

Influence of season on daytime behavioral activities of donkeys in the Northern Guinea Savanna zone of Nigeria

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The present experiment was performed with the aim of investigating the effect of season on behavioral activities of donkeys during the rainy and harmattan seasons in the Northern Guinea zone of Nigeria. Sixteen apparently healthy donkeys were used as subjects and divided into four groups based on age. During each season, behavioral activities of each donkey were evaluated for three weeks using the focal animal sampling technique. The dry-bulb temperature (DBT), relative humidity (RH), and temperature-humidity index (THI) were obtained three times each day during the experimental period using standard procedures. In the rainy season, the mean DBT ($31.65 \pm 0.49^\circ\text{C}$), RH ($73.63 \pm 1.09\%$), and THI (84.39 ± 0.71) were significantly ($P < 0.0001$) higher than the corresponding values of $24.00 \pm 0.44^\circ\text{C}$, $36.80 \pm 0.92\%$, and 64.80 ± 0.62 in the harmattan season. During the rainy season, the donkeys spent $60.00 \pm 0.77\%$, $25.40 \pm 0.69\%$, and $2.94 \pm 0.21\%$ on grazing, resting, and grooming, respectively. During the harmattan season, the donkeys spent the most time on grazing ($76.76 \pm 0.43\%$), less time on resting ($11.97 \pm 0.38\%$), and the least time on grooming ($0.89 \pm 0.05\%$). In conclusion, season and seasonal variations affect the daytime behavioral activities of donkeys in the zone, and this should be considered in husbandry practices for donkeys.

Key words: rainy and harmattan seasons, donkey, behavior, daytime

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The domestic equid species (horse and donkey) belong to the taxonomic order *Perissodactyla*, family *Equidae* and genus *Equus*. The use of donkeys as draught animals in rural areas has improved considerably the involvement of small-scale farmers in the market economy [16, 38]. In Nigeria, donkeys are used mainly in the transportation of goods and agricultural produce to market [7]. Donkeys continue to be important in the transportation of goods in countries with large rural sectors, particularly in areas without access to affordable motor power, and those with rocky terrains [38]. Donkey milk could be considered for probiotic production because of its ability to upregulate the immune response of healthy and elderly humans [35]. Behavioral observation of animals in their natural environment is a vital key to the

practice of husbandry, as deviation from normal behavior is a reflection of some form of stress or disease [19, 23, 39]. Behavioral responses are the first line of defence against environmental challenges [5, 13]. Although behavior generally is used to measure stress, health, and productivity [15], which are prerequisites for animal welfare, an abnormal behavior indicates lack of adequate welfare [20]. Behavioral activities exhibited by donkeys include grazing, drinking, defecating, standing, grooming, lying down, walking, urinating, mutual grooming, aggression (kicking and biting), vocalization, sniffing, and flehmen [10, 12, 29].

The aim of the present study was to determine the influence of season on daytime behavioral activities (time budget) of donkeys, kept on natural pasture during the rainy and harmattan seasons.

Materials and Methods

Study area

The study was carried out during the rainy and harmattan seasons at the National Animal Production Research Insti-

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tute, Shika-Zaria (11° 12' N; 7° 33' E), in the Northern Guinea Savanna zone of Nigeria at an altitude of about 610 mm.

Management of animals

The donkeys were preconditioned for two weeks, during which they were screened and treated for ectoparasites and endoparasites. They were kept under a semi-intensive management system. At night (19:00–06:00 hr, GMT+1), they were confined in an open, fenced area with a partly roofed space without walls. They grazed during the day (08:00–10:00 hr, 12:00–14:00 hr and 16:00–18:00 hr) on natural pastures, comprising mainly Bermuda grass (*Cynodon dactylon*), gamba grass (*Andropogon gayanus*), and Egyptian crowfoot grass (*Dactyloctenium aegyptium*), and were supplemented with maize and sorghum bran. The donkeys were given access to water *ad libitum* during the experimental period.

