

RESEARCH ARTICLE

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Distribution and Morphometric Characteristics of Domesticated Rabbit Breeds in North Rift and Western Regions, Kenya

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Abstract

Rabbits (*Oryctolagus cuniculus*) occur throughout the world with their breeds distinctively identified phenotypically by coat color, body size and shape. The common rabbit breeds in Kenya are New Zealand White, Californian White, Flemish Giant, French Ear Lop, Chinchilla, Angora, Kenya White and their crosses. The present study was designed to assess morphometric characteristics of rabbit breeds in North and Western regions of Kenya. The combination of information derived from the study was intended to provide important baseline data for future breed conservation and production improvement in Kenya. Onsite study was conducted at University of Eldoret (UoE) Farm – Rabbitry Section. Rabbit breeds from farmers in the regions were obtained through snow balling technique. In order to investigate patterns of morphometric variation within and among the breeds, the study collected individual does and bucks from each county in the region and transported to University of Eldoret to be taken care of prior to weighing and taking linear body measurements. Breeds were kept in standardized housing, feeding and health management were provided. Morphometric characterization was made according to Khalil (2010). Data collected were subjected to analysis using SPSS Version 21. The two regions had same breeds of rabbits ($\chi^2=9.422$, $df=7$, $p=0.2240$). For the counties within the regions in which the breeds were collected, New Zealand White was distributed in all counties with largest percentage in Baringo County (92.86%). Significant difference was between counties in the regions in which breed were collected ($\chi^2=77.1940$, $df=49$, $p=0.0060$). Majority of characteristics did not differ between male and female rabbits. As per sex, only female Agouti rabbits had larger ear length than males ($t = 2.3378$ P -value = 0.0393). New Zealand White females weighed more than males ($t = 2.4226$, $p= 0.0194$). Chinchilla rabbit breed had higher significant body length (51.00 ± 4.15 ; $F=2.49$, $p=0.0356$). In terms of males' weight, Palmino followed by Silver Fox had the highest weight (2.55 ± 0.12 ; 2.49 ± 0.57 , respectively). For females, Chinchilla had the highest weight (3.31 ± 0.48) than Rex (1.49 ± 0.44) and Agouti (1.93 ± 0.57). In conclusion, only weight differed in both males and females for all breeds. Only female Agouti rabbits had larger ear length than males. This research work recommends more studies be conducted on morphometric characterization of the indigenous rabbit at pre-determined ages including genetic, molecular, and immunological characterization and genetic parameter estimation. It is also recommended that breeding programs be carried out to improve the production performance of local rabbit.

Keywords: Domesticated Rabbit, Distribution, Morphometric Characteristics

INTRODUCTION

Food produced on small farms feeds most of the world's human population which have continued to get smaller with increase in human population (Crist et al., 2017). Livestock production in these small farms has huge untapped potential around the globe that if optimally exploited can subsidize food security (Burg et al., 2018). Rabbit production on small farms occur throughout the world (Olagunju et al., 2018) and belong to several genera in the sub-families leporidae and Palaeloginae of the family Lepidae in the order Lagomorpha, super order Glives (Hungu, 2011).

Rabbit breeds are distinctively identified phenotypically by coat color, body size and shape (Serem et al., 2013). Rabbits have further been classified as: small-sized rabbits, medium-sized breeds and large breeds weighing 1.4 – 2 kg, 4–5.4 kg and 6.4 – 7.3 kg weight, respectively (Khan et al., 2017). American Rabbit Breeders Association (2010) use this basis of classification, recognizing forty-seven (47) distinct rabbit breeds with only a few reared in Kenya (Serem et al., 2013).

The common rabbit breeds in Kenya are New Zealand White, Californian White, Flemish Giant, French Ear Lop, Chinchilla, Angora, Kenya White and their crosses (Serem et al., 2013). Rabbits (*Oryctolagus cuniculus*) produce large quantities of tasty meat for domestic consumption (Khan et al., 2017). Rabbit meat is known to have high protein and low fat thus possessing health promoting qualities (Cullere & Dalle Zotte, 2018).

