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# THE ROLE OF THREE WILD ANIMALS IN THE DISTRIBUTION OF PREFERRED FORAGE PLANTS IN THE DINDER NATIONAL PARK (D.N.P) SUDAN

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**ABSTRACT:** *This study was conducted in Dinder National Park (D.N.P.) of Sudan during the dry season (March, April and May). Waterbuck (Kobus defassa), warthog (Phacochoerus aethiopicus) and Tiang (Damaliscus korrigum) in D.N.P were chosen for this study. Seeds of Acacia nubica, Acacia seyal and Piliostigma reticulatum recovered from the fecal samples of waterbuck showed a highly increased rate of germination above the control. Acacia polycantha and Sesbania sesban showed decreased rate of germination below the control. The germination rate of Acacia siberiana showed no positive effect (zero) versus the control. The germination rate of the seeds of Ziziphus-spina-christi remained more or less above the control (53% and 50%, respectively). The germination of seeds of Ziziphus spina-christi from fecal samples of warthog showed higher increased rate of germination. The results of this study confirmed that the three wild herbivores are grazers, but they shift their diets towards forbs, woody plants and fruits of leguminous trees during the dry season. Waterbuck, Tiang and Warthog they depended on the plant diversely around water collecting places in the pank (Mayas) for their diets, but they selected other plant species from the surrounding. Also this study provides the information regarding food habits and feed requirements of these wild herbivores. Such information might help in the management of the habitat (Mayas) and the protection and sustainability of wild herbivores in D.N.P.*

ORIGINAL ARTICLE

**Key words:** *Dinder National Park (D.N.P.), Wild Animals, Forage Plants*

## INTRODUCTION

Fecal material accompanying vertebrate-dispersed seeds at deposition sites plays an important role in enhancing seed germination and seedling survival (Traveset et al., 2001). Passage of the seeds of fleshy-fruited plants through vertebrates' guts has varying results on germination behavior (Traveset, 1998). Vertebrate dispersal agents include birds, mammals, fish and reptiles. Among mammals, the major dispersers in tropical regions are bats and primates (Abrahamson, 1989).

Claudia et al. (1997) found mammals constitute an important spectrum of dispersal agents of *Prosopis flexuosa* (Fabaceae) through strategies that, although significantly affecting viability in some cases, make germination easy. Riyou et al. (2004) found that high-density herbivore species often play an important role in forest regeneration sika deer *(Cervusnippon yakushimae)* and that deer herbivory was important for preferred species.

The ingestion of seeds by vertebrates is an important process affecting the distribution, structure, and composition of plant communities (Fenner, 2000). Gut passage can break the dormancy of pondweed seeds (Santamarıa et al., 2002). The possible interaction between gut passage and other dormancy-breaking processes (such as stratification or drought, Probert, 2000) can explain the great diversity of

Results obtained when analyzing the effects of gut passage on seed germination patterns (Traveset and Verdu, 2002). Interactions between animal behaviour (chewing, digestion), seed characteristics and germination success were positively related to seeds longevity, remarkably, to seed mass, seed shape and retention time of seeds In stomach of animals (Cosyns et al., 2005).



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Two mechanisms that could determine how herbivores affect germination in dry-fruited plants. These are the mechanical and/or chemical scarification of the seed-coat, which may depend upon chewing behaviour and gut retention time (Fredrickson et al., 1997) or on the type of food ingested with seeds (Jones and Simao, 1987), and the effect of surrounding faecal material on germination and/or future seedling growth (Ocumpaugh *et al.*, 1996).

Germination of most un-infested *Acacia* seeds without an external factor that scarify seed coat is very low or zero (Halevy, 1974). Passage through herbivores gut or artificial chemical or mechanical scarification of the seeds increases the seed germination level (Or et al., 2003). Lampery et al. (1974) found that germination of *Acacia* seeds ingested by impala, Thomson's gazelle (*Gazella thomsoni*), dikdik (*Madaqua kirkii*) and dorcas gazelle (*Gazella dorcas*) was found to range from 11 to 28 %. Miller (1995) found that the cumulative germination of ingested seeds to *A. tortilis* and *A. nilotica* retrieved from the stomach of Kudu exhibited greater germination (48 and 22% respectively) than control (7 and 3.5%, respectively), but lower germination than seeds retrieved from kudu's dung (60 % for *A. nil*otica and *A. tortilis*) (Miller, 1995).