Experimental procedure

Sixteen donkeys comprising four adult males, four adult females, four yearlings, and four foals were used for the study. The behavioral responses of the donkeys were evaluated using the continuous sampling method [2, 26]. The behavior of each donkey was monitored for a period of six hours each day, during which the duration (min) and frequency of behavioral activities were observed and recorded. Each behavioral parameter performed by the donkeys during three one-week recording periods in the rainy and harmattan seasons was expressed as the mean and standard error of the mean and as a percentage of the 6-hr period in minutes (360). The 6-hr observation period was divided into three periods: 08:00–10:00 hr, 12:00–14:00 hr, and 16:00–18:00 hr. These intervals divided the day into morning, afternoon, and evening periods. The experimental procedure was carried out two times a week for the three one-week periods in the rainy and harmattan seasons. The ambient temperature (AT) was recorded simultaneously at the experimental site using a wet- and dry-bulb thermometer (S. Brannan & Sons, Cumbria, England), and the relative humidity (RH) was obtained using an Omsons hygrometric table (Narindra Scientific Industries, Haryana, India). The temperature-humidity index (THI) during the experimental period was calculated using the method of Yousef [43] and the following equation:

$$\text{THI} = (0.35 t_d + 0.65 t_{wb}) \times 1.8 + 32,$$

Where t_d was the dry-bulb temperature (°C) and t_{wb} was wet-bulb temperature (°C).

Evaluation of behavioral parameters for the first, second, and third weeks during the rainy season commenced on August 22–23, September 1–2, and 9–10, 2013, respectively. Behavioral observation for the three weeks during the harmattan period was performed on December 22–23,

2013, and January 2–3 and 11–12, 2014. Ethological parameters of the donkeys were observed and recorded during the rainy and harmattan seasons. For practical reasons, all observations took place during the day between 08:00–18:00 hr, GMT+1. The donkeys were videotaped during the experimental procedure using a 16.0 MP Canon digital camera (PC 1741, A810, Canon, Tokyo, Japan). Prior to the commencement of each procedure, the animals were habituated to the presence of humans, and they could be approached closely (1 m) without appreciably influencing their behavior. The events that were monitored included grazing, resting, drinking, standing, walking, lying down, defecating, urinating, grooming, standing alert, braying, and kicking [12, 29].

Statistical analysis

The behavioral parameters were subjected to the Shapiro-Wilk test to determine values that were not normally distributed. The Mann-Whitney test for nonparametric data was used to compare grazing behavioral activities of donkeys during the rainy and harmattan seasons. Seasonal variations in thermal environment parameters were analyzed using the independent *t*-test. GraphPad Prism 5.0 for Windows (GraphPad Software, San Diego, CA, U.S.A.) was used for the analysis. Values of $P < 0.05$ were considered significant.

Results

Thermal environment parameters from the study period

During the rainy season, DBT and THI were lowest at 08:00–10:00 hr, with the values being $29.83 \pm 0.58^\circ\text{C}$ and 81.36 ± 0.74 , respectively (Table 1). In the afternoon (12:00–14:00 hr), DBT and THI rose to the peak values of $34.56 \pm 0.32^\circ\text{C}$ and 88.43 ± 0.54 , respectively. The RH was lowest in the afternoon (12:00–14:00 hr), with the value being $70.33 \pm 1.25\%$, while the highest RH ($76.00 \pm 1.99\%$) was recorded at 16:00–18:00 hr during the rainy season. During the harmattan season, DBT and THI were lowest at 8:00–10:00 hr, with values being $24.00 \pm 0.44^\circ\text{C}$ and 65.02 ± 0.47 , respectively. The DBT and THI were highest at 12:00–14:00 hr ($27.00 \pm 0.94^\circ\text{C}$ and 66.91 ± 1.09 , respectively) (Table 1). The highest RH ($36.80 \pm 0.92\%$) was recorded at 8:00–10:00 hr, while the minimum value of $32.90 \pm 1.93\%$ was obtained at 16:00–18:00 hr. The overall mean DBT recorded during the rainy season was $31.65 \pm 0.49^\circ\text{C}$, whereas during the harmattan season, the value was $24.65 \pm 0.49^\circ\text{C}$ ($P < 0.0001$). The overall mean values of RH during the rainy and harmattan seasons were $73.63 \pm 1.09\%$ and $35.30 \pm 0.95\%$ ($P < 0.0001$), respectively. The overall THI value decreased significantly ($P < 0.0001$) from 84.39 ± 0.71 during the rainy season to 64.80 ± 0.62 during the harmattan season (Table 1).

