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Desiccation and storage of *Lannea microcarpa* seeds from Burkina Faso

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Abstract

Seeds of *Lannea microcarpa* collected from Burkina Faso in 1997 and 1998 were subjected to desiccation and a range of storage conditions. Seeds were able to tolerate desiccation to low moisture contents (ca. 5%) with little loss of viability. In addition, it was possible to store seeds at 25°C at reduced moisture contents (approx. 6%), for up to 14 months. However, seeds stored at -20 or 4°C exhibited a reduction in viability within three months of storage. This indicates that seeds of *L. microcarpa* may exhibit non-orthodox seed storage behaviour.

Introduction

Lannea microcarpa Engl. & K.Krause is a tree, which belongs to the Anacardiaceae family. The species is found in all the Sudanian zones of West Africa. The Northern limit of its habitat is the Sahelo-sudanian zone and the southern limit is the Guinean zone. It likes deep soil but can also withstand uncultivated and lateritic soil. The tree can reach 16 m high. The bark is grey white, smooth when the tree is young, and becomes splintery when getting old, and the slash is red. The compound leaves, with 2 to 9 leaflets, are alternate and measure up to 25-cm long. The flowers are small, green yellowish with glabrous sepals. The fruit is a drupe, which becomes purple

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black at maturity. The fruits are edible and are used for cooking and production of wine. The bark is used for making cords.

Preliminary studies on *L. microcarpa* indicate that the seeds are difficult to store (Gaméné, pers. comm.). The purpose of this investigation was to detail the response of *L. microcarpa* seeds, collected in Burkina Faso, to desiccation and storage.

Materials and methods

Initial tests

Fruits were collected on 18–20 June 1997 and 4–6 July 1998, from Bissiga (12°40'N 01°10'W), Burkina Faso. After harvest, 100 individual fruits were sampled and weighed. The remaining fruits were soaked in water and immediately de-pulped, polished with sand to remove the mesocarp tissue and finally washed with water. The seeds were then soaked in 1% NaOCl solution for 10 minutes, dried with a cloth and then coated with fungicide: 1 g of Benomyl and 1 g of Thiram per 1 kg of seeds. Following this treatment one sample of seeds was sent by airmail to the Royal Botanic Gardens, Kew, and another to Wageningen: the remaining seeds were retained at CNSF, Burkina Faso.

Desiccation and germination trials

Desiccation trials were undertaken at both Kew and CNSF. Seeds were desiccated by mixing them with silica gel (1 kg of seeds for 1 kg of silica gel) or smaller quantities of seeds mixed on a 1:1 ratio (wt) with silica gel. During desiccation, a seed sample was regularly weighed which allowed seeds to be dried to target moisture contents of 20, 16, 13, 10, 8 and 5%. As a control for the desiccation experiment, samples of seeds were mixed with sawdust or vermiculite and held at 25–26°C: bags were regularly vented.

Germination at each moisture content was assessed by sowing 100 seeds (4 × 25) at 26 (Kew), 25 (CPRO) or 30°C (CNSF). A photoperiod of 8 h a day was applied at CPRO and Kew, on seeds sown on filter paper and a gel of 1% agar in water, respectively. Seeds were sown in sterilized sand and at constant light at CNSF.

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Moisture content vs. relative humidity

The relationship between moisture content and equilibrium relative humidity (eRH) was established to construct a water sorption isotherm for *L. microcarpa*. Seeds (2 × 3 at each target relative humidity) were incubated above silica gel (4% eRH) and a range of saturated salt solutions (lithium chloride (15%), calcium chloride (33%), zinc nitrate (42%), sodium bromide (59%) and sodium chloride 76% eRH) at 21°C, until they reached constant weight. Equilibrium relative humidity of the seeds was then determined using a Rotronic WA-14P water activity measuring station (Rotronic Instruments UK, Horley) set up with a DMS 100H humidity sensor. Following relative humidity determinations, the moisture content of the seeds was determined by drying the seeds at 103°C for 17 h. The data of moisture content were then plotted against those of eRH.

Storage trials

In 1997 storage trials were undertaken at CNSF and CPRO with non-dried and dried seeds with different moisture contents ranging from 3 to 25%, as well as their controls, at -20, 5, 15, 16, 20 and 25°C. To reach the desired moisture level, the seeds were mixed with silica gel (CNSF) whereas at CPRO, the fresh seeds were gradually dried in a cabinet with fixed 32% relative humidity. Seeds of each treatment sample were sealed in aluminium foil at CPRO and enclosed in plastic bags at CNSF for their storage. Two to four replications of 25 seeds were used for the assessment of the germination while 25 seeds were used for the MC.

