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The Daily Behavior of Bali Cattle (*Bos sondaicus*) at the Conservation *Ex-Situ* of PT Taman Satwa Kota Semarang

(PERILAKU HARIAN SAPI BALI (*BOS SONDAICUS*) DI LEMBAGA KONSERVASI *EX-SITU* PT TAMAN SATWA KOTA SEMARANG)

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ABSTRACT

Bali cattle are tropical animals that adapt to environmental changes in an effort to maintain survival. The presence of visitors at the conservation area affects the daily behavior of Bali cattle. The study was aimed to analyze the daily behavior of Bali cattle at the Conservation *Ex-situ* of PT Taman Satwa Kota Semarang under conditions of weekday and weekend; on weekdays (Monday to Friday) there were fewer visitors, and on weekends (Saturday to Sunday) there were more visitors. This study was conducted for 30 days, and behavior observation using the focal animal sampling method included eating behavior, group tendency behavior (allelomimetic) and avoidance behavior (agonistic), shelter seeking, and eliminative behavior. Cattle were observed for two hours at 10-minute intervals. Data analysis was carried out using the t-test at a significant level of 5%. The results of the study showed that visitor activity caused Bali cattle to tend to reduce their active movement and choose to remain silent away from the enclosure fence. The excitement of visitors on weekdays and weekends had a significant effect ($P<0.05$) on the duration of eating (foraging), agonistic, and eliminative behaviors, as well as the frequency of allelomimetic and eliminative behaviors. The conclusion of this study was that the elimination and group behavior of Bali cattle in conservation areas occurred more frequently and for longer durations on weekdays as an indicator that the cattle were uncomfortable, so it was necessary to limit visiting time in the cattle pen area, which may improve cattle welfare.

Keywords: Bali cow; cattle welfare, foraging; eliminative behavior

ABSTRAK

Sapi bali merupakan hewan tropis yang telah mampu beradaptasi terhadap perubahan lingkungan dan dapat bertahan sampai dengan saat ini. Kehadiran pengunjung pada hari kerja ataupun hari libur di lembaga konservasi dapat memengaruhi perilaku dan dalam jangka panjang dapat berdampak pada kesejahteraan sapi bali. Tujuan dari penelitian ini adalah menganalisis perilaku harian sapi bali di Lembaga Konservasi PT Taman Satwa Kota Semarang pada kondisi sepi pengujung dan ramai pengunjung. Kondisi sepi pengunjung dijumpai pada hari kerja (Senin sampai Jumat) dan pada hari libur (Sabtu dan Minggu) jumlah pengunjung lebih banyak. Pengamatan dilakukan selama 30 hari dengan metode *focal animal sampling*, perilaku harian sapi bali diamati selama dua jam dengan selang waktu 10 menit, yang meliputi perilaku makan, kecenderungan berkelompok (allelomimetik), berselisih, bertengkar, dan menghindar (agonistik), mencari tempat berteduh, dan membuang kotoran (eliminatif). Analisis data dilakukan menggunakan t test pada taraf signifikansi 5%. Hasil penelitian menunjukkan bahwa aktivitas pengunjung menyebabkan sapi bali cenderung mengurangi pergerakan aktifnya dan memilih berdiam diri menjauhi pagar kandang. Perbedaan signifikan (P<0,05) ditemukan pada durasi perilaku makan, perilaku agonistik, perilaku membuang kotoran serta frekuensi perilaku kecenderungan berkelompok dan perilaku membuang kotoran pada hari kerja dan hari libur. Simpulan dari penelitian ini perilaku eliminatif dan berkelompok sapi bali di area konservasi lebih sering muncul dengan durasi lebih lama pada hari libur sebagai indikator bahwa sapi tidak nyaman sehingga diperlukan pembatasan waktu berkunjung di area kandang sapi yang mungkin dapat meningkatkan kesejahteraan sapi.

