



## Review Article

# Morphological Differentiation Among Donkey Breeds: A Review

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### ABSTRACT

The different parts of the world, which have different geographic set ups and climatic conditions have resulted in the creation of different types of donkeys which speak to the characteristics of the different regions. The current state of information on breed level characterization documented data is not enough and generates a low level of research interest on conservation of donkey genetic resources. The objective of the current review was to describe the morphological variations between different donkey breeds. This review study shows forms of slight variation in morphological traits among donkey breeds of the same area within that country. One of the key aspects in animal evolution and migration from one area to another is at the core of it informed by adaptability. This study will help donkey farmers, extension officers and researchers to understand the morphological variation among donkey breeds.

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TLT and MM designed the manuscript. MM wrote the manuscript. TLT revised, read, edited, and approved the final manuscript.

### Key words

Body length, Withers height, Body length, Coat colour, Head length

## INTRODUCTION

The donkey belongs to the equine family along with the horse, mule, and zebra, for many years donkeys have been used by human for various reasons that are aimed at addressing human needs (Yilmaz *et al.*, 2012). The different parts of the world, which have different geographic set ups and climatic conditions have resulted in the creation of different types of donkeys which speak to the characteristics of the different regions (Buneveski *et al.*, 2018). According to Carneiro *et al.* (2018) the original ancestral trace of donkeys is believed to be closely linked to *Equus asinus africanus*, a native of the North Eastern region of Africa, and *Equus asinus europeans*, which is known to be from the Mediterranean basin. Donkeys have a large range of economic benefits which have not been fully explored (Geiger *et al.*, 2020). Köhle (2018) revealed that Chinese medicine, make use of gelatin, which is found in donkey hides, as to attend to human health. While on the other hand in some parts of the world, donkey milk is used for human consumption and formulation of beauty products

(Camillo *et al.*, 2018). While Polidori *et al.* (2008) went further and discovered that donkey meat has low fat and cholesterol contents, good in protein and high potassium content. Donkeys also play a critical role in providing transport means, generating income through animal traction, and providing food security to many marginalised households in rural and semi urban areas of Africa (Geiger *et al.*, 2020). There are several studies which have been done on different donkey breeds such as the Amiata donkey breed (Sargentini *et al.*, 2018), the Eastern Algeria donkey breed (Hannani *et al.*, 2020), Central highland Kenya donkey breed (Gishure *et al.*, 2020), Bulgaria Donkey breed (Vlaeva *et al.*, 2016), D/Kudu district breed (Khaleel *et al.*, 2020), Banat donkey breed (Stanisic *et al.*, 2020), Czech Republic donkey breed (Košťuková *et al.*, 2015) and the Balkan donkey breed (Stanišić *et al.*, 2015). However, to the best of our knowledge there has been no review delineating the morphological diversity between donkey breeds. Hence, the objective of the current review is to describe the morphological differentiation between different donkey breeds. This study will help donkey farmers, extension officers and researchers to understand the morphological variations among donkey breeds.

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## ORIGIN OF DONKEY BREEDS

The Amiata donkey breed is found in Tuscan as an endangered breed and originates from Mount Amiata which located in Siena and Grosseto provinces, in southern Tuscany of Italy (Sargentini *et al.*, 2018). The Amiata

donkey breed has the physical characteristics of the Amiata donkey ancestors (the *Equus asinus africanus* and the *Equus asinus somaliensis*) (Sargentini *et al.*, 2018). While the Algeria donkey is found mostly in the Northern side of Alegria (Ayad *et al.*, 2019). As per the study conducted by Hannani *et al.* (2020) the Algerian donkey was genetically traced to have an ancestral origin of the African Wild ass donkey. The central high land Kenya donkey traces its historical origin to the Nubian wild ass (Angare *et al.*, 2011). Vlaeva *et al.* (2017) says that the current Bulgaria donkey breed traces its historical origin from the Nubiana wild ass and Somali wild ass. The D/Kudu donkey is traced to be dominant in the Kano State which is in the Northern side of Nigeria (Khaleel *et al.*, 2020). According to Stanisic *et al.* (2015, 2020) both the Balkan and Banat donkey form part of the indigenous breeds of the Serbian donkeys. While the origin of the Czech Republic donkey is not clear, its origin traced to ancestral origin to be *Equus asinus somaliensis* and *Equus asinus africanus* and to some donkey breeds around Europe (Košťuková *et al.*, 2015).

