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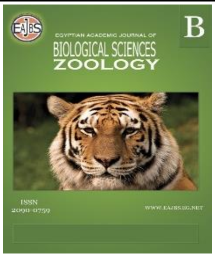

Relevance of Mineral Salt Lick Influence on Ecotourism Conservation of Protected Areas

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ABSTRACT

This study was examined in Kainji Lake National Park. A systemic random sampling method was used for data collection around the mineral salt lick areas. Line transect was used to actualize the ecotourism activity within the ecosystem. Salt lick areas and soil samples were collected and analyzed in the laboratory for their mineral composition. Secondary data were taken from the park management. The result revealed that the manganese concentration (trace element) was higher in salt lick area 1 (7.69), while the least was observed in salt lick area 5 (1.96 mg/L). Calcium which is a major element was observed to be high in salt lick area 1 (4.22 mg/L), while the least was recorded in salt lick area 6 (0.40 mg/L). Observation showed that the mineral content of the salt lick areas 3 and 6 was not adequately utilized in the dry season period. It is pertinent to realize that the mineral composition of the salt lick areas serves as an influence affecting the optimum utilization of fauna species. The turnout of eco-tourists sighting the park varied due to human anthropogenic activities and other limiting issues. The influence of mineral salt licks on wildlife well-being and their health care primarily herbivores depict decisive good maintenance of a healthy wildlife community for the physiological and biochemical activity that enhances their reproductive survival.

INTRODUCTION

Abundant wildlife species visit salt licks to consume soil (geophagy) or to drink water. Mammals use salt licks as they are easily recognized due to larger body size, the prevalence of using these resources, and probable movement and behavior, as well as numerous conventional postulates such as mineral supplementation (Razali *et al.*, 2022). A good location for observing the dynamics of wildlife communities in protected areas is salt licks. The licks are generally found in large, relatively undisturbed forested areas. It provides beneficial health minerals for food digestion, assimilation, and other body metabolisms to many species of wildlife especially herbivores (Wahab *et al.*, 2020). Salt licks are areas with salt or mineral deposits visited by nature to consume soil or water for

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nutritional and health benefits. A salt lick may take the form of a mineral water spring (Sim *et al.*,2020), dry land (Ramachandran *et al.,* 1995), muddy pool (Razali *et al.*,2020, Sim *et al.*,2020), or rocks-rich in specific minerals (Razali *et al.*,2020; Sim *et al.*,2020). Salt licks are abundant in temperate and tropical forests (Panichev *et al.*,2017, Kroesen *et al.,* 2020) Salt licks serve as a determinant of herbivore density in the rainforest, which in turns influence the density and distribution of predators. They could be artificial or natural. Natural salt licks are mineral-rich deposits that play a significant role in the ecosystem of the tropical rainforest. Also, the relevance of salt lick in terms of the physiological well-being of animals of plant-based diets is well documented and its utilization should not be affected by sex and age categories. The artificial salt licks come in two forms based on two types of commercially available salt either bagged or blocked. They are helpful in agriculture and wildlife management aimed at the development and health improvement of animals and habitat enrichment (Bakri *et al.*,2019, Simpson *et al.,* 2020). Some of their utilization is to attract wildlife for surveillance or photography as part of tourist attractions (Lameed and Adetola 2012, Simpson *et al.*, 2020) and hunting (Lameed and Adetola 2012). Importantly, regular maintenance is required to keep artificial salt licks effective (Maginta *et al.*,2015). Many wildlife species are known to visit salt licks to consume soil (geophagy) or to drink water (Razali *et al.*, 2022), which include ungulates (Lameed and Adetola 2012), Primates (Gomez- Hoyos *et al.,* 2017), birds (Griffiths *et al.,* 2020) and reptiles generally. Aside, from being significant in providing mineral supplements to wildlife, salt licks also provide pharmacological treatment against toxins (Diamon *et al.*,1999, Dominy *et al.*,2004) as well as play a role in gut pH regulation (Mahaney *et al.*, 2015). The ingestion of a range of soils, from stones to clay refers to avian geophagy (Downs *et al.*,2019). Ingestion of grit as gastroliths expand the mechanical digestion of food in the gizzard and may provide minerals (e.g., sodium and calcium) (Brightsmith *et al.*, 2008). Clay acts as a pH buffer and adsorbs plant secondary compounds to prevent avian digestive tracks erosion, in addition to providing sodium (Sanders and Koch, 2018). Avian geophagy at the salt licks is either frugivorous or granivorous, predominantly the Psittacidae (parrots, macaws, and parakeets) and Columbidae (doves and pigeons) (Blake *et al.,* 2011; Downs *et al.,* 2019). Soil consumption at natural licks is connected to the nutritional ecology and/or the health of the users. Despite nutritional benefits, the salt licks similarly function as assembly venues for the animal that facilitates social encounters. Consequently, the existence of natural licks in a specific habitat may decrease the costs of obtaining adequate nutrition, while maintaining health; which may be fundamental to population determination. Notwithstanding advances to understand ecological factors determining population density and animal interactions, no study has investigated how salt lick and ecological systems influence the ecotourism development of Kainji Lake National Park. Therefore, the aim of this study is to identify the effective utilization of salt licks by the species in their ecological realm and how this salt lick has influenced the ecotourism of the park.

