Endocarp Removal Enhances *Butia capitata* (Mart.) Becc. (Pindo Palm) Seed Germination

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ADDITIONAL INDEX WORDS. palms

SUMMARY. Germination rate was significantly improved by removing the thick, hard endocarp from *Butia capitata* (pindo palm) fruit. Time to 50% of final germination rate was not affected by endocarp removal. Afterripening storage did not improve germination rate or time. Germination at 104 °F (40 °C) was superior to that at 93 °F (34 °C).

Butia capitata (pindo palm) is a cold-hardy palm commonly grown as a landscape ornamental in southeastern United States and California and Arizona. *Butia* fruit have an orange fleshy, but fibrous, mesocarp and a hard, stony endocarp containing one to three seeds (Uhl and Dransfield, 1987). The seeds planted by nurserymen and previous researchers are actually endocarps, and when treated like other palm seeds they germinate very slowly and erratically over a 2-year period. This poor germination has been attributed to dormancy (Carpenter, 1988) and to the thick, impervious seedcoat (Sento, 1976).

Carpenter (1988) found that temperatures of 40 °C were optimum for germination in this species, and that the seeds responded positively to an afterripening period of 30 to 150 d. He showed that mechanical or acid scarification, followed by soaks in gibberellic acid (GA_3) or deionized water, did not improve germination time or percentage for this species. The purpose of this study was to evaluate endocarp removal as a method of enhancing *Butia* seed germination.

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Materials and methods

EXPERIMENT 1. The orange, pulpy mesocarp was removed from the mature fruit of two *Butia capitata* trees. These cleaned seeds (endocarps) were air-dried at ≈25 °C for 2 d. Five replicate lots of 100 endocarps each were subjected to the following germination treatments: 1) immediate planting of the cleaned, intact endocarps; 2) afterripening storage of cleaned, intact endocarps in slightly moist sphagnum peat in polyethylene bags for 150 d at 23 °C before planting; or 3) immediate planting of seeds obtained by cracking the endocarps in a vise. Endocarps in this seed lot contained an average of 2.3 seeds per endocarp. Propagules were dusted with thiram fungicide before planting or storage. Propagules were planted in flats using a 1 sphagnum peat : 1 perlite (v:v) medium with ≈2 mm of medium covering the tops of the propagules. Flats were maintained under intermittent mist in a greenhouse with temperatures between 23 and 38 °C. The number of seedlings emerging each week was counted for each replication. This experiment was terminated after no seedlings emerged for 4 consecutive weeks (17 months).

EXPERIMENT 2. Treatments and sample sizes in this experiment were identical to those in Expt. 1, but the propagules were germinated in polyethylene bags filled with moist sphagnum peat as described by Carpenter (1988). These bags were placed in a growth chamber maintained at 40 °C. Each week the contents of each bag were dumped into a tray, the germinated seeds were counted and removed, and the ungerminated seeds and medium were replaced in the bag. This experiment was terminated after 11 months.

EXPERIMENT 3. Treatments were similar to those in Expt. 1, except that seven replicate lots of 50 endocarps were germinated in flats maintained in a growth chamber set at 34 °C. After 56 weeks, a growth chamber malfunction forced us to move the seed flats into the greenhouse used in Expt. 1. This experiment was terminated after 17 months.

EXPERIMENT 4. This experiment differed from Expt. 1 in that four replicate lots of 50 endocarps were germinated in seed flats maintained at 40 °C in a growth chamber. The afterripening storage time was 120 instead of 150 d as in the other three experiments. This experiment was terminated after 7.5 months.

Results and discussion

EXPERIMENT 1. Seeds with their endocarps removed began to germinate after 7 weeks (Fig. 1A). Endocarps that were not stored began to germinate after 47 weeks, while none of the afterripened endocarps had germinated when the experiment was terminated after 17 months. The final germination rate for seeds planted with their endocarps removed averaged 133.6 seedlings per 100 endocarps versus 0.8 for endocarps planted intact and without storage (Table 1).