Kata-kata kunci: sapi bali; kesejahteraan sapi; merumput; perilaku eliminatif

INTRODUCTION

Indonesia has several types of cattle that have adapted well over a long period of time, such as Bali cattle, Ongole crossbred cattle (PO), Madura cattle, Javanese cattle, Sumatran cattle (coastal cattle), and Aceh cattle (Hikmawaty *et al*., 2014). Bali cattle (*Bos sondaicus*) is an indigenous Indonesian beef cattle that has been domesticated from bulls (*Bos javanicus*), which includes wild banteng in the areas of Java, Bali Islands (Toelihere, 2003; Marsetyo *et al*., 2012). The population of Bali cattle in 2023 reached 38.6% of the total number of beef cattle raising (Ditjenakkeswan, 2023). The decline in productivity of Bali cattle is caused by a decrease in the genetic quality of Bali cattle due to negative selection and improper maintenance management (Hikmawaty *et al*., 2014). The productivity of Bali cattle can be increased through genetic and environmental improvements or maintenance management (Baco *et al*., 2020). Bali cattle has the potential to be developed, so efforts need to be made to improve the genetic quality of Bali cattle in order to preserve it in the future (Sutarno and Setyawan, 2015).

Conservation efforts for Bali cattle carried out through breeding can support the survival of Bali cattle through the provision of quality feed, health checks, and pens cleaning. The efforts to preserve Bali cattle carried out in the breeding grounds can stimulate Bali cattle to adapt because the conditions in the conservation breeding grounds are different from pastures or pen. This difference can form a different behavioral pattern for intensively (pens) or extensively (grazing) raised individuals (Muslimah *et al*., 2020). Bali cattle in conservation areas will adapt to the outside environment and can increase interaction with humans. Optimization of this conservation

area can be used as a success in preserving Bali cattle (Talib *et al*., 2003).

Behavior is an expression produced by coordinated neural activity to detect, process, and respond to internal (nutrients, hormone levels, and neurotransmitters) and external (environment, unconditioned, and conditioned stimuli) stimuli. The detection of stimuli requires afferent pathways as an entry point to the central nervous system. Stimulation received by the central nervous system produces innate and learned behaviors; this information is processed depending on the age, sex, endogenous hormonal status, and memory of the animal. Activation of efferent pathways requires muscle, endocrine, emotional, cognitive, and behavioral responses. The subcortical nervous system regulates basic neurobiological operations in producing innate emotions and behaviors, such as seeking, fear, aggression, sex, care, panic, and play systems (Coria-Avila *et al.*, 2022). Research on the behavior of animals, particularly beef cattle, has not yet established a connection between the physiological functions of the animal's body and its daily behavioral patterns. This research is crucial to obtaining clear scientific information on the daily behavior of Bali cattle at the *ex-situ* conservation areas that is related to the physiological processes that drive the daily behavior to be expressed, as there is currently very little information on the relationship between animal behavior and body functions that are expressed in animal welfare. This research was aimed to analyze the daily behavior of Bali cattle at the Conservation *Ex-situ* of PT Taman Satwa Kota Semarang under conditions of few (weekday) and high (weekend) visitor numbers, including ingestive, allelomimetic (tendency to group and engage in the same activity), agonistic (disagreement, fighting, and avoidance), shelter seeking behavior, and eliminative behavior (defecation and urination).

RESEARCH METHODS

This research was conducted in the conservation *ex-situ* area of PT Taman Satwa Kota Semarang. The objects observed in this research were five Bali cattle, consisting of four females and one male. The method for observation behavior is using focal animal sampling (Martin and Bateson, 2007). The duration and frequency of all daily activities observed by Bali cattle occurred for two hours with 10-minute intervals. Data collection was carried out through direct observation by recording all daily activities and indirectly by recording all behavior using a video camera (Redmi Note 9 6/128, versi MIUI 13.0.3) with a tripod. Observation was arranged on weekdays (Monday-Friday) and weekends (Saturday-Sunday). Each day consisted of three observation times: morning (07.30-09.30 a.m.), noon (10.30 a.m-12.30 p.m.), and af-ternoon (01.30-03.30 p.m.). The definition of each observed behavior is listed in Table 1.

The data obtained was presented descriptively, which was to compare the data between weekdays and weekends. Daily behavior data were analyzed using normality and homogeneity tests as a prerequisite before being analyzed with a t-test at a significance level of 5% ($\alpha = 0.05$) using SPSS version 23 for Windows.