Rhone and Ward (1999) showed that the germination levels of intact *A. raddiana* and *A. tortilis* seeds from dorcas gazelle (*Gazelle dorcas*) and Arabian Oryx (*Oryx leucoryx*) fecal matter were significantly higher than those of undigested seeds. Most experiments except that of Coe and Coe (1987) showed that ingestion by herbivores causes an increase in germination.

There was a positive effect of herbivore body mass on the germination of ingested seeds. This effect is presumably mediated through the allometric scaling of digestion time to herbivores body mass, which results in greater removal of the hard seed coat, thereby facilitating germination. This result indicates that species composition of the ungulates might have important consequences for the recruitment of Acacia trees (Robbins, 1993). The wild ruminant they had the unique ability to shift their dietary preference and select various vegetation types and plant species or plant portions in accordance with season and availability of plant biomass without affecting the nutritional quantity of their diet. Hence, habitat preferences vary seasonally depending upon the nutrient and water content of grasses and browse at the time of forage utilization (Evans, 1979).

### Statistical analysis

Data's were analyzed by standard analysis of variance (SPSS) The treatment means were compared and Spearman's Rank Correlation using to test Least Significant Difference (LSD) procedures at 5% level and 1% (Gomez and Gomez, 1984).

## MATERIALS AND METHODS

### Sample Collection

Random sample of 10 and 27 Kg of Warthog and Waterbuck feacal pellets were collected from heaps of pellets deposited around dry from Mayas including Abdel Ghani, Samaaya, Musa and Ein El Shames during dry season 2004. Hundred Pellets were picked randomly from feacal samples and gently ground to release and check the type of the seeds. The numbers of the released seeds were counted and identified as percentage in the 100 pellets. A small number of pellets were collected for tiang from Samaaya maya.

### Isolation, assessment and germination of undigested seeds

Seeds separated from pellets were germinated in the germination room of the National Seed Center of the Forestry Research Corporation (Soba) following ISTA Rules Standards (1993).The temperature and light were fixed (temperature 30°C, 12 h illumination from fluorescent lamps). Seeds were grown in plastic trays full with pure sand and arranged in a randomized block design which were watered daily. Four replicates of 25 seeds were used for each type of seed. Germination statuses were done and counted every 7 days. The counted seedlings were removed from germination trays. To find the number of seed per kilogram of pellet and seedling per kilogram the following formula was used (ISTA 1993):

$$\text{Number of seed /kg (N)} = \frac{\text{number of seed in kg pellets}}{\text{Number of Kg of pellets}}$$

$$\text{Number of seedling /kg} = \frac{\text{N X Germination rate}}{100}$$

## RESULTS

Seeds of seven forage plants were separated from 27 kg pellets of Waterbuck. Six of these were legumes, *(Acacia siberiana, Acacia polyacantha, Acacia seyal, Acacia nubica, Piliostigma reticulatum and Sesbania sesban*, in addition to *Ziziphus spina–christi* which not legumes (Table 1). Only 50 seeds/ kg of woody plant (*Ziziphus spina-christi*) were separated from the 10 kg of fecal samples (Table 2) of Warthog.

The percentage of seed germination of three species (*Acacia nubica, Acacia seyal* and *Piliostigma reticulatum)* separated from pellets of waterbuck was about 733%, 128% and 77%, respectively, above control. The germination of seeds of *Acacia polyacantha* and *Sesbania sesban* separated from pellets of waterbuck about 12% and 40 % respectively. The germination of *Acacia siberian*a showed no positive effect (zero) and *Ziziphus spina-christi* (Table 3). Warthog showed a higher germination tendency, with rate (66% above control) for of seeds of *Ziziphus spina-christi* (Table 4). No seedlings germinated from whole pellets sowing except *Acacia seiberiana* and *Sesbania sesban* in the fecal samples of Waterbuck (Table 3, and 4).



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The germination rate of seeds recovered from faeces of Waterbuck and Warthog showed different effect of seeds coat (Table 5). For the medium seed coat thickness, the germination rate was 55.00 % against 27.50% for the control. For the soft coated seed, germination rate was 45.50% against 75.00% for the control. For the hard coat, germination rate was 41.33 % against 25.66%for the control.