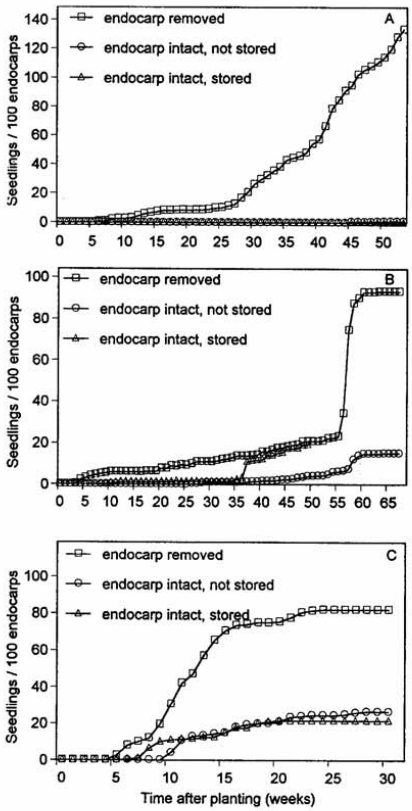

Fig. 1. Effects of endocarp removal and afterripening storage on germination in *Butia capitata* (pindo palm). (A) Germination in a 23 to 38 °C greenhouse. (B) Germination in a 34 °C growth chamber for 56 weeks followed by transfer to the above greenhouse. (C) Germination in a 40 °C growth chamber.

Table 1. Effects of endocarp removal and afterripening storage on germination time and rate for *Butia capitata* (pindo palm).

	Greenhouse (23–38 °C)		Growth chamber (34 °C)[z]		Growth chamber (40 °C)	
	Germination					
Treatment	Time[y]	Rate[x]	Time	Rate	Time	Rate
Endocarp removed	42.4	133.6 a[w]	57.6	93.7 a	11.5	82.0 a
Endocarp intact, not stored	46.0	0.8 b	48.2	15.1 b	17.8	26.5 b
Endocarp intact, stored	---	0.0 b	41.3	19.1 b	12.3	21.5 b
P	0.021	<.0001	0.204	<.0001	0.075	0.034

[z]Flats were moved into 23 to 38 °C greenhouse after 56 weeks.
[y]Time in weeks to 50% of final germination rate.
[x]Seedlings/100 endocarps.
[w]Mean separation within columns by Waller-Duncan k ratio method, k = 100.

Experiment 2. When endocarps and seeds were germinated in slightly moist sphagnum peat in polyethylene bags, most of the seeds without endocarps rotted. However, intact endocarps were generally unaffected by this seed-rotting fungus. Thus, this germination method is not suitable for seeds without endocarps. Final germination rate for afterripened intact endocarps was 41.4 seedlings per 100 endocarps, versus 37.8 for nonafterripened endocarps, a nonsignificant difference (data not shown).

Experiment 3. Very little germination occurred in the growth chamber at 34 °C during the first 56 weeks (36 weeks for afterripened endocarps due to later planting) (Fig. 1B). After 56 weeks, germination rate increased sharply following their transfer to the greenhouse with a maximum temperature of 38 °C. Time to 50% of final germination rate did not differ significantly among treatments, but final germination rate was significantly higher for seeds with endocarps removed than for intact endocarps (Table 1).

Experiment 4. Time to 50% of final germination rate in a seed flat maintained in a 40 °C growth chamber did not differ among treatments, but seeds without endocarps had significantly higher final germination rates than intact endocarps (Table 1, Fig. 1C).

These experiments showed that afterripening storage of endocarps did not improve germination rate nor decrease germination time as reported by Carpenter (1988). Experiments 1, 3, and 4 each differed in some way from Carpenter's experimental design, but Expt. 2 followed his design and still did not show an improvement in germination time or rate for afterripened seeds.

Germination rate was greatly increased by removing the endocarps. Since each endocarp contains from one to three seeds, germination rates of >100 seedlings per 100 endocarps are possible with this method. Although germination of two seedlings from a single intact endocarp was observed once by the author, such seedlings cannot be physically separated and grown as normal single-stemmed palms.

As in most other palm seed germination studies (Broschat and Donselman, 1986; Carpenter, 1988; Nagao et al., 1988), high germination temperatures were superior to lower temperatures. Experiments 3 and 4 were performed in 34 and 40 °C growth chambers, respectively, but little germination ever occurred at 34 °C. An average of 12 seedlings per 100 endocarps germinated after 56 weeks at 34 °C versus 82 seedlings after 22 weeks at 40 °C for seeds without endocarps (Fig. 1 B and C).

Although the endocarps in these experiments were individually cracked in a vise, commercial nut crackers have been successfully used for this purpose in Brazil (L. Van der Ven, personal communication). Endocarps were found to crack with less seed damage if they were allowed to air dry for 2 to 3 d following mesocarp removal.

In summary, endocarp removal appears to be a highly effective method for improving germination of ***Butia capitata*** seeds. This technique was not successful, however, when seeds were germinated in polyethylene bags filled with damp sphagnum peat. Afterripening storage does not appear to provide any advantage for the germination of ***Butia*** endocarps.

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