Seasonal Variations in Behavioral Activity Patterns of *Antilope cervicapra* in Captivity

**Anqash Ayyub¹, Shabana Naz¹*, Sajida Arooj¹, Ibrahim Alhidary²,
Rifat Ullah Khan³ and Gianluca Pugliese⁴**

¹Department of Zoology, Government College University, Faisalabad, Pakistan
²Department of Animal Production, College of Food and Agriculture, King Saud University, Riadh, Saudi Arabia
³College of Veterinary Sciences, The University of Agriculture, Peshawar, Pakistan
⁴Section of Veterinary Science and Animal Production, Department of Precision and Regenerative Medicine and Jonian Area, University of Bari Aldo Moro, Valenzano, 70010 Bari, Italy

A B S T R A C T

The study aimed to observe the behavioral activity patterns of blackbucks in response to seasonal changes. Over a period from August 2022 to May 2023, a herd of 20 blackbucks, consisting of 4 bucks, 11 does, and 5 fawns, was monitored at the Wildlife Breeding Center, Gatwala, Faisalabad. The observation spanned three consecutive days for each season, with sessions from 6:00 am to 10:00 am, during which behavior was recorded at 30-minute intervals. This cycle was repeated every four hours for three subsequent days, covering each of the four seasons. Behavioral activities, including resting, feeding, ruminating, sleeping, sitting, foraging, walking, running, standing, and various others, were documented using binoculars, the naked eye, and a camera (Sony DSC-W800). Results indicated that blackbucks predominantly engaged in feeding and sitting during autumn, while winter saw increased sitting, resting, and foraging. In spring, they spent more time resting, feeding, ruminating, sitting, and foraging. Summer activities were centered around resting and sitting. Furthermore, doe blackbucks exhibited longer durations of resting, feeding, ruminating, sleeping, sitting, and foraging compared to bucks and fawns. While bucks and fawns generally displayed similar activity levels, fawns exhibited a higher tendency for sleeping.

INTRODUCTION

A broad understanding of the behavioral patterns is required for the better understanding of social relationships of an animal (Aktar *et al.*, 2015). When the behavior of an animal changes then the pattern of characteristics among a population across generations will also change (Rita and Khanal, 2019). Their behavior changes in captivity due to many factors like a stressful environment as compared to wild, rainfall etc. (Ali *et al.*, 2021). The Indian blackbuck (*Antilope cervicapra*) is one of the largest herbivores that can regulate its body temperature quite well and is adapted to moderate to high temperatures (Arandhara *et al.*, 2021). It lies in the subfamily Antelopinae and order Artiodactyla (Prasad *et al.*, 2020). They are diurnal animal but sometimes they may be active at night (Long, 2003). Does are smaller than the buck species. They are distinguished by the color of their heads and backs (Meena and Saran, 2018). The blackbucks are rapidly grazing animal (Sauer *et al.*, 2016). The species thrives in grassy plains, semi-desert, open spaces, and thin woodlands (Mahato *et al.*, 2010). Blackbucks show highest rut behavior during February and March as compared to July and August. The increased birth rate was noted in the months of July and August, suggesting a greater conception rate in the months of February and March (Saud *et al.*, 2022). In Pakistan, species preferred to live in hot deserts, tropical and subtropical climates (Sheikh and Molur, 2004). Average recorded lifespan in general for blackbuck is ten to fifteen years. They are reproductively functional around the whole year (Khalil *et al.*, 2020).

The quality of the food, its availability, and a variety of other conditions, such as daylight and weather, all have

a significant impact on the behavior of blackbuck (Meena *et al*., 2017; Meena and Saran, 2018). Zoo visitors also had an immense impact on its behavior (Rajagopal *et al*., 2011). Little research has been done on behavioral activity pattern of blackbuck in Pakistan (Farooq *et al*., 2022). Mostly, the preference is always given to the wild animals to study rather than a captive animal because there is a difference between the behavior of wild and captive specie (Jhala and Isvaran, 2016; Vats and Bhardwaj, 2009). The small and isolated population of blackbuck in captivity cause genetic problems as stress brought on by inbreeding, environment, and homozygosity (Tahir *et al*., 2022). Studying the blackbuck's stress reaction helps the management of the population in captivity and design of the facilities for successful conservation (Nikhil, 2020). Blackbuck is the quickest animals with the recorded average speed of 80km/h (Kumar and Rahmani, 2008; Khalil *et al*., 2020). Due to extinction of blackbuck in wild habitat of Pakistan, the only availability to study the individual specie is captivity. Keeping in view the above information, the present study was initiated to observe the behavioral activity pattern of blackbuck with seasonal changes.