The practical potential of rabbit meat in supplying world's protein needs has been reported by Petrescu & Petrescu-Mag, 2018; Li et al., 2018 and Cullere & Dalle Zotte, 2018. Some rabbit's fast growth rate, high prolificacy, short gestation period, early sexual maturity, high genetic selection potential, high efficiency in feed conversion and economic utilization of space and ability to re-breed shortly after kindling make them

a viable option of meat in Africa (Daader et al., 2016; Cullere & Dalle Zotte, 2018).

In Africa, the major participants in rabbit production include Nigeria, Ghana, Zambia and Togo (Oseni & Lukefahr, 2014). In Nigeria, Ethiopia and Kenya, little awareness of the rabbit productive potential has been under looked. Kenya has potential to sustain itself as rabbits bring no competition to feed resources (Oseni, 2012).

The combination of information derived from the study of morphometric traits and genetic characteristics provide important baseline data for future breed conservation (Dalle Zotte, Paci, & Sartori, 2012). The growth of animals involves an increase in body weight, which can change the conformation of various parts of the body (Irshad et al., 2013). Also, the sex can affect phenotypic aspects. For this reason, it is important to study the effect of these two factors on morphometric development (Shahin and Hassan, 2002). The aim of this study was to provide information on the relationships among body measurements with age and gender in dwarf rabbits. There is insufficient information on morphometric characteristics of domesticated rabbits in North and Western regions of Kenya.

The present study was therefore designed to assess morphometric characteristics of rabbit breeds in North and Western regions of Kenya. The two regions were chosen on the basis of being in different agro ecological zones (AEZs) which may influence distribution and production potential. The combination of information derived from the study is intended to provide important baseline data for future breed conservation and production improvement in Kenya.

MATERIALS AND METHODS

Study Area

Onsite study was conducted at University of Eldoret (UoE) Farm, (Rabbitry Section) of Animal Science Department and the Department of Biological Sciences Laboratory in Uasin Gishu County, Kenya

located in latitude 0° 31' N and longitude 35° 17' E with an elevation of 2154 m above sea level (Figure 1; Kareri, 2013). An average unimodal rainfall pattern of 1000 mm to 1520 mm per annum has been recorded over

the last ten years. The rains span from February to August. The temperatures range from 23.6°C daytime to 9.6°C night time (Jaetzold & Schmidt, 1982).