Table 1. List of observed daily behaviors and definition of each behavior

Daily behavior	Definition
Feeding behavior (ingestive)	A series of activities that include foraging, grazing, and ruminating
Grouping behavior (allelomimetic)	Foraging activity with a tendency to be in groups
Agonistic behavior	Mock fighting/butting calf which is play or

	fighting behavior
Shelter seeking behavior	The tendency to seek a shady environment, avoid danger and to maintain body temperature.
Eliminative behavior	Defecation and/or urination activities to remove the body's metabolic waste

RESULTS AND DISCUSSION

Observation of the daily behavior of Bali cattle at the concervation area on weekdays and weekends showed that the duration of foraging behavior, agonistic, and eliminative behavior a significant diff-erence ($P<0.05$; Table 2), as was the frequency of allelomimetic (tendency to group) and eleminative behavior ($P<0.05$; Table 3). The number of visitors who attend on weekdays was an average of 100 visitors, while on weekends the number of visitors reaches 300 visitors per day. The feeding behaviors observed in this study included foraging, grazing, ruminating, and drinking activities. The Bali cattle we-re fed with kolonjono grass, sweet pota-toes, and polar using the drop-in method by the keeper. Foraging behavior of Bali cattle on weekdays required a longer du-ration than on weekends, while the du-ration of grazing, ruminating, and drinking showed no significant difference on week-days and weekends.

Table 2. Duration of Bali cattle behavior in *weekday* and *weekend*.

Variable	Duration (minute)	
	Weekday $\bar{X} \pm$ SD	*Weekend* $\bar{X} \pm$ SD
Foraging	$15,40^{a} \pm 4,65$	$9,68^{b} \pm 3,27$
Grazing	$71,74 \pm 12,94$	$49,28 \pm 7,51$
Ruminating	$27,85 \pm 5,16$	$31,31 \pm 5,74$
Drinking	$1,35 \pm 0,48$	$1,78 \pm 0,32$
Allelomimetic (grouping)	$53,60 \pm 22,32$	$64,14 \pm 13,52$
Agonistic	$0,71^{b} \pm 0,37$	$1,38^{a} \pm 0,18$
Resting	$60,70 \pm 14,04$	$62,31 \pm 9,29$
Eliminative	$1,32^{b} \pm 0,26$	$1,81^{a} \pm 0,42$

[a-b]Different superscripts on the same row indicated significantly differ ($P<0.05$).

Table 3. Frequency of Bali cattle behavior in weekday and weekend.

Variable	Frequency (times)	
	Weekday $\bar{X} \pm$ SD	*Weekend* $\bar{X} \pm$ SD
Foraging	$16,80 \pm 8,23$	$11,60 \pm 4,51$
Grazing	$20,40 \pm 8,33$	$16,80 \pm 2,78$
Ruminating	$20,20 \pm 7,43$	$24,20 \pm 7,53$
Drinking	$3,80 \pm 0,84$	$5,00 \pm 0,71$
Allelomimetic (grouping)	$17,00^{b} \pm 2,45$	$19,80^{a} \pm 3,56$
Agonistic	$3,40 \pm 1,14$	$6,00 \pm 1,58$
Resting	$20,40 \pm 3,13$	$29,80 \pm 7,36$
Eliminative	$4,00^{b} \pm 0,71$	$6,20^{a} \pm 1,64$

[a-b]Different superscripts on the same row indicated significantly differ ($P<0.05$).

The difference in feeding behavior of Bali cattle between weekdays and weekends was influenced by the visitor factor. There were relatively few visitors at the conservation area on weekdays, so the foreging duration was longer, and cattle were free to express their natural behavior to find their food. Conversely, on weekends, because of the crowded condition and the higher visitors, we assumed the Bali cattle were uncomfortable and reduced their movements of active foraging; cattle prefer to perform drinking and ruminating activities under shelter. Kusuma *et al.* (2015) reported that in crowded conditions, cattle are likely to feel disturbed and stressed, which can affect their appetite and reduce feed intake. Wiyono *et al*. (2022) stated that the daily feed requirement of cattle was the same as 10% of their body weight, while the rumen could accommodate 10-15% of dry matter.