MATERIALS AND METHODS

Study area

Wildlife Breeding Center, Gatwala is located at a distance of 11 km from Faisalabad district, Punjab province. The 24 acres facility of breeding center is divided into two areas for the purpose of raising wildlife. One division of breeding center is utilized by the reptiles and birds with independent enclosures. The second enclosure is for ruminants. This section is only accessible to staff members and researchers with specific permissions for research purposes, or to feed or shift the individuals from one enclosure to another etc. Additionally, there is a sitting space in the area outside the enclosures.

Species selection

A herd of 20 blackbucks (4 buck, 11 doe and 5 fawns) is maintained in an enclosure. Green fodder and a feed additive are supplied to the animals. *Tamarix aphylla* (Farash), *Albizia lebbeck* (Shareen), *Dalbergia sissoo* (Tahli), *E. globu* (Safeda), and *P. ciliate* (Himalayan poplar) are the prevailing plant species in the enclosures, as well as the *Ziziphus mauritiana* (Beri), *Moringa oleifera* (Suhanjna), *Melia azedarach* (Darek), *Syzygium cumini* (Jamun), *P. cineraria* (Jand), and some ornamental plants. Between the hours of 8:00 AM and 5:00 PM, the visitors are permitted to walk, enjoy observe species from outside the enclosures.

Data collection

The study was carried out from August, 2022 to May, 2023 to determine the activity pattern of blackbuck at captivity. The selected species was observed for three consecutive days, from 6:00 am to 10:00 am, during which its behavior was noted after every 30 minutes. Similarly, for the following three days, observations were made from 10:00 am to 2:00 pm, and for the subsequent three days, from 2:00 pm to 6:00 pm. This pattern continued for the next three days, with observations from 6:00 pm to 10:00 pm, followed by observations from 10:00 pm to 2:00 am for the next three days, and observations from 2:00 am to 6:00 am for the last three days. Therefore, the total trial period for each season consisted of 18 days. Every season was observed over the course of eighteen days throughout the following seasons: autumn (August), winter (December), spring (March) and summer (May). The total observation time was 4,320 min (72 h) for each of the four seasons. By using binoculars, naked eye, and a camera (Sony DSC-W800), the total time spent on various activities was visualized at the level of individual animals. Low-intensity light settings and exposure times were limited during nighttime observations as preventative measures against disruption. To prevent direct involvement with the animals, observations were also conducted from a distance. At each visit, general observations on age composition, sex, morphological changes during lactation, fighting, scent marking, licking, and potential grazing on wild plants was also noted. The night behavior was observed with the illumination of torches and the moonlight. By the use of common procedures, the activities that were observed included: Resting (individual be seated while the lower jaw and neck touching the floor), Feeding (variety of food desire, variety of leaf favored), Ruminating (the individual chewing the cud), Sleeping (inactive individual with closed eyes), Sitting (twisting of the legs), Foraging (straw picking), Walking (movements), Running (following, jumping, etc.), Standing (no motion, no alteration in position) and rubbing, licking, grooming, drinking, scratching, scent marking, fighting, aggression, playing etc.

Statistical analysis

Blackbuck's activities were changed and the percentage of time spent was noted. Using SPSS (version 24), the standard deviation and mean of the devoted time by fawns, does, and bucks were determined. The activity of fawn, doe, and buck blackbucks was compared by using the ANOVA technique. ANOVA was used to determine the significance of differences in time budgeting and group behavior at the 0.05 significant level.

RESULTS

A group of twenty blackbucks consisting of 4 adult bucks, 11 doe, and 5 fawns, was monitored for a total duration of 4,320 minutes (72 h) in each season at the Wildlife Breeding Center in Gatwala, Faisalabad. Table I shows the basic parameter of buck, doe and fawn. According to Table II, there are notable variations in the behaviors exhibited by buck, doe, and fawn blackbucks throughout the year.

Table I. Basic parameters of buck, doe and fawn.

