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Original article

Effects of gut passage by kudu (*Tragelaphus strepsiceros)* and pericarp on the germination percentage of morula (*Sclerocarya birrea*) seeds

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A B S T R A C T

The study was conducted to determine the effects of gut passage of Sclerocarya birrea (morula) seeds by Tragelaphus strepsiceros (tholo) and pericarp of S. birrea fruits on the germination time and percentage of S. birrea seeds. The S. birrea seeds used in this study were distributed into three sets of thirty. These were the gut passed seeds (GP), mechanically extracted seeds (ME) and seeds in intact fruits (IF). The GP and IF seeds served as treatments while ME seeds served as a control. The seeds were planted into black nursery bags filled with soil and kept in the shade. They were watered daily and the date on which seedlings appeared and the number of seedlings recorded as the seeds germinated. The duration of the study was 60 days. There was a statistically significant difference between seed percentage germination of different treatments ($P < 0.0001$). Gut passage of S. birrea seeds by T. strepsiceros enhanced seed germination percentage and time while seed pericarp inhibited S. birrea seed germination. Conservationists may introduce T. strepsiceros in areas where S. birrea is needed and may be decreasing in numbers.

1. Introduction

Vertebrates play a vital role in seed dispersal, especially the frugivores (for example Hnatiuk, 1978; Hansen et al., 2008; Wabel et al., 2012). Frugivores may thus help in the restoration of degraded land areas as well as in the resurrection of some endangered plant species. Seed dispersal by vertebrates especially mammals may occur in several ways such as epizoochory, which is whereby seeds stick to the fur of the animal or by endozoochory, which occurs via seed ingestion. The seeds may be ingested by an animal in intact fruits then be egested in feaces (gut passed seeds). For example, Aldabra giant tortoise Aldabrachelys gigantea was found to disperse Diospyros egrettarum seeds and to improve their germination by gut passage (Griffiths et al., 2011). Sclerocarya birrea fruits are eaten by some vertebrate frugivores and their seeds passed out in feaces. The ingestion of S. birrea fruits and the egestion of the seeds by elephants (Loxodonta africana) are reported to have a positive effect on the germination of the seeds (Lewis, 1987; Dudley, 2000; Helm et al., 2011; Midgley et al., 2012). There are other vertebrate frugivores which feed on the S. birrea fruits and information on the effects of their gut passage on the germination of the seeds is scarce.

Most of the studies conducted on the effects of gut passage on the germination of some seeds do not consider the possible effects of the pericarp of the fruit itself on the germination of the seeds. Investigating this can elucidate on whether the particular fruit bearing tree in the wild can become extinct in the absence of the frugivores that disperse and support germination of their seeds.

The present study investigated the effects of gut passage (ingestion and deposition in faeces) by Tragelaphus strepsiceros (kudu) and pericarp of S. birrea fruits on the germination of S. birrea seeds. The results of the study could be of importance to wildlife conservationists.

2. Materials and methods

2.1. Seed collection

According to Teichman et al. (1986), seeds of Sclerocarya birrea occur in locules within a hard lignified endocarp. Thirty S. birrea endocarps were collected from the feaces (gut passed seeds) of Tragelaphus strepsiceros in a field at Manyelanong lands (located at S 24° 17' 21.8", E 025° 50' 50.8") near Lentsweletau village in Kweneng district of Botswana in February 2013. The village is about 60 km north of Gaborone, the capital city of Botswana. The T. strepsiceros had naturally fed on the S. birrea fruits. The endocarps were used to check whether the ingestion and egestion of the S. birrea fruits by T. strepsiceros had any effect on the germination of S. birrea seeds. Sixty freshly fallen mature S. birrea fruits were collected under an S. birrea tree near the field in Manyelanong lands in February 2013. The fruits were divided into two sets of thirty. The endocarps were removed from one set of fruits by hand (mechanically extracted seeds), washed and used as the non-ingested treatment. The other thirty intact fruits were used to test for the effect of pericarp on the germination of S. birrea seeds. The two sets of endocarps and the set of intact fruits were planted directly into black nursery bags filled with soil collected from the field and kept in the shade. The planted endocarps and intact fruits were watered daily and number of seedlings recorded as the seeds germinated. The study was conducted over a two months period, from the 9th March 2013 to the 9th May 2013.