Duration and frequencies of foraging and grazing activities were most prevalent in the morning, as shown in Figure 1 and Figure 2, respectively. The feeding behavior of Bali cattle in the conservation area was dominated by grazing activities rather than other feeding activities. Bali cattle are diurnal animals, so the morning was the first feeding activity after resting in the evening until night. Ruminating activity was more prevalent at noon (Figure 3). Balinese cattle performed ruminating activity under shelter in the afternoon, accompanied by shelter-seeking behavior. Ruminating activity was observed when the air temperature was lower, such as in the late noon, afternoon, or evening. In line with research conducted by Wiyono *et al.* (2022), cattle perform foraging and grazing activities in the morning. The highest foraging activity occurred in the morning, twice, with a duration of 26.58 minutes, while grazing activity was the dominant feeding behavior in cattle.

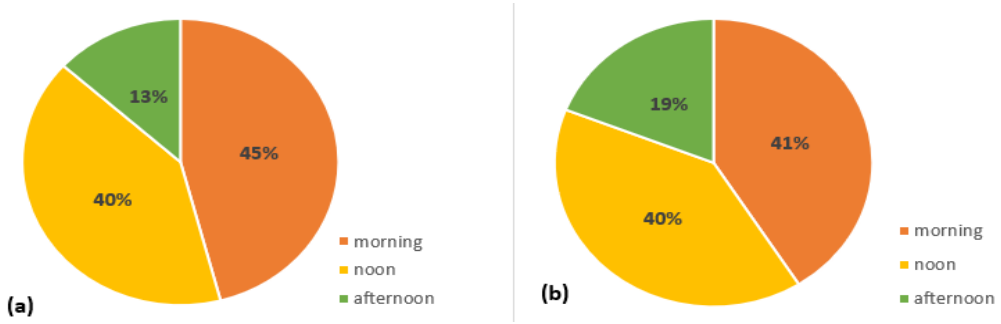

Figure 1. Percentage of foraging behavior of Bali cattle occurrence in the morning, noon, and afternoon based on duration (a) and frequency (b). Foraging activity was longer and more frequently found in the morning.

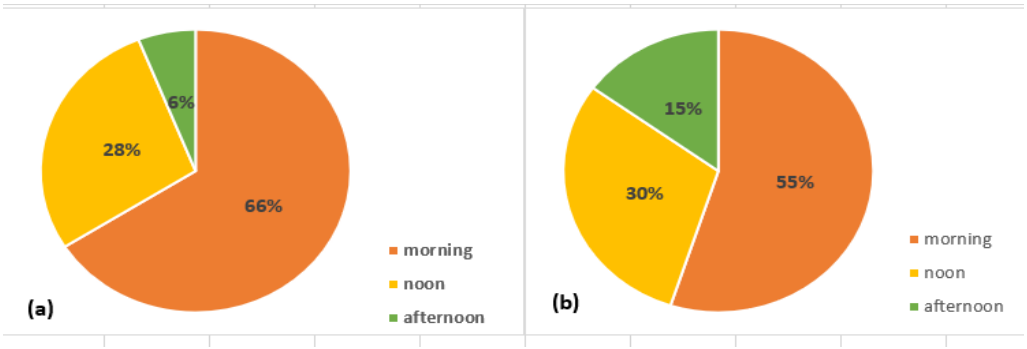

Figure 2. Percentage of grazing behavior of Bali cattle occurrence in the morning, noon, and afternoon based on duration (a) and frequency (b). Grazing activity was longer and more frequently found in the morning.