	Buck	**Doe**	**Fawn**
Weight	35-50kg	30-45kg	8-20kg
Shoulder height	65-80cm	65-75cm	35-45cm
Horn	Present	Absent	Absent
Color	Blackish brown	Yellowish white	Yellowish white

Autumn

The *A. cervicapra* spend most of their time feeding and sitting in autumn. They spend most of their time resting, sitting and foraging in autumn and winter. They spend most of their time resting, feeding, ruminating, sitting and foraging in spring. Resting and sitting were the dependent activities seen in *A. cervicapra* in summer. Animals were fed with *Trifolium alexandrinum* and *Sorghum bicolor* as a continuous feed. Natural rock salt is provided to ensure the blackbucks with essential minerals for optimal health. During winter, grains were also provided regularly to control the body conditioning of blackbucks. During harsh weather conditions like raining, intense heat etc., the blackbucks preferred to sit under the shady trees. Blackbucks spent more time grazing during the rainy season.

The resting, feeding, ruminating, sleeping, sitting, foraging, and walking activities show statistically highly significant differences in mean time spent between buck, doe, and fawn *A. cervicapra*. These activities are likely to be influenced by factors such as energy requirements, social dynamics, and environmental conditions.

The doe of *A. cervicapra* tends to spend more time in resting (23.09 ± 21.18), feeding (51.20 ± 85.59), and ruminating (19.54 ± 18.76) followed by fawns (14.15 ± 10.48; 6.70 ± 16.53; 10.75 ± 8.35) and bucks (6.92 ± 8.27; 11.72 ± 18.20; 5.81 ± 6.47). This may be due to the specific nutritional and reproductive needs of the doe population. Fawn spent more time in sleeping (15.45 ± 19.04) followed by doe (7.04 ± 11.06) and buck (1.96 ± 4.60). Doe spent highest average time in sitting (29.37 ± 24.33), foraging

(29.23 ± 41.07) and walking (13.06 ± 18.33) followed by fawn (24.88 ± 18.05; 8.20 ± 13.11; 5.20 ± 9.84) and buck (13.56 ± 15.80; 10.27 ± 14.66; 5.79 ± 9.21). There is a significant difference in the time spent on running (F = 3.526, P < 0.05) and standing (F = 3.713, P < 0.05) activity between buck (0.69 ± 2.32; 0.66 ± 2.20), doe (0.22 ± 1.04; 1.72 ± 4.63), and fawn (0.28 ± 1.18; 0.94 ± 2.99) during the autumn season in captivity. Other activities (rubbing, licking, grooming, drinking, scratching, scent marking, fighting, aggression, and playing) with F = 1.815, P > 0.05 do not exhibit statistically significant differences among the buck (1.35 ± 2.67), doe (1.47 ± 3.11), and fawn (0.91 ± 1.88). In the wild, breeding peaks in autumn, but there is no breeding apex in captive condition.

Winter

The doe spent the most time resting (19.54 ± 25.72 SD), followed by fawns (15.18 ± 19.19 SD), and buck (5.93 ± 8.41 SD) (Table II). There is a statistically significant difference in resting time among the three groups (F = 45.173, P = 0.002). Unlike their wild counterparts, captive blackbucks were not subjected to the same bitter cold. Still, behavioral changes were seen, such as a greater amount of time spent in covered places or a decrease in activity during the winter months. Similar to resting, doe spend the most time feeding (15.33 ± 30.52 SD), followed by fawns (10.12 ± 19.88 SD), and buck (2.95 ± 7.96 SD). There is a statistically significant difference in feeding time among the three groups (F = 32.349, P = 0.020).

Doe also spend the most time ruminating (18.62 ± 24.69 SD), followed by fawns (14.31 ± 18.27 SD), and buck (5.33 ± 7.70 SD). There is a statistically significant difference in ruminating time among the three groups (F = 45.062, P = 0.002). There is no statistically significant difference in sleeping time between buck, doe, and fawns during the winter season (F = 39.598, P = 0.066). However, doe (5.75 ± 11.01 SD) tends to spend slightly more time sleeping compared to buck (1.85 ± 4.31 SD) and fawns (5.62 ± 10.74 SD). Doe spend the most time sitting (28.66 ± 35.44 SD), followed by fawns (24.16 ± 28.97 SD), and buck (11.89 ± 15.05 SD). There is a statistically significant difference in sitting time among the three groups (F = 24.564, P = 0.001).