**Table1** - Number of seeds / 27 kg of pellets of Waterbuck during the dry season from mayas in D. N. P.

| Plant species | *Seed coat thickness | Number of seed /kg pellets | Seeds /kg pellets | **Number of seedling /kg pellets |
|---|---|---|---|---|
| *Sesbania sesban* | Soft | 57 | 2.1 | 1.13 |
| *Acacia. polyacantha* | Soft | 14 | 0.51 | 0.27 |
| *A. seyal* | Medium | 150 | 5.6 | 3 |
| *Piliostaigma reticulatum* | Medium | 1357 | 50.3 | 26.65 |
| *A. nubica* | Hard | 40 | 1.48 | 0.74 |
| *A. siberiana* | Hard | 850 | 31.5 | 6.6 |
| *Ziziphus-spina-christi* | Hard | 28 | 1.04 | 0.55 |

*classes of seed coat thickness were recorded from Mahgoub, 2004 National tree seed centre Sudan.
**% germinated seed x No of seed / kg pellets

**Table 2** - Number of seeds / 10 kg of pellets of Warthog during the dry season from mayas in D. N.P.

| Plant species | Control | Separated seeds from pellets % | Pellets % | Increased or decreased % |
|---|---|---|---|---|
| *Ziziphus-spina-christi* | 50 | 83 | 0 | +66 |

**Table 3** - Germination percentage of different seed species of plants recovered from pellets of Waterbuck collected from D.N.P.during dry season

| Plant species | Control | Separated seeds from pellets % | Pellets% | Increased or decreased % |
|---|---|---|---|---|
| *Acacia. polyacantha* | 60 | 53 | 0 | - 12 |
| *A. seyal* | 25 | 57 | 0 | +128 |
| *A.siberiana* | 21 | 21 | 21 | Zero |
| *A. nubica* | 6 | 50 | 0 | +733 |
| *Piliostaigma reticulatum* | 30 | 53 | 0 | +77 |
| *Sesbania sesban* | 90 | 54 | 10% | - 40 |
| *Ziziphus-spina-christi* | 50 | 53 | 0 | +06 |

*Increased or decreased % calculated: $\frac{\text{Separated seeds from pellets - Control}}{\text{Control}} \times 100$

**Table 4** - Germination of percentage different seed species of plants recovered from pellets of Warthog collected during dry season against their contro

| Plant species | Number of seed /10 kg pellets | Seeds /kg pellets | *Number of seedling /kg pellets |
|---|---|---|---|
| *Ziziphus-spina-christi* | 50 | 5 | 41.5 |

*% germinated seed x No of seed / kg pellets

**Table 5** - Germination rate (%) of the soft, medium and hard coated seeds recovered from fecal samples of waterbuck and warthog and control collected from D.N .P.

| Seeds coat | Germination rate (%) ( Mean ± SD) | |
|---|---|---|
| | Fecal | Control |
| Soft | 45.50 ±13.44 | 75.00 ± 21.21 |
| Medium | 55.00 ± 2.83 | 27.50 ± 3.54 |
| Hard | 41.33±17.67 | 25.66 ± 22.37 |
| Total | 46.42±13.16 | 40.28 ± 28.41 |

## DISCUSSION

The present result revealed that fruit of *Ziziphus spina-christi* occurred in the fecal samples of Warthog and undigested seeds showed high germination rate of this plant also Dorst and Dandelot (1993) found that Warthog consumed fruits. Warthog was also observed to show high activity in the surroundings of the Mayas including,


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digging the ground during the dry season. This mechanism could help the biota species to fertilize the ground. Some wild ruminants, such as eland (*Taurotragus oryx*) and impala (*Aepyceros melampus*) are ca11ed "broad spectrum feeders" (Olsen and Hansen, 1977). The present finding seven seeds of plant species (six legumes and one not legume) were separated or undigested by Waterbuck. The fruit of *Ziziphus spina-christi* was found in the diet composition of Warthog. This could be used as basic information on distribution, vegetation structure with regard to frequency, availability and variability. Also Waterbuck has the major role in seed dispersal and germination.

