SEED STORAGE BEHAVIOUR OF *CHUKRASIA TABULARIS* AND *C. VELUTINA*

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PINYOPUSARERK, K., KALINGANIRE, A. & McLEOD, I. 2001. Seed storage behaviour of *Chukrasia tabularis* and *C. velutina*. Seeds of *Chukrasia tabularis* collected in Vietnam and *C. velutina* collected in Thailand were tested for germination capacity after being subjected to three different storage regimes: at room temperature (23 °C), in the cold room (4 °C) and in the freezer (-16 °C). Results showed that the seeds which were stored under these conditions for up to 40 months maintained a relatively high level of viability irrespective of storage temperature regimes. However, seeds of *C. tabularis* deteriorated more rapidly when stored at room temperature. After 40 months of storage, seeds of *C. velutina* had a mean germination capacity of 69.3, 72.0 and 78.7% respectively for room temperature, cold room and freezer storage while those of *C. tabularis* had a mean germination capacity of 29.3, 58.8 and 58.7% respectively.

Key words: *Chukrasia tabularis* - *Chukrasia velutina* - seed storage - storage temperature - storage period - germination capacity

PINYOPUSARERK, K., KALINGANIRE, A. & McLEOD, I. 2001. Kelakuan penyimpanan biji benih *Chukrasia tabularis* dan *C. velutina*. Biji benih *Chukrasia tabularis* yang dikutip di Vietnam dan *C. velutina* yang dikutip di Thailand diuji keupayaan percambahannya selepas diletakkan di bawah tiga regim penyimpanan yang berbeza: pada suhu bilik (23 °C), di dalam bilik sejuk (4 °C) dan di dalam bilik dingin beku (-16 °C). Keputusan menunjukkan bahawa biji benih yang disimpan di bawah keadaan-keadaan ini sehingga 40 bulan mengekalkan tahap kebolehhidupan yang tinggi secara relatif tanpa mengambil kira regim suhu penyimpanan. Bagaimanapun, biji benih *C. tabularis* merosot lebih cepat apabila disimpan di bawah suhu bilik. Selepas penyimpanan selama 40 bulan, keupayaan percambahan biji benih *C. velutina* masing-masing ialah 69.3, 72.0 dan 78.7% di bawah suhu bilik, bilik sejuk dan bilik dingin beku manakala min keupayaan percambahan biji benih *C. tabularis* masing-masing ialah 29.3, 58.8 dan 58.7%.

Introduction

Chukrasia is a distinctive genus in the family Meliaceae comprising possibly two species, *C. tabularis* and *C. velutina* (Pennington & Styles 1975). The natural distribution extends from Bangladesh, India, Nepal, Sri Lanka and the east and south-east of southern China to Indo-China, Myanmar, Thailand, Peninsular Malaysia, Sarawak, Sumatra and to areas on the western tip of Borneo (Ho & Noshiro 1995, Mabberley & Pannell 1995). Although many botanists consider

C. velutina to be a variant of *C. tabularis* (Ho & Noshiro 1995) both taxa are recognised in India and Sri Lanka (Bandara 1999) as well as Thailand (Smitinand 1980). The two *Chukrasia* species can be distinguished by the rough and deeply fissured bark of *C. velutina* and the smoother bark of *C. tabularis* (Kalinganire & Pinyopusarerk 2000). The seeds of both species are, however, very similar and difficult to differentiate. The seeds are flat and winged and have an average size of 4 × 18 mm and weights of 9–14 g/1000 seeds varying with localities. Both *Chukrasia* species are grown for their highly prized timber and have been nominated as priority species for plantation forestry and genetic conservation in many tropical countries (Kalinganire & Pinyopusarerk 2000).

The ability of seed to retain its viability is an important factor for consideration by nursery managers. This is because rapid loss of viability can affect seedling production and jeopardise planting programmes. The storage behaviour of *Chukrasia* seed is not well known. The seed of *C. tabularis* has been reported to retain viability for less than three months (von dem Bussche 1982, Rai 1985) or less than one year (Troup 1921, Dent 1948). In India the seed of *C. velutina* was reported to maintain viability for five months (Anonymous 1974) but in Thailand, *C. velutina* seeds which were kept in sealed jars under cold room conditions (2–4 °C) for 25 months had a germination capacity of 83–87% (Wasuwanich 1999).