2.2. Data analysis

The data were analysed using SAS statistical software. All significant tests were computed at 5% level of probability. Duncan's Multiple Range test was used to compare treatments means.

3. Results

The analysis of variance (ANOVA) showed a statistically significant difference between treatments ($P < 0.0001$). The Duncan's Multiple Range test revealed that all the means of seed germination percentage for different treatments were statistically significantly different from each other ($P < 0.0001$). The cumulative germination success for gut passed seeds (GP), mechanically extracted seeds (ME) and intact fruit seeds (IF) over 60 days is shown in Figure 1. Table 1 shows the germination percentage summary while Figure 2 shows the comparison between the percentage germination means of Sclerocarya birrea seeds at different treatments.

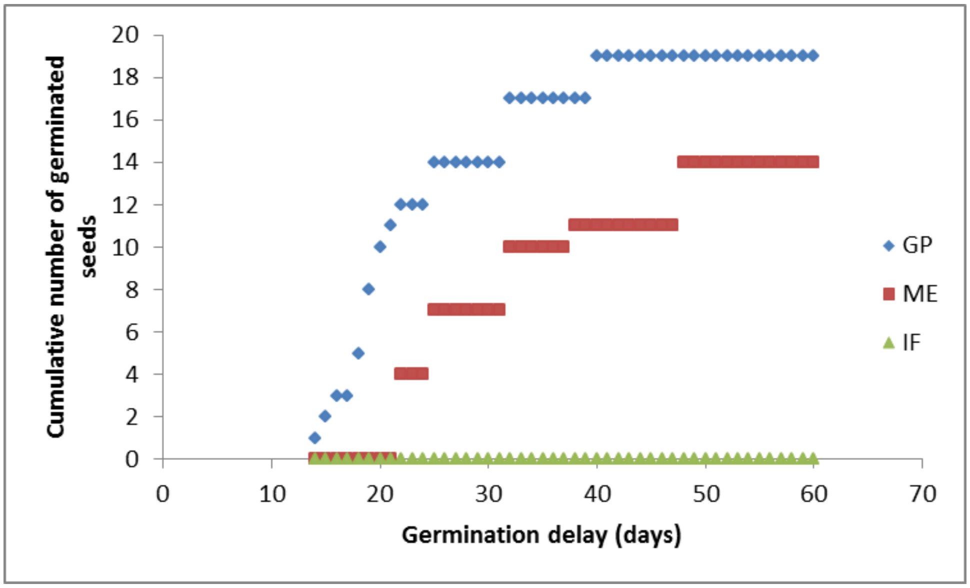

Fig. 1. Cumulative germination success for gut passed *Sclerocarya birrea* seeds (GP), mechanically extracted seeds (ME) and intact fruit seeds (IF) over 60 days.

Table 1
Seed germination percentage of gut passed (GP), mechanically extracted (ME) and *Sclerocarya birrea* seeds in intact fruits (IF) over sixty days experimental period.