MATERIALS AND METHODS

Study Area:

Kainji Lake National Park is the first experimental established and managed National Park (Fig.1). It was established in 1997 (under decrees 46 of 29th July 1979) between latitudes 90° 401N to 100° 30N and longitudes 40° 30'E -50° 50'E; and is highly endowed with fauna and flora resources. The Park is made of two sectors; the Borgu and Zuguma sectors with the former (3, 970.83Km^2 accounting for 74.3% of the total land mass) larger than the latter (1,370Km^2 accounting for 25.7% of the total landmass). The park is characterized by the wet and dry seasons hovering around a savanna climatic condition. The Park is of six main broad vegetation classifications;

a. Burkea Africana/*Deuterium microcarpus* (Woodland savanna).
b. *Diospyrus mespiliformis* (Dryforest).
c. Riparian forest and woodland.
d. *Terminalia macroptera* (Tree savanna).
e. *Isoberlinia tomentosa* (Woodland).
f. *Isoberlinia doka* (Savanna woodland).

Oli Camp complex is dominated by the tree species assemblage of characteristics rain forest species such as *Annogeissus leocarpus, Kyaya senegalensis, mitragyna linernus, Vitex doniana* and *Chlorophaora excelcia*. This made the Oli camp complex and riparian forest to be closely associated.