At CPRO, germination and moisture content, of stored seeds, were assessed every two or three months, up to 24 months, as described above. After storage, the aluminium sachets representing each seed treatment were equilibrated overnight at 25°C before germination tests were commenced the next day.

In 1998, storage trials at CNSF were undertaken with seeds dried to four target moisture contents (3, 6, 9 and 12%) and stored at -18, 4 and 25°C for up to 6 months.

Results

Initial tests

L. microcarpa seeds harvested in 1997 and 1998 had similar characteristics for fruit and seed weights (Table 1). However, their initial moisture contents for the whole seeds, and seed parts varied. Whole seeds from the 1997 collection had a high initial moisture level (28.4%), while their embryos had the lowest moisture content (10.5%). Seeds collected in Burkina in 1998 had a lower moisture content and germination when tested at CNSF compared to when assessed at Kew (Table 1).

Table 1. Initial characteristics of seeds of *L. microcarpa* from Burkina Faso

	Fruit weight (g)	Seed weight (g)	Initial MC (%)			Germination (%)
			Whole seed	Seed coat	Embryo	
CNSF (1997)	1.14±0.29	0.20±0.03	28.43	14.74±8.64	10.5±7.5	94±5
CNSF (1998)	1.04±0.16	0.19±0.03	12.56±4	8.89±4.27	15.2±5.9	78
Kew (1998)	–	0.18±0.03	22±2	18±1	25±3	88±3

Seed desiccation and germination

Seeds of *L. microcarpa* collected in both 1997 and 1998 survived desiccation to moisture contents of approximately 5% with little loss of viability (Fig. 1). Seeds desiccated gradually from >20% MC to 5% MC retained high germination, which did not alter ($P<0.05$) with drying.

Based on the plot of seed moisture content against relative humidity, it was observed that seeds that had tolerated drying to 5% MC, had equilibrated to a whole seed relative humidity of approximately 35% (Fig. 2).

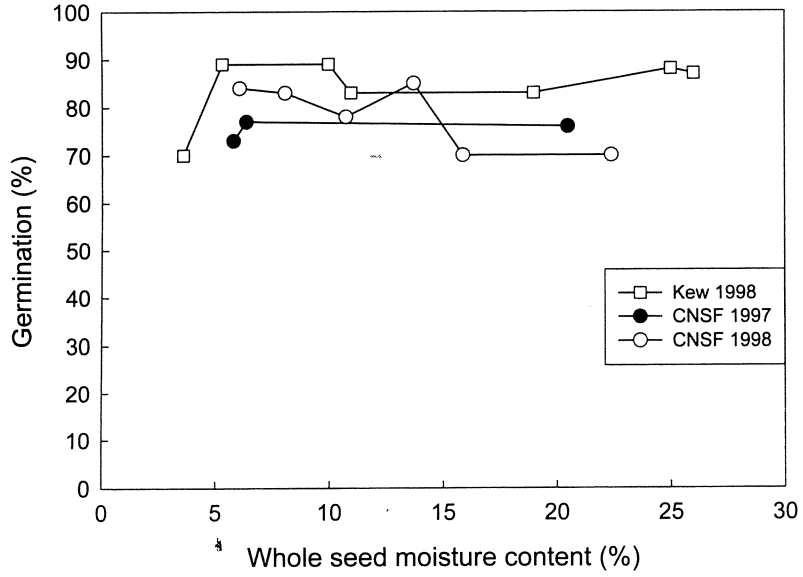

Figure 1. Effect of desiccation on viability of *L. microcarpa* seeds. The trials were carried out at CNSF, Burkina Faso (1997 and 1998) and at Kew (1998).