#### VISIBILITY VARIATIONS AMONG DONKEY BREEDS

Amaita donkeys has a grey coat, with dark shoulder stripes, less visible leg stripes, dovetail, collar buttons and healthy dark hoof (Sargentini *et al.*, 2018). Eastern Algeria donkey: Hannani *et al.* (2020) noted to have a variation of back stripes and zebra marks with coat that is bay colour with shades of light, dark and burnt, others were light to dark grey and head muzzle, eye contour that was grey. Central highland Kenya: donkeys are said to have grey–dun coat colour, with some that have chocolate brown colour, while all the donkeys have equine stripes in the backline, with shoulder stripes and the muzzle together with the nostrils area was white in colour (Gishure *et al.*, 2020). Regions of Bulgaria donkey: The notifiable dominant colours are grey and brown, which had a dark cross on the back, while a few animals were observed to be black and roan (Vlaeva *et al.*, 2016). Khaleel *et al.* (2020) states that D/Kudu: district donkeys have variation of colours, white grey and light brown being the most dominant colours, while others are dark grey and dark brown. The Banat and Balkan: donkeys have closely related similarities which local donkey farmers usually confuse the exact separation of the two breeds, the breeds have grey to chocolate in coat colour and differ on the black stripe on legs, silver bright coat pigmentation on the chest area and around the nose and eyes (Stanisic *et al.*, 2015, 2020). Czech donkeys have been difficult to identify as no donkey originates from the republic, they are coming from across other parts of Europe and resemble those donkeys (Košťuková *et al.*, 2015).

#### MORPHOLOGICAL TRAIT MEASUREMENTS IN DONKEYS

According to Vlaeva *et al.* (2016) Sargentini *et al.* (2018) and Ayad *et al.* (2019) and, identified morphological measurements to be conducted as follows: Chest circumference: circumference measurement taken around the chest just behind the paws and behind the withers; Withers height: measured from the highest point at the withers to the ground; Body length: the distance between the tip of the shoulder and ischium; Ear length: measured from where the ear is joined to the head to the tip end of the ear; Head length: measured on the midline between the top of the occipital region and the tip of the nose and Neck length: measured between the cranial and the edge of the atlas wings, the apex of the scapula; the left and right ear length.

#### *Chest circumference variations among different donkey breeds*

Chest circumference differentiation has been conducted in different donkey breeds (Table I). Hannani *et al.* (2020) investigated the size of the chest circumference to range between 112.97 – 116.85 centimetre (cm) for both males and females between age ranges of 3 to 16 years of age for Eastern Algeria donkeys found in Algeria. Central Highland Kenya donkeys found in Kenya measured 113.7 cm for females and males of ages below 3 years and above 3 years (Gishure *et al.*, 2020). In the country of Bulgaria Vlaeva *et al.* (2016) discovered measurements for regions of Bulgaria donkeys to be around 126.78–138.31 for the geldings found which included one jennet. Results obtained from Khaleel *et al.* (2020) showed that D/ Kudu area donkeys in Nigeria that were below the age of 2 and above measured 113.2 cm for the males. Banat donkeys found in Serbia that were between ages of 3 to 8 years had measurements that ranged between 114.5 cm–138.5 cm for male and females (Stanisic *et al.*, 2020). Measurements taken by Košťuková *et al.* (2015) indicated that for male and female around ages 2-5 years, donkeys found in the Czech Republic in Czechia were found to be between 127–132.9 cm. Stanišić *et al.* (2015) also noted that Balkan donkeys in the country of Serbia had measurements of 119.6 – 114 cm for male and female around ages of 3 years and above.

#### *Withers height variations among different donkey breeds*

Table II shows the variations of withers height among donkey breeds. Amiata donkeys found in different parts of Italy that were jennets only were recorded to have height at whither between 123.2–130.7 cm (Sargentini *et al.*, 2018). Hannani *et al.* (2020) recorded 112.67–107.55 cm for Eastern Algeria donkeys, that were found to be in the

age range of 3 to 16 years in Algeria for male and females. Central Highlands donkeys below and above the age of 3 years which included both sexes in Kenya measured 99.67 (Gishure *et al.*, 2020). The Bulgaria donkey found in regions of Bulgaria investigated to have a height at whither of 112.94–126.09 cm as per Vlaeva *et al.* (2016) findings. Khaleel *et al.* (2020) recorded 102.4 cm for male animals of 2 years that were found in the D/Kudu area of Nigeria. Measurements in the range of 106.0–109.9 cm were recorded by Kost'uková *et al.* (2015) for both sexes between ages of 3 to 5 years in the Czech Republic. Stanišić *et al.* (2015) recorded 103.3–104.9 cm for Balkan Donkeys in Serbia, these donkeys were below and above age of 3 years for both male and female.