Table 1. Thermal environment parameters during the study period

Season	Hour of the day	Dry-bulb temperature	Relative humidity	Temperature-humidity index
Rainy	08:00–10:00	29.83 ± 0.58	74.56 ± 1.95	81.36 ± 0.74
		(28.00–32.50)	(67.00–85.00)	(78.90–85.20)
	12:00–14:00	34.56 ± 0.32	70.33 ± 1.25	88.43 ± 0.54
		(33.00–36.00)	(63.00–75.00)	(86.20–91.00)
	16:00–18:00	30.56 ± 0.53	76.00 ± 1.99	83.36 ± 0.87
		(28.00–36.00)	(62.00–80.00)	(78.90–87.89)
	Mean ± SEM	31.65 ± 0.49 ^a	73.63 ± 1.09 ^a	84.39 ± 0.71 ^a
		(28.00–36.00)	(62.00–85.00)	(78.90–91.00)
Harmattan	08:00–10:00	24.00 ± 0.44	36.80 ± 0.92	65.02 ± 0.47
		(22.50–26.00)	(33.00–42.00)	(63.50–67.10)
	12:00–14:00	27.00 ± 0.94	32.9 ± 1.93	66.91 ± 1.09
		(23.00–31.00)	(20.00–40.00)	(62.90–71.30)
	16:00–18:00	23.2 ± 0.55	36.22 ± 1.75	62.50 ± 1.07
		(21.00–25.50)	(26.00–43.00)	(58.10–66.80)
	Mean ± SEM	24.65 ± 0.49 ^b	35.30 ± 0.95 ^b	64.80 ± 0.62 ^b
		(21.00–31.00)	(20.00–43.00)	(58.10–71.30)

Mean ± SEM, Values in parentheses are minimum and maximum values, ^{a, b}Values with different superscript letters are significantly ($P < 0.05$) different.

Behavioral activities of donkeys during the rainy and harmattan seasons

Grazing: The percentage of time spent by the donkeys on grazing during the rainy and harmattan seasons is shown in Table 2. The overall mean percentage of time spent by the donkeys on grazing during the rainy season ($60 \pm 0.77\%$) was significantly ($P < 0.0001$) lower compared with the overall percentage of time spent by all donkeys during the harmattan season ($76.76 \pm 0.43\%$).

Resting: The percentage time spent resting during the rainy and harmattan season is shown in Table 2. During the rainy season, the overall percentage of time spent by all donkeys on resting ($25.41 \pm 0.69\%$) was significantly ($P < 0.0001$) higher compared with that of donkeys ($11.79 \pm 0.38\%$) during the harmattan season.

Walking: The percentage of time spent walking is shown in Table 2. During the rainy season, the overall mean percentage of time spent walking ($5.10 \pm 0.10\%$) was significantly ($P < 0.0001$) lower than that during the harmattan season ($6.09 \pm 0.16\%$).

Others: The percentage of time spent performing other behavioral activities including kicking, biting, flehmen, pawing, feet stamping, and head shaking is shown in Table 2. The mean percentage of time spent in other activities during the rainy season ($5.08 \pm 0.09\%$) was significantly ($P < 0.0001$) higher than that during the harmattan season ($3.20 \pm 0.10\%$).

Grooming: The percentage of time spent on grooming during the rainy and harmattan seasons is shown in Table 2. The overall percentage of time spent by all the donkeys on grooming during the rainy season ($2.94 \pm 0.21\%$) was

Table 2. Time spent (percentages) on daytime behavioral activities during the rainy and harmattan seasons (n=16)