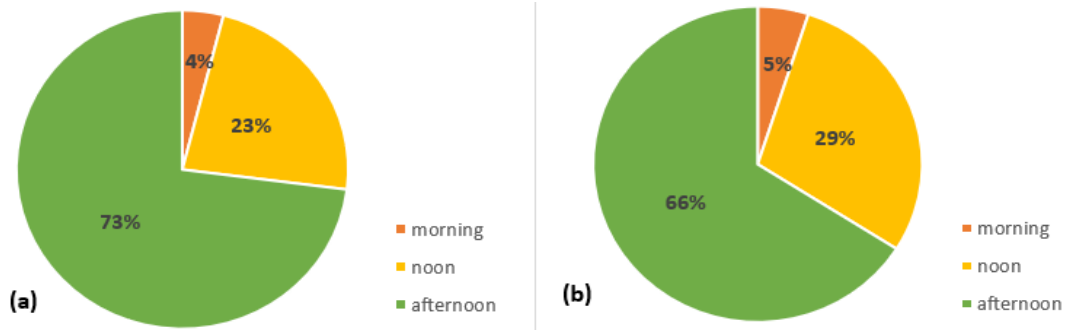

Figure 3. Percentage of ruminating behavior of Bali cattle occurrence in the morning, noon, and afternoon based on duration (a) and frequency (b). Ruminating activity was longer and more frequently found in the afternoon.

The factor that causes the emergence of feeding behavior is an empty stomach and low blood sugar levels, which cause hunger. Scanes and Hill (2018) revealed that 95% glucose is needed as energy in ruminants. Furthermore, Palza (2023) stated that the body in need of energy would send a hunger signal to the hypothalamus to decrease leptin and increase ghrelin, which can increase appetite. The hunger signal from the hypothalamus is continued to the prefrontal cortex, which plays a role in initiating eating by activating dopamine, which increases the desire to eat. Cattle are ruminant animals with a complex digestive system to process crude fiber in grass and straw.

Drinking behavior was associated with rumination activity because water intake was needed to maintain a stable rumen condition. The drinking behavior of Bali cattle was more prevalent during noon (Figure 4). Cattle tend to rest under shelter and occasionally perform feeding behaviors with low frequency due to the high temperature at noon. Reece *et al.* (2015) stated that the body's mechanism to increase water consumption occurs because of signals sent by osmoreceptors in the anteroventral hypothalamus to the cerebral cortex. The release of angiotensin II causes thirst and triggers the desire to drink.

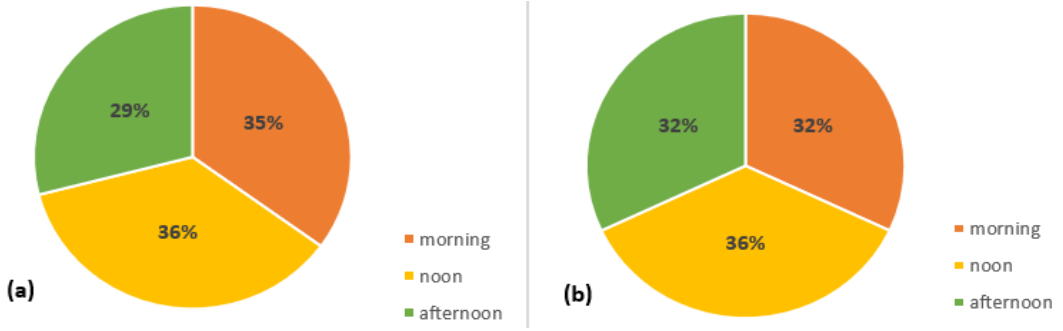

Figure 4. Percentage of drinking behavior of Bali cattle occurrence in the morning, noon, and afternoon based on duration (a) and frequency (b). Drinking activity was longer and more frequently found in the noon.

Bali cattle live in large groups containing 10-30 individuals, with the male Bali cattle forming defensive formations to protect their groups. The tendency for Bali cattle to group at the conservation area was more prevalent on weekends than on

weekdays. The crowded condition of visitors at weekends was thought to be a disturbance, so the cattle spent more time together within the group. Allelomimetic behavior was more common in the morning and noon during grazing (Figure 5). The tendency for grouping behavior was caused by a neuroendocrine mechanism that triggers the ability to form social bonds. Yulistyo (2015) stated that when feeling disturbed, Bali cattle tend to join together to increase safety and protection. On the other hand, Kelly and Vitousek (2017) reported that in grouping behavior, individual cattle require a rapid response to maintain group coordination mediated by the neuroendocrine signaling system, such as oxytocin and vasopressin. The hypothalamus releases the oxytocin to increase trust and promote group affiliation behavior in cattle, while vasopressin plays a role in influencing the territorial behavior of male cattle to defend social hierarchy within their group.