#### *Body length variations among different donkey breeds*

Body length size vary among donkey breeds as indicated in Table III. Sargentini *et al.* (2018) measured serious variation in body length amongst same breeds of the same sex but of different location within Italy his findings were ranging between 47.3–55.3 cm. In Eastern Algeria the male donkeys showed a slight difference in size for donkeys around the ages of 3 to 16 years of age, the recorded were 114.64–116 cm (Hannani *et al.*, 2020) these included both male and female which had a greater

body length than Italy breeds. Male and female donkeys of central highlands of Kenya, according to Gishure *et al.* (2020) they had an exact measurement of 113.2 cm, which is below the findings of Vlaeva *et al.* (2016) who recorded 117.06–133.09 cm for Donkeys found in in Regions of Algeria. The 2 years old and above 2 years which were dominantly males in D/Kudu district donkeys measured 64 cm (Khaleel *et al.*, 2020). Which was very low when compared to the Banat donkeys which according to Stanisic *et al.* (2020) measured 113–132 cm at an age range of 3 to 18 years. Kost'uková *et al.* (2015) measured body length of Czech Republic donkeys to be 115.5–116.1 cm and their age was around 3–5 years. The Measurement for Balkan donkey was just by a centimetre to the Czech Republic donkey, Stanišić *et al.* (2015) measured them to be 110–117 cm.

#### *Ear length variations among different donkey breeds*

Several research studies showed that ear length vary in different donkey breeds (Table IV). Amiata donkeys of Italy had the measurement of 28.0–29.9 cm for ear length (Sargentini *et al.* 2018). Which was greater than Eastern Algeria, D/Kudu, Balkan donkeys which showed measurements ranging between 25–26 cm (Hannani *et al.*, 2020; Khaleel *et al.*, 2020; Stanišić *et al.*, 2015).

**Table I. Chest circumference variations among different donkey breeds.**

Length (cm)	n	breed	Age (Years)	Sex	Country	Author
112.97-116.85	65	Eastern Algeria donkey	3-16	Males and females	Algeria	Hannani <i>et al.</i> , 2020
113.7	360	Central Highlands Kenya donkey	<3 and >3	Males and females	Kenya	Gishure <i>et al.</i> , 2020
126.78 -138.3	96	Regions of Bulgaria donkeys			Bulgaria	Vlaeva <i>et al.</i> , 2016
113.2	144	D/Kudu	2 and above	Males	Nigeria	Khaleel <i>et al.</i> , 2020
114.5 -138.5	53	Banat Donkey (Central Balkans)	3-8	Males and females	Serbia	Stanisic <i>et al.</i> , 2020
127 -132.9	70	Czech Republic donkey	3-5	Males and females	Czechia	Kost'uková <i>et al.</i> , 2015
119.6 -114	74	Balkan Donkey	<3 and >3	Males and females	Serbia	Stanišić <i>et al.</i> , 2015

N, sample size

**Table II. Withers height variations among donkey breeds.**

Length (cm)	n	breed	Age (Years)	Sex	Country	Author
123.2-130.7	32	Amiata donkey		Females	Italy	Sargentini <i>et al.</i> , 2018
112.67-107.6	65	Eastern Algeria Donkey	3-16	Males and females	Algeria	Hannani <i>et al.</i> , 2020
99.67	360	Central Highlands Kenya donkey	< 3 and > 3	Males and females	Kenya	Gishure <i>et al.</i> , 2020
112.94-126.09	96	Regions of Balgaria donkeys			Bulgaria	Vlaeva <i>et al.</i> , 2016
102.4	144	D/Kudu	2 and above	Males	Nigeria	Khaleel <i>et al.</i> , 2020
106.0- 109.9	70	Czech Republic donkey	3-5	Males and females	Czechia	Kost'uková <i>et al.</i> , 2015
103.3- 104.9	74	Balkan Donkey	< 3 and >3	Males and females	Serbia	Stanišić <i>et al.</i> , 2015

N, sample size.

**Table III. Body length variations among different donkey breeds.**

Length (cm)	n	breed	Age (Years)	Sex	Country	Author
47.3-55.3	32	Amiata donkey		Females	Italy	Sargentini <i>et al.</i> , 2018
114.64- 116.9	65	Eastern Algeria donkey	3-16	Males and females	Algeria	Hannani <i>et al.</i> , 2020
113.2	360	Central Highlands Kenya	<3 and >3	Males and females	Kenya	Gishure <i>et al.</i> , 2020
117.06- 133.1	96	Regions of Bulgaria			Bulgaria	Vlaeva <i>et al.</i> , 2016
64.0	144	D/Kudu	2 and above	Males	Nigeria	Khaleel <i>et al.</i> , 2020
113- 132.0	53	Banat donkey (Central Balkans)	3-8	Males and females	Serbia	Stanisic <i>et al.</i> , 2020
111.5-116.1	70	Czech Republic Donkey	3-5	Males and females	Czechia	Košťuková <i>et al.</i> , 2015
110-117.2	74	Balkan Donkey	< 3 and >3	Males and Females	Serbia	Stanišić <i>et al.</i> , 2015

N, sample size.