Behavior	Rainy season*	Harmattan season*
Grazing	60.00 ± 0.77 ^a	76.76 ± 0.43 ^b
Resting	25.41 ± 0.69 ^a	11.79 ± 0.38 ^b
Walking	5.10 ± 0.10 ^a	6.09 ± 0.16 ^b
Others	5.08 ± 0.09 ^a	3.20 ± 0.10 ^b
Grooming	2.94 ± 0.21 ^a	0.89 ± 0.05 ^b
Rolling	0.28 ± 0.03 ^a	0.20 ± 0.02 ^b
Drinking	0.11 ± 0.01 ^a	0.22 ± 0.18 ^b
Urinating	0.08 ± 0.08	0.10 ± 0.05
Defecating	0.19 ± 0.01 ^a	0.27 ± 0.01 ^b
Alertness	0.13 ± 0.02 ^a	0.18 ± 0.01 ^b

*Mean ± SEM, ^{a, b}Values with different superscript letters are significantly ($P < 0.05$) different.

higher ($P < 0.0001$) than that of the donkeys ($0.89 \pm 0.05\%$) during the harmattan season. The average frequency of grooming for a donkey during the rainy season was 16 times per day, while the frequency of grooming during the harmattan season was 7.5 times per day when evaluated during the 6-hr period.

Rolling: The time spent rolling is shown in Table 2. The mean percentage of time spent by the donkeys on rolling ($0.28 \pm 0.03\%$) during the rainy season was higher ($P < 0.05$) compared with that obtained during the harmattan season ($0.20 \pm 0.02\%$).

Drinking: The percentage of time spent drinking during the rainy and harmattan season is shown in Table 2. There was a significant ($P < 0.0001$) difference in overall

percentage of time the donkeys spent drinking water ($0.11 \pm 0.01\%$) during the rainy season compared with the overall percentage during the harmattan season ($0.22 \pm 0.18\%$). The average frequency of water intake was once per day for the donkeys during the rainy season and twice per day during the harmattan season.

Urination: The percentage of time spent urinating is shown in Table 2. The overall percentage of time spent by the donkeys on urination during the rainy season did not differ from that in the harmattan season. The average frequency of urination for the donkeys was once per day in both the rainy and harmattan seasons.

Defecation: The percentage of time spent defecating during the rainy and harmattan seasons is shown in Table 2. The overall percentage of time spent by all the donkeys on defecation ($0.19 \pm 0.01\%$) was significantly ($P < 0.0001$) lower compared with that of the donkeys ($0.27 \pm 0.01\%$) during the harmattan season. The average frequency of defecation was three times per day during the rainy season, whereas it was four times per day during the harmattan seasons. **Alertness:** The percentage of time spent on alertness is shown in Table 2. During the rainy season, the overall percentage of time spent by the donkeys on standing alert ($0.13 \pm 0.02\%$) was significantly ($P < 0.05$) lower compared with the value recorded during the harmattan season ($0.18 \pm 0.01\%$).

Discussion

Thermal environmental parameters

The DBT obtained during the rainy season was outside the thermoneutral zone ($22\text{--}32^\circ\text{C}$) established for donkeys in the tropical region [17]. The high DBT and high RH recorded during the rainy season suggest that the rainy season was thermally stressful for the donkeys. The peak DBT obtained during the harmattan season fell within the comfort zone ($22\text{--}32^\circ\text{C}$) established for donkeys by Fielding and Krause [17]. The THI is used to estimate the degree of thermal stress experienced by an animal [25]. The high THI of 88 recorded during the rainy season was above the comfort zone of 80 established for animals [3]. This finding is an indication that the peak of the rainy season was apparently thermally stressful for the donkeys. The peak THI, which fell below 80 during the harmattan season, was suggestive of thermal comfort. The high RH obtained during the rainy season was above the thermoneutral zone of 30–70% established for donkeys [34]. However, the highest RH recorded during the harmattan season was within the comfort zone of 30–70% [34]. The results on the thermal environment showed that the rainy season was thermally stressful for the donkeys.

Seasonal variation in grazing behavioral responses in donkeys

The percentage of time spent by the donkeys on grazing during the rainy season showed that the donkeys spent more time grazing during the harmattan season than during the rainy season, which agrees with the results of previous investigations [6, 11, 24, 27] showing that grazing time is lower during the summer than during the winter period. Duncan [14] and Xia *et al.* [41] observed that the Camargue horse and the Asiatic wild ass increased their grazing time in winter in an attempt to maintain a high-quality diet. Increased grazing time may be related to a decrease in quantity and quality of grass available [24, 40, 42].