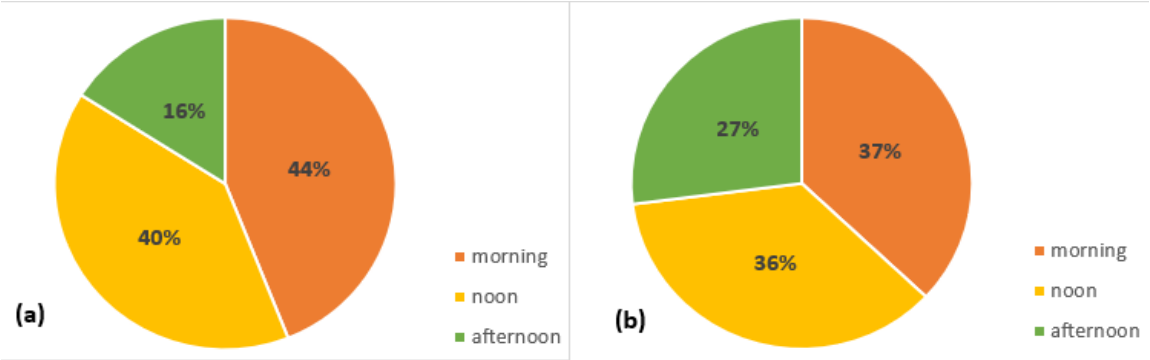

Figure 5. Percentage of allomimetic behavior of Bali cattle occurrence in the morning, noon, and afternoon based on duration (a) and frequency (b). Allomimetic activity was longer and more frequently found in the morning.

Agonistic behavior is the activity least performed by Bali cattle, and this behavior was only seen under certain conditions, such as when competing for feed. Agonistic behavior in this research had a more longer duration on weekends because Bali cattle are quite sensitive to human activities, especially to high-frequency sounds. The average visitor was a group of kindergarten students who are very enthusiastic about interacting with animals. In this condition, Bali cattle became more aggressive, as indicated by snorting when a group of visitors made noise and approached the fence of the pen. In addition, aggressive behavior was found to be higher in the morning (Figure 6) when the cattle were grazing and felt disturbed because they competed for feed and would butt each other. Kuswanto *et al.* (2017) reported that agonistic behavior was a response to animal feeling disturbed by swishing their tails, butting heads, and snorting sounds from their noses when competing for feed, external disturbance, and stress due to noise.

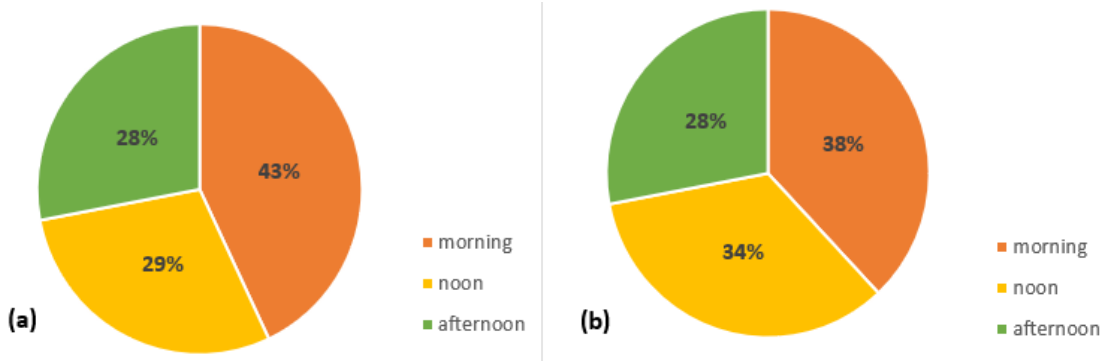

Figure 6. Percentage of agonistic behavior of Bali cattle occurrence in the morning, noon, and afternoon based on duration (a) and frequency (b). Agonistic activity was longer and more frequently found in the morning.