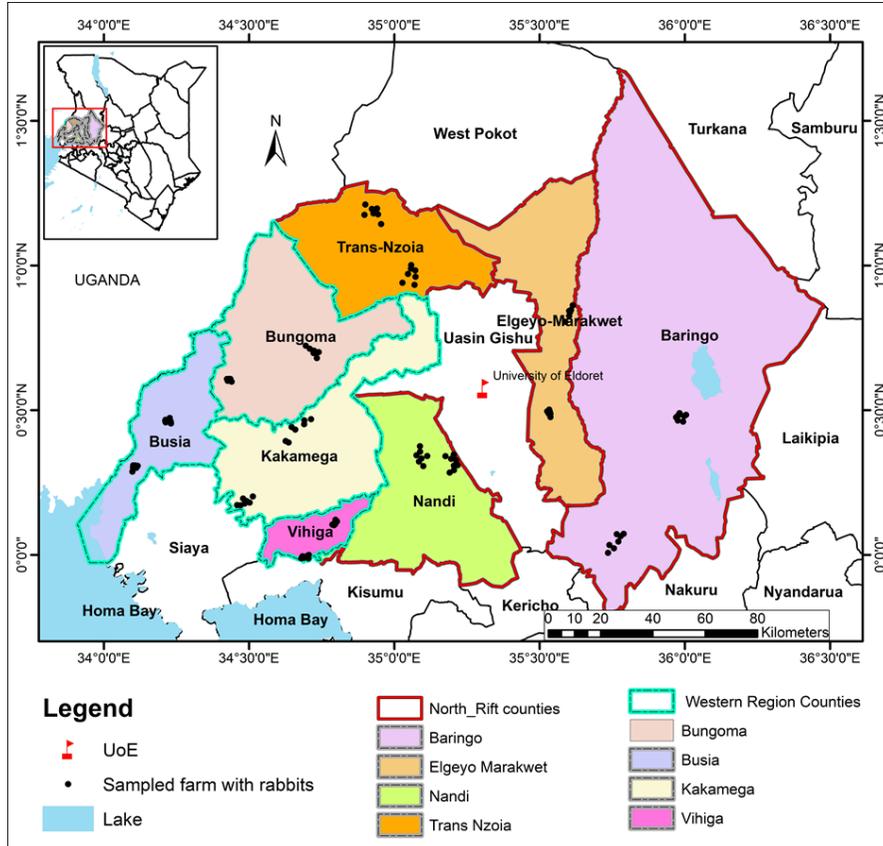


Figure 1: Map of the study area where rabbit breeds were sourced.

Experimental Animals and Management

The sampling design was divided into two main parts: first, the regions in which the rabbit breeds were sourced representing different agro-ecological zones. The breeds were assumed to have a wide range of phenotypes and for which historical records indicate an old and mostly unrelated origin. The rationale behind this choice was that 1) high phenotypic divergence may reflect higher genetic divergence and 2) older breeds may represent reservoirs of genetic diversity. Eight Rabbit breeds (Agouti, Chinchila, Dutch, Flemish Giant, New

Zealand White, Palmino, Rex and Silver Fox) were sourced from two regions (North Rift and Western Provinces) in Kenya. There were fourteen rabbits of each breed sourced giving a total of 114 rabbits. The counties in the said regions were Nandi, Elgeyo Marakwet, Baringo and Trans Nzoia in the North Rift region and Bungoma, Busia, Kakamega and Vihiga Counties in the Western region of Kenya.

The rabbit does and bucks from farmers in the Western and North Rift Kenya were obtained through snow balling technique. In order to investigate patterns of morphometric

variation within and among the rabbit breeds, the study used individual does and bucks from each county. The rabbits selected were of a random population between five to six months old. One or two individuals were sourced from farmers for each breed. The identified breeds were transported to university of Eldoret rabbitry section to be taken care of prior to weighing and linear body measurements taking.

Animals' Housing, Feeding and Health Management

Sufficient room was provided for the rabbits with standard requirements for does and bucks as 30 x 24 x 18 inches or 24 x 24 x 18 inches depending on the size or breed of rabbit to reduce stress, fighting and injury (Hungu, 2011). Each rabbit breed was housed individually in all-wire metallic cages designed for easy collection of faeces and urine. They were provided with water *ad-libitum* while feed was served twice daily at 08:30 and 15:30 h. The diets were a standardized meal of 40% pellets and 60% hay. General health, hygiene and husbandry practices for the animals was taken care of. The rabbit house and cages were thoroughly cleaned and disinfected before placing the rabbits in cages. The house and cages were cleaned daily. Earthen bowls were used as feeders and drinkers and were washed with clean water before new feed or water was offered.

Body Measurements and Indices

The morphometric characterization of the rabbit breeds from farmers in North Rift and Western Kenyan regions were made according to Khalil (2010) and included life body weight, profile body of the head, ears, eyes, neck, and legs and the coat colours on a total of 112 mature rabbits. Rabbit breeds were weighed using a digital weighing balance in kilograms and body measurements taken at predefined anatomical points using a measuring tape (cm). Procedures for measuring anatomical

lengths of the rabbits involved lying the rabbit on a table and the same person measuring the animals.

The body length of each rabbit was measured from atlas to the first coccygeal vertebrae, while the chest circumference was measured behind the shoulder blades and the abdominal circumference was taken at the level of the seventh lumbar vertebrae. The ear width was from the outside to the other side at the distance of 2 cm from the top of the ear. Ear length was taken from the bottom to the top while the foot length was from behind the foot to start of the fingers/ tarsus. Measurements were replicated twice and their means taken for statistical analysis.

Statistical Analysis

Data collected were subjected to analysis using Statistical Package for Social Sciences (SPSS version 21). Rabbits breed distribution was analysed using cross tabulation chi squares (χ^2). Least square means for body weight and body dimension measurements was estimated using the Generalized Linear Modelling (GLM) procedure. Significant differences between the populations was defined by Duncan test.

