monitoring of these changes using body measurements can help guide a selection program (Berg and Butterfield, 1976). From studies of linear body measurements, Spencer and Eckert (1988) derived weight production equations. A study of linear body measurements in local cavy ecotypes is important because most traditional farms lack scales and sufficient knowledge to understand their handling. In our study on the characterization of guinea pigs, a few variables based on correlations were found to be of interest in the zootechnical performance of domestic cavies. These are body length, thoracic perimeter, back length often equated to body length, and also thigh length and to some extent face length. This length was on average 27.7 cm. shorter than that of populations of domestic cavies in central Cameroon (28.6 cm) and those found in western Cameroon (29.5 cm) (Ayagirwe et *al.*, 2015). It is rather longer than that reported by Ayagirwe et *al.* (2015) in the highlands of northwest Cameroon (22.3 cm) and southwest Cameroon (19.3 cm). The mean length reported in this study was even greater than that reported with cavies in Kinshasa by 22.8 cm at 20 weeks. In South Kivu Meter (2012) found a mean length of 25.0 cm at 34 weeks of age with a daily mean linear growth for both sexes of about 0.06 cm. In Nigeria, Egena et *al.* (2010b) recorded body lengths of 25.7 cm and 24.6 cm, respectively, in adult male and female animals of unknown age after 12 weeks under controlled conditions. Fotso et *al.* (1995) revealed 27.6 cm at 15 weeks of age on station in Cameroon. This parameter, which influences weights by 71%, can be improved to obtain productive guinea pigs. During decades of research and development in Peru since the mid-1960s, the body length of adults has been considerably increased by selection to obtain guinea pigs with weights up to 2 kg (Chauca de Zaldívar, 1997).

In terms of back length, Ayangirwe (2014) reported a greater length (24.73 cm) than the animals in our area. Faradja (2012) found a back length of 25.56 cm and a live weight of 713.27g for the cavy population of DR Congo in South Kivu. As for the thoracic perimeter, the highest measurements were observed on cavies from Kambove (19.44 cm), followed by animals from Lubumbashi and Kasenga. Overall, the mean thoracic perimeter was 15.8 cm. A large thoracic perimeter indicates the meatiest animal. However, this parameter was positively correlated with weight in this study. Thus, its improvement would lead to an increase in the weight of our local guinea pigs. It was demonstrated by Orheruata (1988) that in beef cattle, a high circumference measurement meant more muscle in the meat.

On the basis of the quantitative traits found in local guinea pigs, it is clear that this species is identified in domestic cavy is type B according to conformation based on the classification made by Saturnino et *al.* (2015).

Concerning the morpho-biometric characterization, a high phenotypic diversity was observed in local guinea pigs. This variation in phenotype indicates the presence of several morphological mutations resulting from random domestication and reproduction.

Our results reported 6 color patterns (white, cream, brown, grey, black and silver). The number of patterns is higher than that reported by Ayagirwe et *al.* (2015) who found four main coat color patterns in Cameroon, resulting in several combinations. The main basic color patterns found in several sub-Saharan African countries are black, brown, ash grey and white. Only white, black and grey patterns are included in our observations. Thus, these authors found many more dichromic combinations (with the most dominant combinations: ash-white, black-white, brown-black and white-brown) whereas in our zone trichromic dominated. These authors further point out that local cavies in Cameroon had smooth and short coats and would be considered as type 1, called 'Inglés' (i.e. 'English'). These details would also be applied to cavies from the agricultural zone of Katanga and in addition these would be based on coat coloration, the compound-coated cavies.

The variety of phenotypic characteristics observed is due to an extraordinary diversity of color patterns in the coat. Fotso et *al.* (1995) in Cameroon and Kouakou et al (2015) in Côte d'Ivoire have also observed this diversity of colors, particularly the multicolored patterns of the hairs. The main types of coat color patterns observed in cavy production systems in sub-Saharan Africa are consistent with the observations made by Harman and Case (1941), Festing (1976) and Warren et *al.* (2008) except for silver and beige. Indeed, these authors, after having conducted studies on the colors of cavy hair in order to identify their underlying genes, discovered the existence of white, black, brown and grey. It was shown that the combination of different colors in the same individual was related to the effect and interaction of several genes, including the extension locus (E), the Agouti locus (A), the Brown locus (B), the Color locus (Albino), the Roan locus (Ro) and the locus responsible for white traces in the coat (S) (Festing 1976; Warren et *al.*, 2008).

In the cavy populations, there are more than 20,000 updated genes distributed over the 64 chromosomes. However, very few of them responsible for visible traits have been studied. Only genes affecting coloration, coat types are studied at some level (Harman & Case, 1941; Neesam, 2008).

The existence of multicolored cavies in a population is mainly the result of genetic interactions and random mating between individuals. This variation in color would be to some extent an advantage: for example, due to the lack of labelling means, breeders would use certain traits. Akouango et *al.* (2004), in their observations in hens, point out that the wide variety of feather colors was thus the result of multiple uncontrolled crosses over several decades between hens with different colors, which gave rise to other combinations.

The different morphometric characteristics led to 4 types of guinea pigs bred in the study area. Type 1 and 2 were less efficient than type 3 and 4 in terms of the average values of the parameters considered. This differentiation would be due to the fact that there is a distribution of microclimate in the area different from one site to another. From an urban environment to a rural environment, the considerations and visions attached to this activity are totally different. This means that in an urban environment the need to have powerful animals (improved breeds) is present to increase productivity than in rural areas.

## Conclusion

Local guinea pigs perform poorly compared to exotic strains, but are within the range of averages reported for local guinea pigs in developing countries. Considerable phenotypic diversity has been observed in this population, which is explained by the lack of directional selection, by the diversity of environmental conditions in which these animals live, but possibly also by the existence of uncontrolled introductions of the several genes from commercial strains. In these cavies, weight improvement can be achieved through: body length, chest circumference, back length, thigh length and to some extent face length. These parameters have a relationship of more than 50% with the weights, and are therefore the parameters of interest in improving the productivity of the cavies. On the basis of conformation, local cavies in the agricultural zone of Haut-Katanga are type B, known as angular, and depending on hair color and appearance, they are type 1, known as English. These results allow us to suggest that it is necessary to put in place strategies for the genetic management and improvement of national domestic cavy improvement.

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