The physiological mechanism of agonistic behavior involved the neuroendocrine system, which plays a role in producing the glucocorticoids underlying aggressive behavior in Bali cattle. Kelly and Vitousek (2017) stated that steroid hormone activity can produce aggressive behavioral effects within seconds. Chronic glucocorticoid exposure disrupts the formation of and reduces affiliative behavior, tends to promote aggressive behavior, and increases social avoidance. The stimulus received by cattle was transmitted to the amygdala, which plays a role in interpreting the stimulus as a threat or a situation that requires an aggressive response.

Shelter-seeking behavior was generally performed during the day with high environmental temperatures or when it rained. This behavior was indicated by the movement of a group of Bali cattle from a feeding area towards shaded areas around trees. Shelter-seeking behavior was more commonly seen on weekends than on weekdays. The cattle choose to remain still under shelter and rest to find a quiet atmosphere away from the crowds of visitors. The hearing of cattle was more sensitive than that of humans, especially at high frequencies. Sanj-aya (2017) stated that Bali cattle tend to seek peace and feel comfortable when undisturbed by crowds and noise. The efforts of cattle in self-defense can be seen from their behavioral responses, such as gathering in the corners of the pen, refusing to eat, and becoming disobedient. The Bali cattle's seeking shelter and resting was also an effort to maintain their bodies's homeostasis when the environmental temperature was high. The shelter-seeking behavior of the Bali cattle at the conservation area was more prevalent in the afternoon (Figure 7). This behavior coincided with ruminating activities carried out under shelter to avoid crowds of visitors. Yulistyo (2015) revealed that shelter-seeking behavior was performed by lying under trees, followed by ruminating activities and moving their ears. This activity was performed by the cattle to reduce the impact of heat stress. The positions taken by Bali cattle when resting were standing, kneeling, and lying down with their heads placed on the ground with eyes closed or open.

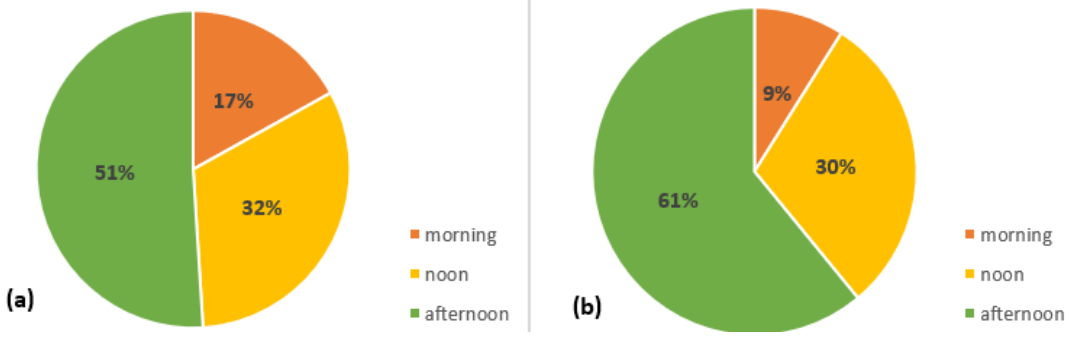

Figure 7. Percentage of shelter seeking behavior of Bali cattle occurrence in the morning, noon, and afternoon based on duration (a) and frequency (b). Shelter seeking activity was longer and more frequently found in the afternoon.

Shephard and Maloney (2023) stated that the behavior of the cattle in responding to rising temperatures was seeking shelter, sweating, and panting. Rising temperatures cause the Bali cattle to reduce their feeding frequency and increase their drinking frequency to maintain their homeostatic condition. The hormonal mechanism can also help maintain homeostasis by reducing thyroid gland activity and metabolic rate, then increasing antidiuretic hormone (ADH) used to support water reabsorption in the kidneys and reduce urine excretion, as well as increasing aldosterone hormone to support water absorption from blood plasma and release heat through sweating.