Doe spend the most time foraging (36.00 ± 37.47 SD), followed by fawns (15.83 ± 22.56 SD), and buck (15.16 ± 23.52 SD). There is a statistically significant difference in foraging time among the three groups (F = 27.985, P = 0.000). Buck (5.31 ± 12.67 SD) spent slightly more time walking compared to doe (4.47 ± 11.10 SD) and fawns (0.08 ± 0.40 SD). There is a statistically significant difference in walking time among the three groups (F = 15.969, P = 0.020). There is no statistically significant

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Table II. Comparison of average time (Mean ± SD) spent in minutes during different activities by buck, doe and fawn *A. cervicapra* during autumn, winter, spring and summer in captivity.

Activity	Group	Autumn	Winter	Spring	Summer
Resting	Buck	6.92 ± 8.27[a]	5.93 ± 8.41[a]	2.93 ± 4.69[a]	4.00 ± 5.88[a]
	Doe	23.09 ± 21.18[c]	19.54 ± 25.72[b]	24.85 ± 28.94[c]	21.64 ± 21.63[b]
	Fawn	14.15 ± 10.48[b]	15.18 ± 19.19[b]	12.81 ± 11.10[b]	21.45 ± 12.62[b]
	F-value	45.173	45.173	17.644	22.338
	P-value	0.000*	0.002*	0.000*	0.000*
Feeding	Buck	11.72 ± 18.20[a]	2.95 ± 7.96[a]	4.75 ± 13.52[a]	3.66 ± 8.13[a]
	Doe	51.20 ± 85.59[b]	15.33 ± 30.52[b]	14.18 ± 26.91[b]	41.60 ± 62.57[b]
	Fawn	6.70 ± 16.53[a]	10.12 ± 19.88[b]	15.18 ± 19.19[b]	9.37 ± 16.37[a]
	F-value	32.349	32.349	3.745	14.175
	P-value	0.000*	0.020**	0.026*	0.000*
Ruminating	Buck	5.81 ± 6.47[a]	5.33 ± 7.70[a]	2.56 ± 4.93[a]	2.85 ± 4.42[a]
	Doe	19.54 ± 18.76[c]	18.62 ± 24.69[b]	20.91 ± 22.53[b]	18.52 ± 19.45[b]
	Fawn	10.75 ± 8.35[b]	14.31 ± 18.27[b]	14.31 ± 18.27[b]	17.06 ± 10.53[b]
	F-value	45.062	45.062	14.370	21.180
	P-value	0.000*	0.002*	0.000*	0.000*
Sleeping	Buck	1.96 ± 4.60[a]	1.85 ± 4.31[a]	1.27 ± 3.41[a]	0.37 ± 1.82[a]
	Doe	7.04 ± 11.06[b]	5.75 ± 11.01[b]	0.91 ± 2.77[a]	1.58 ± 3.87[a]
	Fawn	15.45 ± 19.04[c]	5.62 ± 10.74[b]	5.43 ± 8.13[b]	5.43 ± 8.13[b]