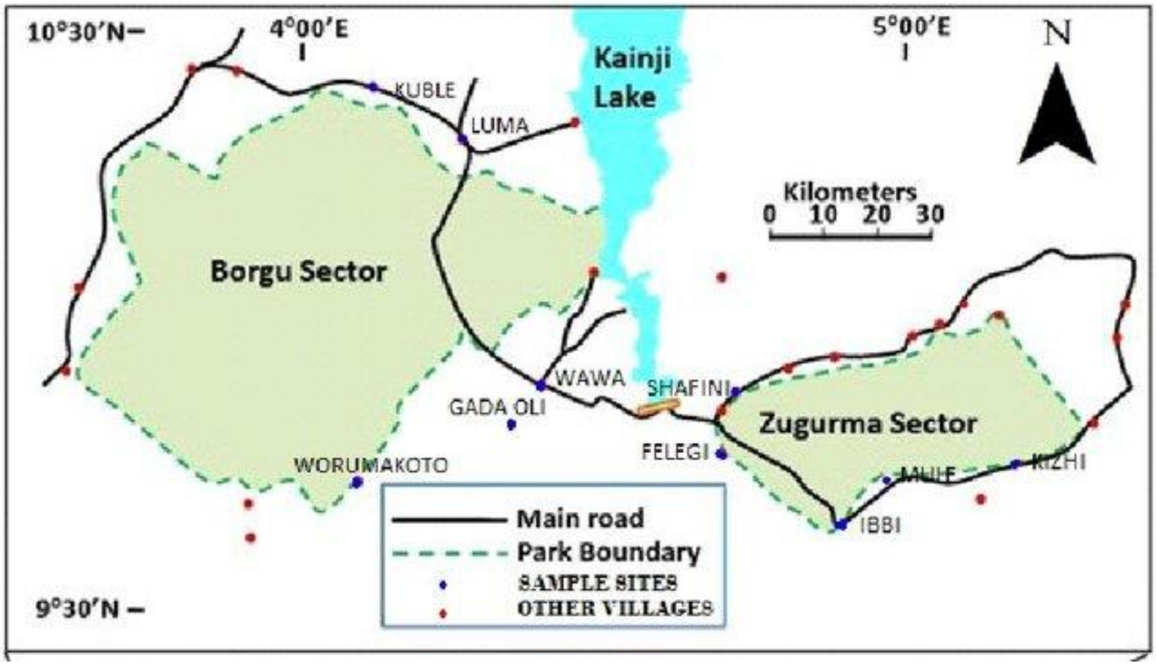

Fig. 1. Map of Kainji Lake National Park.
Source: Online.

Description of the Mineral Salt Lick Areas:

The mineral salt lick areas of the park that promote ecotourism development were chosen along the Oli range through a reconnaissance survey and secondary information from the park management and literature reviews on the significance of mineral salt lick in the park (Table 1). A Systematic random selection of the mineral salt lick areas was sampled in six different Jeep track locations along with varying distance coordinates in the Oli range towards river Oli. The eco-destination of the park is well pronounced for tourism in the Borgu sector of the park due to its eco-touristic features of it; as well as enhancing the species diversity of the industry.

Table1: Description of sampled salt lick sites.

S/N	Track Name	Range	Co-ordinate location	Elevation (m)	Distance to the Jeep Track M	Distance to the Oli River (m)
1	Shagari	Oli	N09⁰54.294’ E003⁰59.194’	239	125	5
2	Shagari	Oli	N09⁰54.451’ E003⁰58.754’	242	100	10
3	Shagri	Oli	N09⁰54.194’ E003⁰57.794’	235	80	210
4	Shagari	Oli	N09⁰54.166’ E003⁰57.941’	237	70	250
5	Yankari	Oli	N09⁰53.815’ E004⁰00.904’	203	3	250
6	Gilbert Child	Oli	N09⁰51.295’ E004⁰01.447’	282	120	40
7	Hippo pool (Km8)	Oli	N09⁰53.941’ E003⁰59.778’	28	100	10
8	Gardo Nasco	Oli	N09⁰54.481’ E003⁰56.930’	284	10	20
9	Kob ii in Zaure	Oli	N09⁰57.062’ E003⁰58.262’	245	20	40

Fauna Assessment:

A line transect of one kilometer was established along the animal trails with which direct and indirect observations of the game were assessed. In each sample site, a total of three (3) by 1km transect was established. Daily survey of animals along the salt lick was conducted early in the morning (06:30 am -11: 00 am) and late survey in the evening period (15: 00 – 18:00) with the assistance of a research officer and two rangers from the park. Each transect is walked thrice a week for a period of four months (April –July 2019) at a speed of 1.0 -1.2km/hr. for the two survey methods of sighting fauna species. The indirect observation includes the identification of fecal droppings, feathers, footprints, and animal carcasses around and along the salt lick sites. Field materials were used to carry out the fauna assessment at the sites such as binoculars, cameras, wristwatches, polythene bags, field note/writing materials, and a Global positioning system.

Mineral Analysis of The Salt Licks:

Soil samples were collected from the salt lick points sampled in the Borgu sector of the park. Analysis for the detection of mineral compositions was carried out using Atomic Absorption Spectrophotometer (AAS) Model PG990 at the University College of Agriculture Laboratory. Samples to be analyzed were first digested by application of concentrated Nitric acid, 1g of the sample was weighed into a digestion flask with a 10 ml addition of acid. The mixture in the digestion flask was heated to 2000 for 1 hour so the element composition can be broken.

Data Analysis for The Fauna /Threat Encounter:

The encounter rate was calculated for fauna species with the identified threat variables in the study area. This was calculated by dividing the total number of animal sightings (across all sampled sites) by the total number of kilometers walked.