Treatment	Germination (%)	Delay (days)
GP	63.33	60
ME	46.67	60
IF	0.00	60

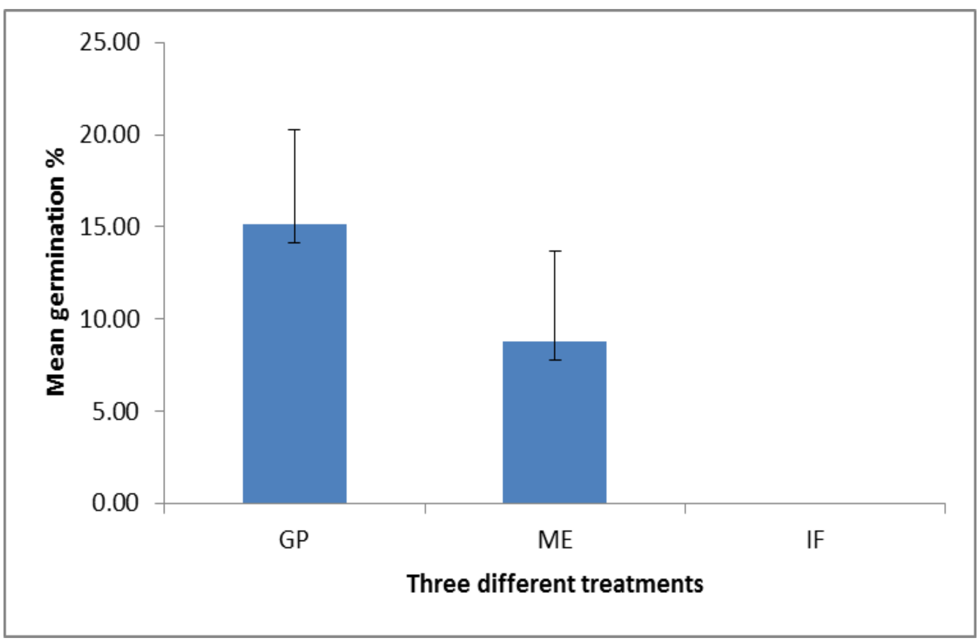

Fig. 2. Comparison between percentage germination (Mean + SE) of Sclerocarya birrea seeds at different treatments (gut passed seeds (GP), mechanically extracted seeds (ME) and intact fruit seeds (IF)).

4. Discussion

4.1. Effects of gut passage by Tragelaphus strepsiceros (kudu) on the germination of S. birrea seeds

The first gut passed (GP) S. birrea seed germinated after fourteen days (Figure 1), which is in accordance with the findings of Moyo et al., (2009) who reported the germination period of depulped S. birrea seeds as fourteen days. The gut passage of S. birrea seeds by the Tragelaphus strepsiceros may have the same effect as depulping the endocarps. The first manually extracted (ME) seed germinated after twenty-one days.

4.2. Effects of pericarp of S. birrea fruits on the germination of S. birrea seeds

No germination was recorded for the planted intact fruits (IF) for the duration of the study (Figure 1). The results of the study suggest that the pericarp inhibit germination of S. birrea seeds while gut passage of the seeds by T. strepsiceros enhance their germination time. The presence of pulp delayed germination by seven days while the presence of both pulp and pericarp completely prohibited germination.

Table 1 shows that the highest germination percentage was from the gut passed seeds (63.33%), followed by the seeds from mechanically extracted endocarps (ME) and lastly no germination recorded from the seeds in intact fruits. The results can be interpreted as IF < ME < GP. According to Samuels and Levey (2005), the interpretation of the results is that gut passage may enhance germination both by removing seeds from fruit, and by altering the seed coat or endocarp.

According to Teichman et al. (1986), the operculum which seals each seed in its own locule in the S. birrea endocarp prevents germination by preventing oxygen from reaching the seeds. In the current study, no germination was recorded for the planted intact fruits. The explanation may be that the pericarp worked together with the locules to prevent oxygen from reaching the seeds, hence completely preventing germination of the seeds. Thickened seed coat is said to have the ability to prevent germination if the seed is not ingested (Temple, 1977).

5. Conclusion

The results of the study demonstrate that gut passage of S. birrea seeds by Tragelaphus strepsiceros could enhance their germination time and percentage success while the pericarp inhibits germination of the seeds. The presence of pulp delays germination while the presence of both pulp and pericarp completely prohibit germination of S. birrea seeds. The results also highlight the need for conservationists to introduce T. strepsiceros in areas where S. birrea is needed and may be decreasing in numbers or lacking.

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