This result agrees with Cosyns et al. (2005) and Or et al. (2003). Leguminous seeds ingested with pod often pass intact through the ruminant ingestion system (Lamprey, 1967 and Lamprey et al., 1974) because browse species played a major role improving feed for ruminants (domestic and wildlife) in arid and semi-arid regions, particularly during dry season when poor quality and quantity residues prevail (Hashim 1990; Lefroy et al., 1992). Passage through the digestive system of waterbuck and warthog reduced germination success of indigested seeds in some species (Gardener et al., 1993). These may by relate to characteristics of chewing intensity, seed shape, type of physiology and morphology of digestive tract. *Acacia nubica*, *Acacia seyal* and *Piliostigma reticulatum* showed higher success of germination (50%, 57% and 53%, respectively) above control (6%, 25%, and 30%, respectively). Lampery *et al.* (1974) found that germination of *Acacia* seeds ingested by implala, Tomosons gazelle (*Gazella thomsoni*), dikdik (*Madaqua kirkii*) and *Gazella dorcas* to range from 11 to 28%. On the other hand, Miller (1995) reported that germination of ingested seeds of *Acacia torilis* and *Acacia nilotica* from stomach of kudu exhibited greater germination (48% and 22%, respectively). Also similarly for *Acacia raddiana* and *Acacia tortilis* seeds from *Gazella drocas* faeces showed higher germination than undigested seeds (29.8% and 13.5%, respectively) (Rohner and Ward, 1999). The germination of *Acacia polyacantha* and *Sesbania sesban* seeds was reduced or decreased (35.71% and 54.54%, respectively). This decrease might be because the seeds stayed longer in herbivores digestive system or damaged by chewing seeds or due to seed characteristics. Lamprey (1967) found that the germination of treated Acacia *polyacantha* to range from 0% to 27%. Miller (1995) found that growth varied depending upon the species of herbivores. Lampery (1967) found that the germination of *Acacia* seeds is very low or zero. In this study seeds of *Acacia siberiana* and *Ziziphus spina-christi* ingested by waterbuck remained more or less the same (21% and 53.57%), as the control (21% and 50%, respectively). Lampery (1967) found that germination of ingested *Acacia siberiana* ranged from one to two %. These findings could be explained in view of seed coat thickness, nature and kind of dormancy. In addition to other factors related to acids found in animal stomach, time the seeds remain soaked in the stomach juice and other food components ingested with seeds. Passage in the animal digestive tract improved germination. Bebawi and Mohamed (1985) divided seeds of *Acacia spp* to three arbitrary groups according to the level of dormancy explained in the degree of thickness of the seed coat. These groups are; the high dormancy *Acacias* with and the thick seed coats (*A. siberiana*, *A. nubica* and *A. nilotica* etc.), the medium dormancy *Acacia* with moderately thick coat (*A.seyal, A. albida, A. radiana*). The third group is the soft coated *Acacia* seeds which include *A. polyacantha, A. senegal and A. mellifera.*

Results obtained are in agreement with this division because *Acacia siberiana* of the high dormancy group (thick coat) was not affected in addition to that seeds of which Acacia are heavy and had an oblong shape this will make the seed movement rather slow in the animal stomach shape (Mahgoub, 2002), while *A. polyacnatha* of the soft coat group was harmed in-between the moderately thick coated *Acacias* (*A. seyal*, *Piliostigma reticulatum).* These are positively affected by animal stomach. *Acacia nubica* seeds, although have thick coat and high dormancy were positively affected.

This may be due to shape of seeds which is spherical, that allows for free rotation and movement in the animal stomach which helps in scarification of different parts of the seed coat (Miller and Coe, 1993).

*Ziziphus spina-christi* have mostly two seed / fruit one of them is dormant the other is not (Mahgoub, 2002). These might be due to the fact that the stomach juice has harmful effect on non dormant seed, but had a positive effect on the dormant ones by breaking their dormancy. *Acacia polyacnatha* and *Sesbania sesban* are of the soft coat legume seeds which might explain the harmful effect of stomach juice on them that it penetrated the seed coat to the embryo. However, for *Sesbania sesban* this harmful effect on seed had a positive effect on the whole vegetation by limiting the frequency and richness of this species otherwise it may invade the whole area outlining other species. As for seeds grown within the pellets all seeds except *Acacia siberiana* did not germinate. This may be either due to the pellets chosen for germination contained no seeds or the atmosphere of the pellets surrounding the seeds was not suitable for germination. These could be confirmed by more future studies.

*Ziziphus spina-christi* seed recovered from pellets of Warthog showed higher germination rate (83%) against control (50%) and high than effect of stomach of waterbuck. This might indicate the important role of this animal in dispersal and germination process. The Warthog stomach juice might be the reason behind breaking the seed dormancy above 66% of control.

## CONCLUSION

The processes of the digestive systems of the herbivores had positive effect on seed germination. This might have resulted from complex herbivores-specific interactions between animal behaviors (chewing) and seeds characteristics (size, seeds coat, shape). Therefore the Waterbuck, Tiang and Warthog have great role in the dispersal of seeds of forage plants in their habitats while they are wondering around and ultimately in the regeneration of natural vegetation of the park.



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