We assembled seeds of both *Chukrasia* species from the natural distribution range for development of domestication strategies. There is a need for long-term storage of these seeds for use in future breeding programmes. An experiment was conducted to determine the best storage temperature for *Chukrasia* seed from the three temperature regimes (23, 4 and -16 °C) available at the Australian Tree Seed Centre of CSIRO Forestry and Forest Products. This paper reports the results of storage under the three temperature regimes over a period of 40 months for *C. tabularis* and *C. velutina.*

Materials and methods

Seed material

We obtained two *Chukrasia* seedlots from Thailand and Vietnam in April 1996. Both seedlots were bulk collections from several trees. *Chukrasia velutina* was collected from the Li-Thern area in northern Thailand (18° 20' N, 99° 20' E, 250 m asl) by the Royal Forest Department in April 1993. *Chukrasia tabularis* was collected from Hoa Binh Province in northern Vietnam (20° 25' N, 105° 28' E, 100 m asl) by the Forest Science Institute of Vietnam in November 1995. After collection *C. tabularis* seeds were air-dried and stored at room temperature while *C. velutina* seeds were air-dried and kept under cold room condition (4 °C).

Before the storage experiment, the moisture content of the seeds of both species was determined and found to be 8%. At the end of the experiment the moisture contents of the left-over seeds were 7.8% for *C. velutina* and 8% for *C. tabularis.*

Storage temperature regime

hree different storage temperature regimes are available at the CSIRO estry and Forest Products, Australia: room temperature (23 °C), cold room C), and freezer (-16 °C). The seeds of both species were each placed in three o bags and allocated randomly to one of the three storage regimes. The bags oom temperature storage were placed in an airtight metal tin while the bags the cold room and freezer treatments were sealed in laminated plastic to ent moisture exchange with storage atmosphere.

Seed germination test

hree germination tests were carried out at 6, 30 and 40 months after the mencement of the storage trial in May 1996. For each germination test, 75 s were randomly taken from each of the two species under each of the three age temperatures. The seeds were placed in a stainless steel tea infuser, rinsed old running tap water for 10 minutes and then placed on a towel to surface dry for four hours. Surface drying the seeds after rinsing was preferred as seeds of both *Chukrasia* species tended to stick together after soaking and were difficult to separate without damage to the seeds. After surface drying, 25 seeds from each storage temperature were separately placed onto a filter paper in a 90-mm glass Petri dish. The filter paper sat on top of 30 g of wet vermiculites. The seeds were germinated in a germination cabinet set at 25 ± 2 °C and 8 hours light (2 × 30 watt cool white fluorescent lights).

Germination started on the fifth day and counts continued until germination was completed in all the dishes (i.e., no new germinants), which was generally achieved within three weeks. The seeds were considered germinated when they had produced green cotyledons. Abnormal germinants were recorded but not included in the final percentage calculation.

Statistical analysis

In view of the differences in the collection time and handling procedures of the seeds of *C. velutina* and *C. tabularis,* separate analysis of variance (ANOVA) was conducted for each species to determine the significant differences between the percentage of germinated seeds per storage regime. A factorial arrangement of three storage temperatures and three storage periods was used for the ANOVA. The data processing package DataPlus, Version 2 was used to generate the Genstat code for statistical analysis.

Results

The ANOVA results are summarised in Table 1. There were significant differences ($p < 0.01$ and $p < 0.05$) between storage temperatures and storage periods in the

germination of seeds of both species. Significant interaction ($p < 0.05$) between the two main factors was observed in the seed of *C. tabularis* but not in *C. velutina*. Table 2 shows mean germination percentage of *C. velutina* and *C. tabularis* at the three storage temperatures over the 40 months of storage.

Table 1 Analysis of variance for mean germination percentage (arc sin transformed) of seeds of *Chukrasia velutina* and *C. tabularis* stored under different temperature regimes and storage periods

Source	d.f.	m.s.	v.r.
Chukrasia velutina			
Replicate	2	129.78	
Temperature	2	374.11	4.85*
Period	2	263.11	3.41*
Temperature x period	4	55.22	0.72^{ns}
Residual	16	77.19	
Chukrasia tabularis			
Replicate	2	142.2	
Temperature	2	399.30	3.57*
Period	2	727.00	6.50**
Temperature x period	4	334.90	3.00*
Residual	15 (1) #	111.80	

one outlying value was treated as missing value.
* and ** indicate significant differences at $p < 0.05$ and $p < 0.01$ respectively
ns indicates no significant difference at $p < 0.05$

Table 2 Mean germination (%) of *Chukrasia velutina* and *C. tabularis* seeds stored under three storage temperature regimes at 6, 30 and 40 months