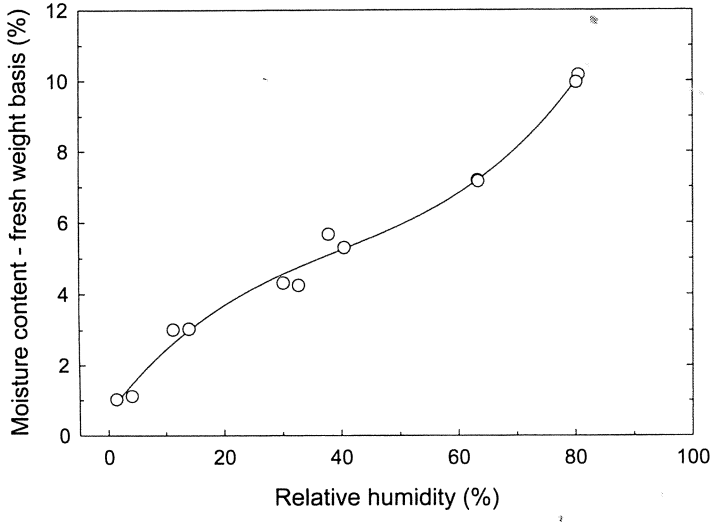

Figure 2. Desorption (water lost from initial fresh seeds) isotherm measured at 21°C, for *L. microcarpa* whole seeds.

Seed storage

Table 2 indicates that seeds collected in 1997 could be stored at 25°C for up to 14 months at 5.5 and 5.8% mean moisture content (5 and 8% target moisture contents) while retaining about one-third of the initial germinability. However, it should be noted that during storage the seed moisture contents fluctuated from the initial value (note the quite large SDs for MCs), which might have affected seed viability.

Table 2. Effect of storage at 25°C and two different moisture contents, on viability of *L. microcarpa* (trials carried out in 1997 at CNSF)

Storage period (months)	Germination (%) post storage	
	5.48±2.4% MC	5.81±2.1% MC
0	73	77
2	49	44
4	31	18
6	15	22
8	43	31
10	31	17
12	20	14
14	27	18
16	2	5
18	3	4
20	0	0

Seeds collected in 1998 were stored at four moisture contents (18, 17, 16 and 11%) at -18, 4 and 25°C for up to 6 months. Seeds survived desiccation to all the target moisture contents, but viability at -18 and 4°C was lost by the first sampling interval at three months, irrespective of moisture content. However, at 25°C up to 50% viability was retained for three months (data not shown).

Storage of seeds (1997 batch) at CPRO revealed a similar pattern (Table 3). Seed retained some viability for up to three months when stored at 25°C, particularly at lower moisture contents. However, viability was slightly lower after -20 and 5°C storage even at low (3–6%) moisture contents.

Table 3. Effect of storage at different temperatures and moisture contents on viability of *L. microcarpa* seeds (trials undertaken at CPRO in 1997).

MC	Temperature	3 months	12 months
25%	25°C	0	0
20%	25°C	0	0
12%	15°C	16	0
9%	15°C	70	0
6%	25°C	84	25
	15°C	84	69
	5°C	58	54
	–20°C	56	44
3%	25°C	90	55
	15°C	84	70
	5°C	62	52
	–20°C	50	44

Discussion

Desiccation trial

Seeds of *L. microcarpa* survived desiccation to moisture contents of approximately 5% (Fig. 1). Thus, seeds of these two batches from Burkina Faso have seeds that are desiccation tolerant. However, these results are in contrast to earlier work, which reported seeds of *L. microcarpa* as being recalcitrant (CNSF, cited in Hong *et al.* 1996).

Seed storage

This study found that seeds of *L. microcarpa* can be stored, at 25°C, for up to 14 months. This is in contrast to the work of Kamra (1990) who found that viability at room temperature was lost within one month. Work undertaken at CNSF found that viability was lost at -18°C. This loss of viability may have resulted from ice crystal formation within the seeds since the seeds were stored at high (>11%) moisture contents, which correspond to a relative humidity in excess of 80% (Fig. 2). At relative humidities of 80% or more, ice crystal formation would be expected to occur upon freezing (Vertucci and Farrant 1995).

In addition, some seed viability was also lost at 4-5°C after three months storage. This loss of viability may reflect chilling sensitivity of these seeds. Chilling sensitivity has been observed in the seeds of a number of species of tropical origin (Corbineau and Côme 1988). A reduction in seed viability of the seeds stored at -20°C, at CPRO, even at low (3-6%) moisture contents suggests that seeds of *L. microcarpa* may exhibit intermediate (*sensu* Ellis *et al.* 1990) seed storage behaviour. Clearly, further work is required to fully clarify the seed storage behaviour of this species.

Conclusions

Seeds of *L. microcarpa* can be dried to low moisture contents with little or no affect on viability. Furthermore, seeds can be stored, at reduced moisture contents, for up to 14 months at 25°C.

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