RESULTS

Diversity and Composition of Fauna Visiting the Salt Lick Sites:

The physical observation of the fauna species across the sampled sites was examined during the study. The indices of observation were recorded which includes footprints, carcasses (Lion's remnant) fecal droppings, feathers, and indirect sightings. The positive sign (+ve) denotes the presence of a species either through direct or indirect observation while the absence of the species is denoted by a negative sign (-ve) as shown in Table 2.

Table2: List of animals sighted across sampled sites.

S/N	Common Name	Scientific Names	Direct Observation	Indirect Observation	Indices of observation
1	Buffalo	*Syncerus caffer*	-	+	Sight/footprint/faecal dropping
2	Bush Buck	*Tragelaphus scriptus*	+	-	Sight
3	Guinea fowl	*Numida meleagris*	-	+	Feathers
4	Hippopotamus	*Hippopotamus amphibious*	-	+	Faecal dropping
5	Kob	*Kobus kob*	+	+	Sight/footprints/faecal dropping
6	Lion	*Panthera leo*	-	+	Remnant
7	Maxwell duiker	*Philantomba maxwelli*	+	-	Faecal dropping
8	Red flanked duiker	*Cephalophus rufilatus*	+	-	Footprint
9	Roan Antelope	*Hippotragus equines*	+	-	Sight
10	Stone partridge	*Ptilopachus petrosus*	+	-	Sight
11	Tantalus Monkey	*Chlorocebus tantalus*	+	-	Sight
12	Warthog	*Phacochorus aethiopicus*	+	-	Sight
13	Western Hartebeest	*Alcelaphus buselaphus*	+	-	Sight

Field Survey, 2018

Encounter Rate:

The frequency of occurrence of fauna species encountered in each and across all the sampled salt lick sites was examined during the study. The highest encounter rate across all sites was recorded for Kob 1.5 individuals/kilometer walked while Tantalus Monkey and Warthog had the least encounter rate at 0.009 and 0.007 respectively.

The species fauna composition which includes the number of sightings and the percentage of species encountered rate was investigated during the study. Observation revealed that Kob (*Kobus kob*) has the highest number of sightings (162) with an encounter rate of 1.5. It implied that 1.5 individuals of Kob would be sighted at every kilometer walked in each salt lick site. While the lowest number of sightings (1) with an encounter rate (0.09) was recorded for Tantalus Monkey (*Chlorocebus tantalus*).; this implied that 0.09 individuals of the species would be sighted in every kilometer walked in each salt lick site. Summarily, *Kobus kob* would be more sighted at each salt lick of the sampled sites while *Chlorocebus tantalus* rarely encountered (Table 3).

Table 3: Summary composition of Fauna species across all the sampled salt lick sites**.**

S/N	Common Name	Scientific Name	Family Name	Number of sightings	Percentage of sighting	Encounter rate
1	Baboon	*Papio Anubis*	Cercopithecidae	72	17.96	0.67
2	Bush Buck	*Tragelaphus scriptus*	Bovidae	22	5.49	0.2
3	Kob	*Kobus kob*	Bovidae	162	40.4	1.5
4	Tantalus Monkey	*Chlorocebus tantalus*	Cercopithecidae	1	0.25	0.009
5	Red flanked duiker	*Cephalophus rufilatus*	Bovidae	37	9.23	0.34
6	Roan Antelope	*Hippotragus equinus*	Bovidae	64	15.96	0.59
7	Warthog	*Phacochoerus africanus*	Suidae	8	2	0.07
8	Western Hartebeest	*Alcelaphus buselaphus*	Bovidae	35	8.73	0.32

Analysis of Mineral Elements in Each Salt Lick Site:

Mineral content in all the soil sampled was examined to determine the trace mineral elements in each saltlick site during the study (Table 4). Observation shows that the amount of copper (Cu^+) found in salt licks 1, 4, and 9 were relatively higher with 0.37mg/L respectively, while the least copper concentration was measured in salt lick 6 (0.09 mg/L). Magnesium (Mg^{2+}) concentration was highest in salt lick 1 (7.686mg/L) while the least concentration (1.946 mg/L) was measured in salt lick 5. Manganese (Mn^{2+}) concentration was highest in salt lick 1 (2.23mg/L) while the least concentration was measured in salt lick 3 (0.701mg/L); and not detected in salt lick 6. The concentration of iron (Fe^{2+}) was observed to be high in salt lick 1(332.33mg/L) while the least concentration (36.36mg/L) was measured in salt lick 6. Zinc (Zn^{2+}) was the highest content (1.398mg/L) in salt lick 1, while the least (0.677mg/L) was measured in salt licks 6, 7and 8 respectively; however, the presence of zinc was not detected in salt lick 9. Above all, the mineral concentration of Calcium (Ca^{2+}) was highest in salt lick 1 (4.216mg/L) while the least concentration was measured in salt lick 6 (0.397mg/L). Calcium and Magnesium are essential mineral minerals vital to living being. The supplementation of these minerals is required in large quantities for enzyme and metabolic activity for the healthy well-being of the ungulates.

Table 4: Mineral elements in soil samples as related to salt lick sites.

S/N	Sampled ID	Cu3+ (Mg/L)	Mg2+ (Mg/L)	Mn2+ (Mg/L)	Fe2+ (Mg/L)	Zn2+ (Mg/L)	Ca2+ (Mg/L)
1	Salt lick 1	0.370	7.686	2.237	332.33	1.398	4.216
2	Salt lick 2	0.258	5.581	1.172	257.03	1.201	2.492
3	Salt lick 3	0.146	2.964	0.701	99.92	1.266	0.583
4	Salt lick 4	0.370	5.909	1.172	737.50	0.941	1.281
5	Salt lick 5	0.202	1.946	1.526	155.37	0.743	1.281
6	Salt lick 6	0.090	2.051	ND	36.36	0.677	0.397
7	Salt lick 7	0.258	5.969	1.054	298.16	0.677	1.563
8	Salt lick 8	0.202	3.459	1.172	148.20	0.677	9.201
9	Salt lick 9	0.370	7.095	0.936	298.16	ND	1.281

Field Survey, 2018

DISCUSSION

Mineral elements are vital in the nutrition of wild animals and cannot be exaggerated as trace elements required for their food supplement. The knowledge of species richness, abundance, and composition is a prerequisite for ecosystem management. The fauna species diversity and composition across all salt licks were determined by direct and indirect observation through footprints, fecal droppings, and feathers. The encounter rate of species diversity and effective utilization of the salt lick site were revealed during the study. The census and monitoring evaluation of animal species diversity in the park showed that *Kobus kobs* were abundant in the calculated encounter rate. Observation in the study shows that salt lick sites which are significant nutritional supplement sites were utilized by *Papio anubis* and *Kobus kob*, as well as promoting eco-touristic values such as game viewing of the species as corroborated by Wahab *et al.*, (2020). Warthogs (*Phacochoerus africanus*) and Tantalus monkeys (*Chlorocebus tantalus*) were usually preyed upon in the park as observed from information during the study. This accounted for a low rate of a warthog (*Phacochoerus africanus)* observed across the salt lick sites during the study and was due to illegal hunting activities. Although, the carcass yield of Warthogs is favorable and can be utilized for commercial game meat products (Swanepoel *et al.*, 2014). Tantalus monkey (*Chlorocebus tantalus*) which is an endangered species in the park constituted a very low number and percentage. The constituent mineral elements in the salt lick sites that were sampled presented a highly varying amount in the concentration of major and trace elements (Idowu, 2018). It was revealed that salt lick 8 has the highest calcium concentration (9.20 mg/L) when compared with other sampled salt lick sites. This is a possible reason for the abundance and high frequency of visitation of *Kobus kob* in this site as calcium is a major element required by the animal. Roan Antelope’s (*Hippotragus equinus*) body requirement for the mineral supplement is apparent, as salt lick 1 and 9 has shown a considerably high concentration of magnesium which corresponds to the highest number of *Hippotragus equinus* signified the encounter rate of the species for the period study. Visitation to these sites is beneficial and adversely dangerous to the fauna species. Its preference for a relatively open habitat along with its size and sedentary habits make this vulnerable and eliminated largely from many of such areas by poaching (Encyclopedia Britannica, 2011), more prone to salt lick sites. The motive behind poaching for meat consumption is proven that wildlife connotes the principal source of animal protein for rural people in most African countries (Montgomery, 2020). The manganese content in salt lick site 1(2.237mg/L) recorded the highest amount in the mineral element analyzed across all salt lick sites, this can be related to the frequency of diverse species visitation. This Manganese is a more desired trace element needed by animals in minute quantity for their enzymatic action. It was significantly observed that iron (Fe^{2+}) is higher in salt lick 4 (737.50mg/L) which depicts a high encounter rate of Red-flanked duiker (*Cephalophus rufilatus*) and *Kobus kob*, as well as a high concentration of iron (Fe^{2+}) in salt lick 1 (332.33mg/L) when compared with all other sampled sites recording a high variety of fauna species in addition. Hence, iron (Fe^{2+}) is shown to be an essential trace element required in an animal’s diet. Conversely, the low number of animals at the sites can be attributed to poaching activities. Salt lick 4 is more prone to the serious danger of illegal hunting as evident as major and trace elements are considerably high with a low number of animals visiting the site for geophysical activity. Though, is pertinent to note two major drivers responsible for the high fauna encounter rate at salt lick sites: (i) High level of protection by park rangers for sites with close proximity to the camp (ii) abundance of essential trace and mineral elements and in a salt lick site.