	F-value	39.598	39.598	10.644	11.915
	P-value	0.000*	0.066[NS]	0.000*	0.000*
Sitting	Buck	13.56 ± 15.80[a]	11.89 ± 15.05[a]	4.08 ± 6.46[a]	7.64 ± 11.26[a]
	Doe	29.37 ± 24.33[b]	28.66 ± 35.44[b]	4.54 ± 7.04[a]	32.54 ± 27.45[b]
	Fawn	24.88 ± 18.05[b]	24.16 ± 28.97[b]	24.16 ± 18.85[b]	41.25 ± 23.14[b]
	F-value	24.564	24.564	42.368	30.919
	P-value	0.000*	0.011*	0.000*	0.000*
Foraging	Buck	10.27 ± 14.66[a]	15.16 ± 23.52[a]	9.52 ± 10.63[ab]	3.75 ± 7.38[a]
	Doe	29.23 ± 41.07[b]	36.00 ± 37.47[b]	5.85 ± 9.17[a]	20.56 ± 28.40[b]
	Fawn	8.20 ± 13.11[a]	15.83 ± 22.56[a]	12.10 ± 13.06[b]	7.87 ± 13.63[a]
	F-value	27.985	27.985	3.861	10.556
	P-value	0.000*	0.000*	0.023*	0.000*
Walking	Buck	5.79 ± 9.21[a]	5.31 ± 12.67[b]	4.77 ± 8.27[a]	2.85 ± 5.85[a]
	Doe	13.06 ± 18.33[b]	4.47 ± 11.10[b]	8.56 ± 19.82[a]	6.39 ± 14.47[a]
	Fawn	5.20 ± 9.84[a]	0.08 ± 0.40[a]	7.60 ± 17.43[a]	4.18 ± 12.09[a]
	F-value	15.969	15.969	0.731	1.181
	P-value	0.000*	0.020**	0.483[NS]	0.310[NS]
Running	Buck	0.69 ± 2.32[b]	0.61 ± 1.60[b]	0.35 ± 1.10[a]	0.06 ± 0.31[a]
	Doe	0.22 ± 1.04[a]	0.10 ± 0.51[a]	0.45 ± 1.64[a]	0.03 ± 0.21[a]
	Fawn	0.28 ± 1.18[a]	0.25 ± 0.91[ab]	0.18 ± 0.64[a]	0.39 ± 2.74[a]
	F-value	3.526	3.526	0.619	0.767
	P-value	0.030**	0.070[NS]	0.540[NS]	0.466[NS]
Standing	Buck	0.66 ± 2.20[a]	0.72 ± 2.53[a]	1.10 ± 2.49[b]	0.37 ± 0.95[a]
	Doe	1.72 ± 4.63[b]	0.83 ± 2.96[a]	0.54 ± 1.42[ab]	0.35 ± 1.06[a]
	Fawn	0.94 ± 2.99[ab]	1.14 ± 3.27[a]	0.16 ± 0.47[a]	0.16 ± 0.47[a]
	F-value	3.713	3.713	3.776	0.834
	P-value	0.025**	0.770[NS]	0.025**	0.437[NS]
Others	Buck	1.35 ± 2.67[a]	3.43 ± 9.83[a]	1.41 ± 3.16[b]	0.37 ± 1.00[a]
	Doe	1.47 ± 3.11[a]	1.27 ± 3.65[a]	1.02 ± 2.39[ab]	0.56 ± 1.54[a]
	Fawn	0.91 ± 1.88[a]	2.04 ± 5.19[a]	0.25 ± 0.91[a]	0.25 ± 0.91[a]
	F-value	1.815	1.815	3.056	0.845
	P-value	0.164[NS]	0.285[NS]	0.050**	0.432[NS]