RESULTS

Rabbit Breeds Distribution

The two regions had same breeds of rabbits ($\chi^2=9.422$, $df=7$, $p=0.2240$). For the counties within the regions in which the breeds were collected, New Zealand white was found in all counties with largest percentage in Baringo County (92.86%). Flemish Giant was the second most populous breed with a largest proportion collected from Vihiga (35.71%) and Nandi (35.71%) Counties. The least populous breed was Palmينو with only one representative recorded in Bungoma County as illustrated in Figure 2. Significant difference was between the counties in the regions in which the breeds were collected ($\chi^2=77.1940$, $df=49$, $p=0.0060$).

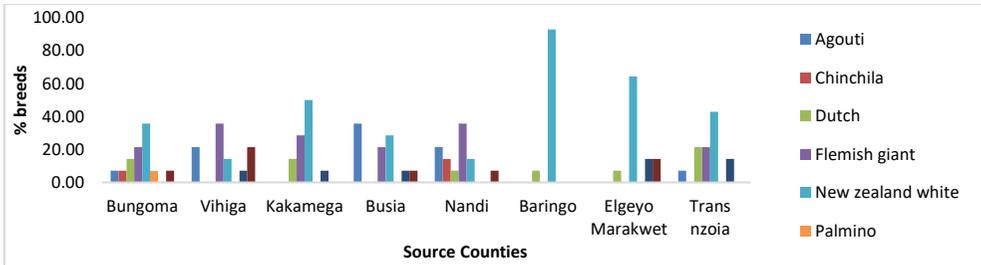


Figure 2: Distribution of rabbit breeds in various counties of Kenya.

Morphometric Characteristics of Rabbit Breeds

All morphometric measurements did not differ between the regions for breed ($p > 0.05$). Body weight characteristic of the rabbit breeds was compared to establish if there was any significant difference in respect to the two regions. For Agouti (2.189 ± 0.41) and Flemish Giant (2.27 ± 0.33)

breeds, sampled from Western region had higher insignificant weight as compared to those from western region ($p > 0.05$). For Dutch (2.36 ± 0.33), New Zealand White (2.16 ± 0.37), Rex (2.25 ± 0.57) and Silver Fox (2.58 ± 0.35) breeds from Western region had higher significant mean weight in kg compared with those from North Rift region ($p < 0.05$) as illustrated in Table 1.

Table 1: Body weight characteristic of the rabbit breeds from the two regions of Kenya

Breed	Region	Average BW±Sd	t- test	p- value
Agouti	North	1.77±0.22	-1.6223	0.1357
	West	2.189±0.41		
Chinchila	North	2.47±0.00	-	-
	West	2.73±0.81		
Dutch	North	1.61±0.29	-3.7498	0.0056
	West	2.36±0.33		
Flemish Giant	North	2.02±0.51	-1.4070	0.1740
	West	2.27±0.33		
New Zealand White	North	1.66±0.38	-4.4612	0.0001
	West	2.16±0.37		
Palmino	North	-		
	West	2.55±0.00		
Rex	North	1.49±0.44	-2.4587	0.0301
	West	2.25±0.57		
Silver Fox	North	1.65±0.52	-3.5748	0.0033
	West	2.58±0.35		

Majority of characteristics did not differ between male and female rabbits. As per sex, only female Agouti rabbits had larger ear length than males ($t = 2.3378$ P-value = 0.0393). As per weight, New Zealand White females had significant larger weight than males ($t = 2.4226$, $p = 0.0194$). Chinchilla rabbit breed (51.00 ± 4.15) had higher significant body length ($F = 2.49$, $p = 0.0356$) than Flemish Giant (43.43 ± 3.27) as illustrated in Table 1. In terms of males'

weight, Palmino (2.55 ± 0.12) followed by Silver Fox (2.49 ± 0.57) had the highest weight than New Zealand White and Dutch (1.92 ± 0.48). There was significant difference in males' weights ($F = 2.51$, $p = 0.0274$). For females, Chinchila (3.31 ± 0.48) had the highest weight than Rex (1.49 ± 0.44) and Agouti (1.93 ± 0.57). There was significant difference in females' weight ($F = 2.87$, $p = 0.0179$) as illustrated in Table 2.