The grazing efficiency of ungulates may be influenced by factors such as the time of day, ambient temperature, RH, THI, season, vegetation type, and reproductive status [18, 36]. The high ambient temperature and THI during the rainy season in the present study may have contributed to the decrease in grazing time or activity. Seasonal variation in grazing time of the donkeys may have also been influenced by seasonal changes in forage quality and quantity. The findings of the present study are also in agreement with those obtained by Brinkmann *et al.* [8], who observed that limited quality of forage and the energy required to maintain an optimum body temperature increase grazing time in horses. The findings of the present study support the suggestion that donkeys absorb more nutrients per day, not only from food with a high-fiber content but also from forage with a wide range of qualities [21, 27, 32]. Thus, this demonstrates that donkeys are true grazers and able to adapt their foraging behavior to an unfavorable environment [30].

In the present study, the mean percentage of time spent resting was significantly higher during the rainy season than during the harmattan season. In a study performed by Lamoot *et al.* [24], donkeys spent significant portion of their time resting during the summer compared with winter period. In the present study, the donkeys spent more time resting during the afternoon period of the day (12:00–14:00 hr) when the ambient temperature and THI were relatively high. Resting normally minimizes energy expenditure of animals, which is a physiological response to high ambient temperature [4]. The results of the present study are in agreement with findings indicating that grazing by horses during the summer is adequate to meet nutritional requirements readily and in a relatively short time, thus, leading to availability of free time for the animals to spend resting [24].

The donkeys spent more time grooming during the rainy season than the harmattan season. This finding may be the result of a high ectoparasite population, high ambient temperature, and RH during the rainy season. Although the reason for the increase in grooming was not investigated in

the present study, it has been shown that grooming helps the donkeys to repel insects. Kimura [22] also observed a seasonal influence on grooming activity, with the highest occurrence of mutual grooming during the summer due to the shedding of coats and presence of insects. Walking was high during the harmattan season in the present study apparently because of exploratory behavior, which assists the animal in determining what was edible.

Donkeys spent more time drinking during the harmattan season than the rainy season in the present study. The volume of water consumed by a donkey during the harmattan season ranged from 20–35 l/day. However, less water was consumed during the rainy season (2–5 l/day). The daily water requirement of the horses ranges from 20–70 l depending on body weight, air temperature, RH, level of activity, and health [31]. Young horses consume an average of 30 l of water per day, but those in a cool environment consume less [18]. Water intake of stable horses ranges from 2–4 l/kg of dry matter in food consumed [21]. In the present study, the average frequency of water intake was once per day, and this is in agreement with the results obtained by Aganga and Tsopito [1], who reported that feral and domestic donkeys normally drink water once per day. The presence of dew and the high moisture content of the forage during the rainy season may be responsible for the lower consumption of water during the rainy season.

There was no significant variation in braying activity of donkeys during the two seasons because braying is used as means of communication between animals, and the loud sound is also a protective mechanism used to scare away predators. Braying is a form of “distress call” that can be initiated by the presence of many factors (such as wild animals and humans) in the environment, irrespective of the season.

When equids receive a stimulus that causes alertness, they react by exhibiting a rigid body posture with the head upright, ears pointed, eyes open, and head oriented toward the object or animal of focus [10, 28, 33, 37]. The percentage of time spent in standing alert was higher in the rainy season than the harmattan season in the present study. A higher percentage time spent in standing alert may be an indication that the donkeys exhibited predatory instinct more often during the rainy season to protect their young. The findings concerning the defecation and urination frequencies agree with those obtained by Canacoo and Avornyo [9], who reported that defecation occurs more frequently than urination in donkeys.

Conclusion

Grazing was the predominant behavioral activity of donkeys in the daytime during the seasons. More time (%)

was spent by the donkeys on grazing during the harmattan season due to the scarcity of forage and poor forage quality. High thermal environment parameters, that is, ambient temperature and RH, during the rainy season decreased the grazing time of the donkeys, with the animals spending more time in other restorative activities such as resting and grooming.

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Conflict of interest: The authors have no conflicts of interest.

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