**Table IV. Ear Length differentiation of different donkey breeds.**

Length (cm)	n	Breed	Age (Years)	Sex	Country	Author
28.0-29.9	32	Amiata Donkey		Females	Italy	Sargentini <i>et al.</i> , 2018
25.38-26.36	65	Eastern Algeria donkey	3 to 16	Males and females	Algeria	Hannani <i>et al.</i> , 2020
26.7	144	D/Kudu	2 and above	Males	Nigeria	Khaleel <i>et al.</i> , 2020
25.6- 26.1	74	Balkan Donkey	< 3 and >3	Males and females	Serbia	Stanišić <i>et al.</i> , 2015

N, sample size.

**Table V. Head length variations among different donkey breeds.**

Length (cm)	n	Breed	Age (Years)	Sex	Country	Author
40.23-41.3	65	Eastern Algeria donkey	3-16	Males and females	Algeria	Hannani <i>et al.</i> , 2020
44.0	144	D/Kudu district donkeys	2 and above	Males	Nigeria	Khaleel <i>et al.</i> , 2020
43.8-45.2	70	Czech Republic donkey	3-5	Males and females	Czechia	Košťuková <i>et al.</i> , 2015
47.6- 49.6	74	Balkan Donkey	< 3 and > 3	Males and females	Serbia	Stanišić <i>et al.</i> , 2015

N, sample size.

**Table VI. Neck length variations among different donkey breeds.**

Length (cm)	N	breed	Age (Years)	Sex	Country	Author
57.2-62.0	32	Amiata donkey		Females	Italy	Sargentini <i>et al.</i> , 2018
38.75- 40.5	65	Eastern Algeria	3-16	Males and females	Algeria	Hannani <i>et al.</i> , 2020
31.1	144	D/Kudu district donkeys	2 and above	Males	Nigeria	Khaleel <i>et al.</i> , 2020

n, sample size.

*Head length variations among different donkey breeds*

Head length was measured in different studies and showed variations among donkey breeds (Table V). The highest measurement was recorded by Stanišić *et al.* (2015) who measured head length to be around 47.6–49.6 cm for both male and female (with males showing slightly higher value) at the ages of 3 years and above. Then followed by donkeys of the Czech Republic which according to

Košťuková *et al.* (2015) findings were 42.8–45.2 cm for male and female between ages of 3 to 5 years. D/Kudu district donkeys of Nigeria had a measurement of exactly 44.0 cm for males at 2 years and above of age (Khaleel *et al.* 2020). The measurements for head length in D/Kudu district donkey was higher than the Eastern Algeria donkey which according to Hannani *et al.* (2020) had a measurement of 40.23–41.33 cm for 3 to 16 year old males



and females.

#### *Neck length variations among different donkey breeds*

Table VI shows a variations of neck length among different donkey breeds. Sargentini *et al.* (2018) measured the longest neck length for Amiata donkeys, his findings of 57.2–62.0 cm of females, was found to be higher than the findings on Eastern Algerian donkeys which measured 38.75–40.45 cm (Hannani *et al.* 2020). D/Kudu district donkeys which were predominantly males measured 31.1 cm (Khaleel *et al.* 2020) which was the lowest.

### CONCLUSION

This review paper investigated the morphological variations of donkey breeds and this review indicated that morphological differentiation of the donkey breeds exists, firstly within animals existing in the same country at different locations. This review also demonstrations forms of slight variations among animals of the same area within the country. The observed donkeys had clear distinctive coat colour variation and a variety of features in coat marks. The colours were grey, chocolate brown, black and roan, though it may appear that the most dominant colour for donkeys is grey, as to which type of grey is dominant remains a research question. Science through evolution has once stipulated that coat colour of an animal responds to the environment an animal is under, such that it survives from predators by blending in well into the environment. Since donkeys have an origin that is traced into wild then one can take that evolution science to be true. Another issue at hand when it comes to colour is uniformity or variation during breeding seasons, if the area has a different colour then colour variation will exist, if not then uniformity will exist. An indication that variation does exist within species of the same sex, also that variation further extends to same breed with different sex. Males in the obtained literature, showed higher measurements than females in some areas, while in other areas it there was no notifiable difference between males and females. This could be that the genetic makeup of those donkey breeds in areas where there were no differences in morphological measurements, could be the same and that their response to the environment was the same.

#### *Statement of conflict of interest*

The authors have declared no conflict of interest.

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