Table 2: Morphometric characteristics of rabbit breeds from two regions of Kenya

	Category	Agouti	Chinchilla	Dutch	Flemish giant	New Zealand white	Palmino	Rex	Silver fox	F	p-value
Body length (cm)	Male	45.83± 3.37	45.50± 0.71	45.50± 1.91	44.44± 4.88	43.07± 3.62	48.00± 0.00	46.00± 5.29	43.75± 2.22	1.01	0.4371
	Female	45.71± 4.15	51.00± 0.00 ^a	46.67± 3.01	43.43± 3.27	46.74± 2.62	-	42.25± 6.13 ^b	42.25± 6.85 ^b	2.49	0.0356*
	All	45.77 3.76	48.25± 0.71	46.08± 2.46	43.94± 4.08	44.90± 3.12	48.00± 0.00	44.13± 5.71	43.00± 4.53	1.102	0.367
Girth (cm)	Male	27.83± 1.60	26.50± 2.12	25.75± 1.71	24.33± 3.00	24.83± 2.45	23.00± 0.00	26.00± 1.73	26.50± 5.07	1.42	0.22
	Female	28.00 4.76	31.00± 0.00	29.00± 4.10	29.14± 4.82	28.37± 4.06	-	24.75± 6.95	28.00± 3.46	0.57	0.7498
	All	27.92± 3.18	28.75± 2.12	27.38± 2.90	26.74± 3.91	26.60± 3.25	23.00± 0.00	25.38± 4.34	27.25± 4.27	0.734	0.644
Belly (cm)	Male	27.67 3.88	28.00± 2.83	27.75± 3.40	24.44± 6.11	26.14± 3.90	25.00± 0.00	26.33± 2.31	26.00± 8.12	0.35	0.93
	Female	29.00± 3.00	42.00± 0.00	25.67± 3.27	26.57± 5.91	27.32± 4.66	-	24.00± 3.92	26.00± 4.32	2.34	0.0463*
	All	28.33 3.44	35.00± 2.83	26.71± 3.33	25.51± 6.01	26.73± 4.28	25.00± 0.00	25.17± 3.11	26.00± 6.22	1.254	0.281
Leg (cm)	Male	7.50± 1.05	8.50± 0.71	8.75± 1.47	8.00± 1.32	7.86± 0.88	7.00± 0.00	8.00± 1.00	7.50± 1.73	0.80	0.5912
	Female	8.71± 1.98	8.00± 0.00	8.17± 1.47	7.14± 0.86	8.05± 1.43	-	8.00± 1.63	6.75± 0.96	1.18	0.3329
	All	8.11± 1.51	8.25± 0.71	8.46± 1.47	7.57± 1.09	7.96± 1.15	7.00± 0.00	8.00± 1.32	7.13± 1.34	1.285	0.265
Ear width (cm)	Male	5.33± 0.52	6.00± 1.41	5.75± 0.50	5.78± 1.20	5.97± 1.18	6.00± 0.00	5.67± 0.58	5.75± 0.50	0.08	0.9991
	Female	6.14± 1.07	6.00± 0.00	5.83± 0.41	6.21± 1.25	5.84± 0.83	-	5.50± 1.29	4.75± 0.96	1.29	0.2803
	All	5.74± 0.79	6.00± 1.41	5.79± 0.45	6.00± 1.23	5.90± 1.01	6.00± 0.00	5.58± 0.93	5.25± 0.73	0.642	0.72
Ear length (cm)	Male	8.83± 1.72	9.00± 1.41	10.50± 1.73	9.78± 0.67	9.31± 1.00	10.00± 0.00	10.67± 0.58	9.25± 0.50	1.63	0.1486
	Female	10.43± 0.53	11.00± 0.00	9.83± 1.33	9.21± 1.31	9.89± 1.15	-	9.50± 1.29	10.00± 1.15	1.62	0.1635
	All	9.63± 1.13	10.00± 1.41	10.17± 1.53	9.50± 0.99	9.60± 1.08	10.00± 0.00	10.08± 0.93	9.63± 0.83	0.474	0.851
Weight (kg)	Male	2.08± 0.42	2.32± 0.22	1.90± 0.56 ^b	2.08± 0.56	1.73± 0.38 ^b	2.55± 0.00 ^a	2.11± 0.67	2.49± 0.57	2.51	0.0274*
	Female	1.93± 0.57 ^b	3.31± 0.00 ^a	1.92± 0.48 ^b	2.26± 0.29	2.03± 0.51	-	1.49± 0.44 ^a	2.13± 0.52	2.87	0.0179*
	All	2.01± 0.49	2.81± 0.22	1.91± 0.52	2.17± 0.43	1.88± 0.44	2.55± 0.00	1.80± 0.56	2.31± 0.54	3.035	0.006*