Identified Threats Across All Sites:

The highest level of encounter rate was observed in spent cartridges while carnivore’s remnant presents the lowest encounter rate, implying a high rate of poaching activities at the salt lick site. Poaching is a threat to conservation management and poses a major challenge to this site (Blake *et al.,* 2013). It is a known fact that poaching and illegal killing of wild animal species in protected and reserved areas has a detrimental effect on the animal population and in most cases enlist some animal species into the endangered list, especially low-profile species. Hartebeest is among the animal species of poacher target at Kainji Lake National Park, that is exerting negative pressure on the animal’s existence; this agrees with the low encounter rate across all salt lick sites in the study corroborated (Akinsorotan,2017). Tourism to eco-destination to watch wildlife is an interesting adventure for ecotourism development. The diversity of species across salt lick sites is a potential for tourist visitation. Hence, the content of minerals in a particular area determines the utilization of fauna and the viewing of fauna (Wahab *et al.,* 2020). Comparison of mineral concentration between salt-lick this study suggested that the herbivorous mammals could supplement calcium by drinking water at the studied salt-licks; the concentration of sodium in salt-lick water was higher than that of stream water regardless of seasons or sites, and that of calcium was also higher in most cases (Lazarus *et al.,* 2021) Observation revealed that turnout of tourists visiting the KLNP fluctuates yearly; as the influx of tourists can be dictated by the current insecurity issues which have caused a reduced operation in the park. Other reasons such as poachers' intrusion in the park as their activities can cause a decline in the fauna population in the park. Summarily, the benefit derived from salt lick sites by animals is for maintaining a healthy community, reproduction, and survival.

Conclusion

The study revealed that salt lick sites are key places and position sight for the ecological dynamics of wildlife communities in protected areas. Such salt lick is a natural mineral deposit area where wild animal visits frequently and are active for mineral uptake through licking. Ecotourism is a special type of wildlife viewing (Safari) that center more on a diverse range of fauna species utilizing the sites as a potential source of mineral content. The investigation shows that facilities and promotion of salt lick are lacking in the country, which depicts poor conservation of this natural landscape. Sustaining the salt licks in remote natural areas is vital to protect them against anthropogenic activities of vegetation loss and species population decline. Evidence shows that interest to visit the salt lick site is behind the satisfactory level as a result of the underutilized ecotourism resources of protected areas or national parks. Sound management of these resources requires effective monitoring and evaluation of the fauna resources to sustain ecological site development. Advocacy /awareness campaigns on the relevant role of salt licks for ecotourism development deserve enhancement by the park authority to combat the negative use of these sites for better sustainability of conservation approaches. This measure of keeping a mineral content site for ecological studies will have a long way toward promoting the endowed natural resources of our protected areas or natural park in terms of ecotourism development.

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