Species	Storage temperature	Storage period (months)		
		6	30	40
C. velutina	Room temperature	78.0	60.0	69.3
	Cold room	81.7	77.3	72.0
	Freezer	87.0	80.0	78.7
	Standard error of difference for storage temperature and period = 4.14			
C. tabularis	Room temperature	69.3	56.0	29.3
	Cold room	58.7	65.3	58.8
	Freezer	70.7	64.0	58.7
	Standard error of difference for storage temperature and period = 4.98			

Effect of storage temperature

The germination capacity of *C. velutina* increased with decreasing storage temperature. Mean germination for the seed stored at room temperature, cold room and freezer was 78.0, 81.7 and 87.0% respectively at the 6-month germination test; 60.0, 77.3 and 80.0% respectively at the 30-month germination test; and 69.3, 72.0 and 78.7% respectively at the 40-month germination test (Table 2).

In the case of *C. tabularis* the germination of seed increased from room temperature storage to cold room storage at the 30- and 40-month germination tests, i.e., 56.0 to 65.3% and 29.3 to 58.8%. Further decrease in the storage temperature from 4 °C in the cold room to -16 °C under freezer condition did not improve the germination capacity of the seed. The 6-month assessment of seed stored in the cold room had an unusually high number of abnormal germinants which were not counted. This resulted in a lower germination rate under the cold room storage than at room temperature and could have contributed to the significant interaction effect.

Effect of storage period

There was a general trend of decline in the germination of seeds for both *C. velutina* and *C. tabularis* from 6 to 40 months storage period under all three temperature regimes. The mean values of seed germination percentage given in Table 2 indicated that germination of *C. tabularis* seeds after 40 months of storage at room temperature dropped to 29.3% compared to 69.3 and 56.0% for seeds stored at the same temperature for 6 and 30 months respectively. Seed of *C. velutina* showed a smaller decline in germination than that of *C. tabularis* over the same period.

Discussion

The results of this study demonstrated that seeds of *C. velutina* and *C. tabularis* retained viability after 40 months of storage under different temperature regimes. The seed which was stored under cold room or freezer conditions retained a higher viability than that which was stored at room temperature. The results are thus contrary to earlier reports where *C. tabularis* seed was found to lose all viability within three months (von dem Bussche 1982, Rai 1985) or one year (Troup 1921, Dent 1948). The robust storage behaviour of *C. velutina* seed as suggested by Wasuwanich (1999) is confirmed by this study. The seed of *C. velutina* used in this study had been in storage in Thailand for three years before being subjected to this storage experiment for another 40 months. The seeds can thus be stored beyond six years while maintaining a high level of germination capacity.

Chukrasia velutina seed showed a higher germination rate than *C. tabularis* seed at all three storage temperatures. The comparison, however, may not be legitimate since *C. velutina* seed from Thailand already had a higher germination percentage in the initial test before the storage treatments. This result suggests that the better the physiological quality of seed going into storage the better its longevity. Apparently *C. velutina* seed, though collected two and a half years earlier than *C. tabularis* seed, had been held under better storage conditions (namely, in cold room 2–4°C) soon after collection. *Chukrasia tabularis* seed on the other hand was kept at room temperature for nearly six months before being dispatched to Australia.

There was no information on the moisture content of the seeds of both *Chukrasia* species used in this study immediately after collection. Tests before and after the 40-month experimental period showed that moisture content of both seeds remained fairly stable at 8%. Other tests by CSIRO Australian Tree Seed Centre on more than 25 provenances of *C. tabularis* and *C. velutina* collected from nine countries showed that moisture contents vary from 8 to 10% with germination varying from 60 to more than 90%. This is considered to be within the normal range for species with seeds tolerant to desiccation of water contents below 12% (Roberts 1973, Berjak & Pammenter 1995). Good germination can be maintained by keeping such seed in sealed containers. Therefore, temperature is believed to be the major factor influencing the storability of *Chukrasia* seed.

Conclusion

This study showed that germination capacity of *C. velutina* and *C. tabularis* seeds could be maintained under controlled storage conditions for more than 40 months, indicating their durability. Temperature was an important factor in the seed storage of both *Chukrasia* species. Although it was observed that the seed stored under room temperature conditions (23 °C) retained a satisfactory germination capacity, better germination was obtained for seeds that were stored in the cold room and freezer. This was particularly true at the longer storage period of 40 months for *C. tabularis* seed, which deteriorated more rapidly at room temperature storage.

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