p- values with * are significant

DISCUSSION

Rabbit Breeds Distribution

The findings indicated that the two regions had similar breeds of rabbits. The findings concur with those of Serem et al. (2013) that the common rabbit breeds in Kenya are New Zealand White, Angora, French Ear Lop, Californian White, Chinchilla, Flemish Giant, Kenya White and their crosses (Olagunju et al., 2018).

For the counties within the regions in which the breeds were collected, New Zealand White was found in all counties. This is attributed to the fact that New Zealand White is the principal breed for commercial meat production in Kenya with meaty haunches and extensive, deep shoulders. The finding

concur with those of Serem et al. (2013) that New Zealand White rabbit is the commonest breed of domestic rabbits all over the world more so in China, United States and Africa for breeds for meat in commercial rabbitries.

Flemish Giant was the second most populous breed. This is attributed to its potential in commercial meat production even though in its purebred does not have adequate reproductive performance for commercial production (Hungu, 2011). The observation in the study was that New Zealand White and Flemish Giant were the most represented rabbit breeds. It is notable that the two breeds are suitable for meat production in Kenya. It further supports the observation that rabbit

meat production is the primary objective of the Kenyan rabbit farmers (Wanjala, 2015)

Morphometric Characteristics of Rabbit Breeds

All morphometric measurements did not differ between the regions for breed. Body weight characteristic of the rabbit breeds for Dutch, New Zealand white, Rex and Silver Fox breeds from Western region had higher significant mean weight compared with those from North Rift region. This can be attributed to the fact that western region belongs to Agro-ecological zone 2 and 3 (high and medium potential) which receives adequate amount of rainfall thus high amounts of food for rabbits as compared to the North Rift region which belongs to zone 4 and 5 (arid and semi-arid areas). This concurs with findings of Mayamba et al. (2020) that areas that receive high to moderate rainfall have a high normalized difference vegetation index (NDVI), a vegetation characteristic index important factor in explaining and predicting species richness across the different study landscapes. Chidodo et al (2020) added that crop type in a region is associated with food availability for an organism especially in mammals. Majority of characteristics did not differ between male and female rabbits. This concurs with Obike et al. (2010) that sex does not affect all linear body measurements in rabbits stating that traits that are significantly affected include heart girth in males being higher in estimates as well as fore limb length, abdominal circumference and tail length. There was a significant difference in males' weights with females Chinchilla having the highest weight.

CONCLUSION AND RECOMMENDATIONS

New Zealand White was the most populous breed while Palmino was the least. Majority of morphometric characteristics did not differ between male and female rabbits. This can be attributed to the fact that they are kept indoors and feeding regimes is equal. As per sex, only female Agouti rabbits had larger

ear length than males inclined to male masculinity. As per weight, New Zealand White females had significant larger weight than males. Some breeds in western region weighed more than those from the North Rift region attributed to more food due to the type of agro-ecological zone. Chinchilla rabbit breed had higher body length than Flemish Giant. In terms of males' weight, Palmino followed by Silver Fox had the highest weight.

This research work recommends more studies be conducted on morphometric characterization of indigenous rabbit at pre-determined ages (juveniles, sub adults as well as in adults) including genetic, molecular, and immunological characterization and genetic parameter estimation. It is also recommended that breeding programs be carried out to improve production performance of local rabbits. In addition, it is recommended that New Zealand being the most populous breed with above average insignificant morphometric characteristics be used to cross breed other local breed to increase meat yield.

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