The eliminative behaviors observed included defecation and urination. Eliminative behavior in Bali cattle was a very vital activity, especially in ruminant animals that require a long time to process their food and excrete urine. Eliminative behavior in the cattle was more commonly found on weekends; this difference was thought to occur because high temperatures and crowded environmental conditions caused Bali cattle to increase their defecation and urination frequencies. Reece *et al*. (2015) stated that increased anxiety in animals triggers a stress response by increasing the frequency of urination. An increase in defecation also occurs when the environmental temperature is high, which helps the cattle reduce their body heat load. Eliminative behavior in Bali cattle at the conservation area of PT Taman Satwa Kota Semarang was more prevalent in the afternoon (Figure 8). Eliminative behavior was performed when the environmental temperature was low, especially in the morning and noon. The defecation frequency of Bali cattle within two hours was 3.3 times, with a duration of 1.15 minutes. The urination frequency within two hours was 1.9 times, and it took 0.4 minutes to urinate. Yulistyo (2015) stated that the habit of eliminating waste was done in the morning and noon when Bali cattle entered and exited the pen. The Bali cattle need 1-2 minutes to excrete urine and about 10 seconds to excrete feces.

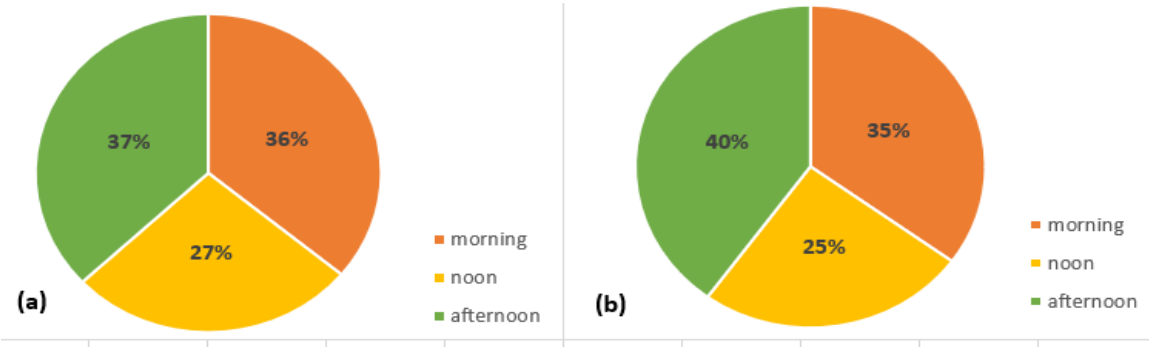

Figure 8. Percentage of eliminative (urination and defecation) behavior of Bali cattle occurrence in the morning, noon, and afternoon based on duration (a) and frequency (b). Eliminative activity was longer and more frequently found in the afternoon.

Defecation begins with the swelling of the rectum due to the gastrocolic reflex. Delfita (2014) reported that in the defecation process, there were two types of

reflexes, namely the intrinsic and parasympathetic reflexes. The intrinsic defecation reflex begins when feces enter the rectum and cause rectal distension, then the mesenteric flexure stimulates peristaltic movement, causing the internal sphincter muscle to relax. The parasympathetic defecation reflex occurs due to feces entering the rectum, which will stimulate the rectal nerve, which is then transmitted to the spinal cord. Stimulation from the spinal cord will be returned to the colon, causing the rectum to perform more intensive peristaltic movements, followed by relaxation of the internal sphincter muscle and defecation.

Urination is the body's controlled process of excreting urine stored in the bladder. de Groat *et al.* (2015) suggested that the micturition process is an automatic spinal medulla reflex that can be inhibited or induced by the brain stem. The micturition reflex occurs when receptors in the bladder are stimulated, and then impulses in the spinal medulla are sent to the brain, producing parasympathetic impulses that are transmitted through the pelvic splanchnic nerve to the bladder. The urination reflex causes the detrusor muscle to contract, the internal and external sphincters to relax, and the pubococcygeus muscle to relax, causing the bladder to descend, inhibiting the uvula from descending, and the initial segment of the urethra to dilate, resulting in the urge to urinate.

CONCLUSION

The conclusion of this study was that the elimination and group behavior of Bali cattle in conservation areas occurred more frequently and for longer durations on weekdays as an indicator that the cattle were uncomfortable, so it was necessary to limit visiting time in the cattle pen area, which may improve cattle welfare.

SUGGESTION

In the next study, it is necessary to conduct observations using the skipping method so that there is no blank data in each observation session and the data obtained is more accurate.

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