difference in running and standing time among buck, doe, and fawns during the winter season (F = 3.526, P = 0.070 and F = 3.713, P = 0.770, respectively). There is no statistically significant difference in the time spent on other activities (rubbing, licking, grooming, drinking, scratching, scent marking, fighting, aggression, and playing) among buck, doe, and fawns during the winter season (F = 1.815, P = 0.285).

Spring

The doe (24.85 ± 28.94 SD) spent significantly more time resting compared to buck (2.93 ± 4.69 SD) and fawns (12.81 ± 11.10 SD) (Table II). The difference in resting time among the three groups is statistically significant (F = 17.644, P = 0.000). Fawns (15.18 ± 19.19 SD) spend more time feeding followed by doe (14.18 ± 26.91 SD) and buck (4.75 ± 13.52 SD). However, the difference in feeding time among the three groups is only marginally statistically significant (F = 3.745, P = 0.026). Doe (20.91 ± 22.53 SD) spend significantly more time ruminating followed by fawns (14.31 ± 18.27 SD) and buck (2.56 ± 4.93 SD). The difference in ruminating time among the three groups is statistically significant (F = 14.370, P = 0.000).

Fawns (5.43 ± 8.13 SD) spend significantly more time sleeping followed by buck (1.27 ± 3.41 SD) and doe (0.91 ± 2.77 SD). The difference in sleeping time among the three groups is statistically significant (F = 10.644, P = 0.000). Fawns (24.16 ± 18.85 SD) spend significantly more time sitting followed by doe (4.54 ± 7.04 SD) and buck (4.08 ± 6.46 SD). The difference in sitting time among the three groups is statistically significant (F = 42.368, P = 0.000). Fawns (12.10 ± 13.06 SD) spend more time foraging followed by buck (9.52 ± 10.63 SD) and doe (5.85 ± 9.17 SD). The difference in foraging time among the three groups is statistically significant (F = 3.861, P = 0.023). There are no statistically significant differences in the time spent on walking, running, standing, and other activities among buck, doe, and fawns during the spring season (F = 0.731, P = 0.483; F = 0.619, P = 0.540; F = 3.776, P = 0.025; F = 3.056, P = 0.050, respectively).

Summer

The doe (21.64 ± 21.63 SD) spent significantly more time resting as compared to fawns (21.45 ± 12.62 SD) followed by buck (4.00 ± 5.88 SD) (Table II). The difference in resting time among these three groups is statistically highly significant (F = 22.338, P = 0.000). Doe (41.60 ± 62.57 SD) spend significantly more time feeding followed by fawns (9.37 ± 16.37 SD) followed by buck (3.66 ± 8.13 SD). The difference in feeding time among the three groups is statistically highly significant (F = 14.175, P = 0.000). Doe (18.52 ± 19.45 SD) spent significantly

more time ruminating compared to fawns (17.06 ± 10.53 SD) followed by buck (2.85 ± 4.42 SD). The difference in ruminating time among the three groups is statistically highly significant (F = 21.180, P = 0.000).

Fawns (5.43 ± 8.13 SD) spend significantly more time sleeping followed by doe (1.58 ± 3.87 SD) followed by buck (0.37 ± 1.82 SD). The difference in sleeping time among the three groups is statistically significant (F = 11.915, P = 0.000). Fawns (41.25 ± 23.14 SD) and doe (32.54 ± 27.45 SD) spend significantly more time sitting as compared to buck (7.64 ± 11.26 SD). The difference in sitting time among the three groups is statistically highly significant (F = 30.919, P = 0.000). Doe (20.56 ± 28.40 SD) spend significantly more time foraging followed by fawns (7.87 ± 13.63 SD) followed by buck (3.75 ± 7.38 SD). The difference in foraging time among the three groups is statistically significant (F = 10.556, P = 0.000). There are no statistically significant differences in the time spent on walking, running, standing, and other activities among buck, doe, and fawns during the spring season (F = 1.181, P = 0.310; F = 0.767, P = 0.466; F = 0.834, P = 0.437; F = 0.845, P = 0.432).
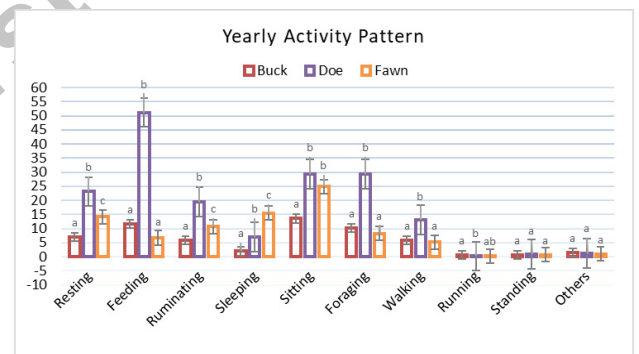

Fig. 1. Mean time spent in minutes by buck, doe and fawn *A. cervicapra* in various activities throughout the year at captivity.

The buck, doe, and fawn Blackbucks showed significant variations in their resting, feeding, ruminating, sleeping, sitting, foraging, walking, and running behaviors (F-values ranging from 3.622 to 95.075, with P < 0.05) throughout the year. Resting was a common activity among the group (Fig. 1). Feeding was most continuous in doe (35.71 ± 66.07) while sleeping was most commonly observed in fawns (10.15 ± 15.04). Sitting was the highly significant behavior observed across the group. Foraging was a significant behavior but it was most common among buck (10.00 ± 15.42) and doe (26.73 ± 38.23). Bucks spent highest period of time in walking (4.76 ± 9.19) and running (0.49 ± 1.73) as compared to doe and fawn. Standing

was observed to be non-significant throughout the study among the group. In other activities, bucks (1.50 ± 4.37) spent more time for example in grooming, urinating due to higher walking activity. In captivity, blackbucks were more alert, particularly when there was a higher density of visitors. In the breeding center, spring and autumn saw the highest visitor densities, which may have an impact on the stress levels of the animals and particularly disturbed the sitting, feeding, sleeping and standing behaviors.

DISCUSSION

A total of 20 blackbucks were monitored to assess the behavioral activity patterns during different seasons. Resting was a common behavior observed in all age groups. Doe spent more time in feeding while Fawn devoted more time sleeping. Throughout the four seasons, there are noticeable differences in the behaviors displayed buck, doe, and fawn of blackbucks. The current study was done at Wildlife Breeding Center Gatwala, Faisalabad. The breeding facility has shown significant progress in the conservation efforts of several endangered species. In addition, there has been a notable increase in the number of blackbucks, an important species for the center's conservation efforts. Breeding peaks occur in the autumn in the wild (Choudhary and Chisty, 2022), but at wildlife breeding center Gatwala, there is no breeding apex under the captive condition. Numerous species of animals got extinct due to rise in temperature (Abas *et al.*, 2017). Behavioral adaptability gives organisms a method to lessen some of the stresses brought on by climate change and may promote persistence in situations that would otherwise be unfavorable. It was observed that many species have the ability to alter their behavior in response to changes in climatic factors (Beever *et al.*, 2017). The temperature of the local environment and the climate has an impact on the ecology of a region, the availability of food, and the behavior of prey and predators (Lovette, 2005). It is challenging to document behavioral observations in natural settings and with human shy species. On the other hand, an animal kept in captivity might be the subject of more planned research. However, compared to the wild, the investigated animals may behave differently in captivity (Abbas *et al.*, 2012). The current study found that blackbucks kept in captivity spend 15% of their daily time feeding and foraging. In earlier research, it spent 17% of its feeding and foraging time in a semi-captive state (Farooq *et al.*, 2022), 65% of its foraging activity in the wild (Priyadarshini, 2005) and 40% and 36% in the Texas Zoo (Mungall, 1978; Ranjitsinh, 1982). Feeding (38.56%) was the most prevalent activity during a typical day, followed by resting (32%), walking (14.2 %), and other activities (8.32 %) (Khanal, 2002).

According to a report, blackbucks preferred to relax in areas with less visitor disturbance (Archunan and Rajagopal, 2013). Blackbuck bucks and does spend 26% of their time walking and 12% resting. Fawns slept substantially more (32% of the time) (Farooq *et al.*, 2022). In the current study, fawns spent 16% of their time sleeping, compared to 12% for bucks and 15% for does. Buck, doe, and fawn walking rates were 9%, 7%, and 5%, respectively. Feeding was limited to the morning and midday, while foraging and other activities had to take place in the evening. Resting at midday in the summer and just feeding in the morning and evening (Meena *et al.*, 2017) while feeding and other activities were present in the morning and evening (Farooq *et al.*, 2022). The blackbuck was observed to ruminate sometimes while standing, resting, and sitting. Rumination was 11% on average in buck and 14% in doe. According to Farooq *et al.* (2022) rumination was 13% for buck and 18% for doe. According to a report, grooming and licking have a significant communication and signaling role, and these behaviors vary depending on the season (Jayarani *et al.*, 1988).

Limitations

The degree of experience of different observers may differ, and the use of tools like cameras and binoculars may favor some activities over others, which might have an impact on the behavioral patterns that are observed. Since just one Wildlife Breeding Center had been employed for the study, it's possible that the behavioral tendencies noticed there aren't typical of blackbucks in other confined settings or across other geographic regions.

CONCLUSION

Due to many reasons including energy requirements and environmental situations, adult bucks, does, and fawns exhibit substantially different behaviors. Does devoted more time to eating and sleeping, perhaps as a result of their particular dietary and reproductive requirements. During various seasons, bucks engage in more strenuous behaviors like standing and running, whereas fawns emphasize sleeping. Visitor's density that was observed higher during the spring and autumn season had a stressful impact on the behavior of blackbuck. Season-specific factors are crucial for wildlife management and conservation efforts. Developing appropriate strategies for the defense and maintenance of this species in its native environment can be made easier with an understanding of these patterns.

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Ethical approval

The Committee on Animal Rights and Welfare, GC University Faisalabad, Pakistan approved this study (DZ/34/2023).

Availability of data and materials

On request.

Statement of conflict of interest

The authors have declared no conflict of interest.

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