

GERMINATION OF DOUM PALM (*Hyphaene thebaica*, L. MART.) SEEDS AS AFFECTED BY SOME SCARIFICATION TREATMENTS

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ABSTRACT

*A field experiment was carried out during the seasons of 2005 and 2006 at Orman Botanical Garden, Giza, Egypt to study the effect of some scarification treatments on germination parameters, endocarp constituents and the quality of doum (*Hyphaene thebaica*, L. Mart.) seedlings.*

The results indicated that endocarp punching or removal treatments slightly improved characters of germination and seedlings quality, which were significant in some cases, specially for punching treatments, while clefting the bare endocarp reduced such parameters to the minimal values in most cases of both seasons. However, the previous three treatments didn't obviously affect thickness, strength and chemical constituents of the bony endocarp. On the other hand, soaking in concentrated H₂SO₄, specially for 6 hrs., significantly improved germination (%), germination velocity, mean germination rate, germination rate index, vigour index and quality of the resulted seedlings; which assessed as first leaf length, root branchlets number/ seedling and aerial parts and roots fresh and dry weights. The least means for endocarp thickness, strength and chemical constituents were also referred to the acid scarification with concentrated H₂SO₄ treatments.

*Hence, soaking the bare seeds of doum (*Hyphaene thebaica*, L. Mart.) in concentrated H₂SO₄ for 6 hrs. can be recommended as a simple, cheap and quick way for high germination percent and good quality of seedlings.*

Key words: Germination, doum palm, *Hyphaene thebaica*, sulfuric acid (H₂SO₄), mechanical scarification, endocarp.

INTRODUCTION

Hyphaene thebaica L. Mart. Doum or Doom palm, Egyptian Doum, Gingerbread palm or Gingerbread tree (Fam. *Palmaceae*). To 6 m. or more; commonly forked one or more times, but sometimes simple; leaf blades stiff, nearly orbicular to 90 cm long, cut to middle or deeper into 20 or more segments; fruit mostly obliquely ovoid or oblong, to 8-9 cm long, usually 1-seeded, dryish fibrous, endocarp thin, endosperm homogeneous. Nile region of N. Africa, but also grown in the tropics and subtropics for the unusual (for palms) branching habit (Bailey, 1976). Moreover, Huxley *et al.* (1992) added that doum is suitable for outdoor cultivation in the humid and dry tropics, making attractive lawn specimens. Fruit mesocarp is orange, edible

and tasting for gingerbread. The powder of exo- and mesocarp is used as a sugared warm beverage for refreshing and blood pressure decrement.

Hard – seeded *Hyphaene species* often present considerable difficulties to nursery owners because of their hard, impermeable seed coats (pericarps). Such seeds often require pretreatments to obtain rapid and uniform germinating. In this concern, Patel (1996) described a technique for germinating the ornamental palm *Hyphaene indica*; as the fruits harvested at maturity and allowed to rest in the open without disturbance; one month after harvest, the fruits are placed in polyethylene bags and kept immersed in water for 10 days; the treated fruits are sown either in plots or boxes (unless metal or asbestos sheets in placed at a depth of approx. 30 cm in the plot below the fruits, the emerging sapling should be transplanted immediately after the emergence of the first leaf otherwise the roots penetrate too deep into the substratum). Germination % ranged between 40-50%, but many seedlings did not reach maturity. On *Hyphaene thebaica*, Moussa *et al.* (1998) found that intact fresh seeds had much lower germination (0.6-2.5%) than either seeds with their pericarp removed (78-82% or bare nuts (pericarp and endocarp removed, 73-85%). Water – soaked seeds had higher germination than unsoaked ones for both the fresh and 13 – month – old seeds, the sulfuric acid treatment resulted in 28.3% germination and was the only treatment which resulted in any germination of intact seeds.

On other palm species, Daquinta *et al.* (1996) reported that scarification with concentrated sulfuric acid for 30 minutes gave 90% germination after 30 days in seeds of *Chamaedorea seifrizii* accompany with improving the quality of the resulted seedlings. Broschat (1998) revealed that germination rate was significantly improved by removing the thick, hard endocarp from *Butia capitata* fruits, whereas time to 50% of final germination rate was not affected by such treatment. On *Caryota urens*, however Maciel (2002) noticed that acid scarification via sulfuric acid dipping for 6 and 12 minutes negatively affected the seedling emergence (2 and 0 %), while dipping in water for 3 and 7 days increased seedling emergence to 42 and 50 %, respectively.

Similar results were also gained by Shahin and El-Shakhs (2001) on *Nelumbium nucifera*, Barnett (2002) on *Pinus palustris*, Dreesen (2003) on *Salix irrorata*, *S. bebbiana* and *S. arizonica*, Olmez *et al.* (2004) on *Capparis ovata* and Singh *et al.* (2005) who indicated that seed coat removal enhanced seed germination of *Pongamia glabra*, a medicinally important ornamental tree in India, up to 85 %. The seeds treated with concentrated H₂SO₄ and HCl for a minute showed 91.3 % germination, while those treated with hot water (50°C) exhibited highest germination (98%).

This study, aims to detect the most suitable treatment for increasing and accelerating germination of the hard-coated seeds of doum palm.

MATERIALS AND METHODS

A field experiment was performed during 2005 and 2006 seasons at the Experimental Area of Orman Botanical Garden, Giza, Egypt to study the effect of some scarification treatments on germination parameters, endocarp constituents and quality of the produced seedlings of doum palm (*Hyphaene thebaica*, L. Mart.).

The mature fruits were rasped by a greater to pull out the dry-fibrous pericarp. The bare seeds with bony endocarp (it diameter ranged between 3.5 and 4.2cm) were then subjected to the following treatments:

- 1- Control; as the bare endocarp received no treatment.
- 2- The bare endocarp was bored with a drill at three different positions.
- 3- The bare endocarp was clefted with a handsaw at the placental end and the facing distal one.
- 4- The bare endocarp was completely removed to get the bony endosperm alone (its diameter ranged between 2.5 – 3.4 cm).
- 5- The seeds with bare endocarp were completely soaked in concentrated sulfuric acid (98.5 % for either 6 or 12 hours).

Treated seeds of various treatments were planted on April, 7th in beds 100 x 80 cm filled with sand to the depth of 100 cm, as every bed contained 20 seeds planted at 20 x 20 cm for both seasons. The seeds were inserted in the sand until they were disappeared, and then covered with a thin layer of fine loam and compressed with a flate wooden piece to ensure the completely intact between the seeds and the soil. Thereafter, the beds were irrigated once every week to fill up and received the usual agricultural practices, specially digging up whenever needed.

The layout of the experiment during the two seasons was a completely randomized design (Das and Giri, 1986) with 3 replicates, as each bed containing 20 seeds expressed one replicate. Clearly visible plumule protrusion was used as a criterion for germination. So, the length of plumule (cm) at germination was registered at first sight.

At the end of the experiment ,on 10th of September, the following data were recorded: germination percentage using the following equation: $G. \% = \text{Total No. germinated seeds} / \text{Total No. raised seeds} \times 100$, germination velocity (G.V.) as the mean No. days from sowing till germination become constant in the treatment, mean germination rate (MGR) as the mean No. days to attain 50% of the total germination (Odetoba, 1987), germination rate index (GRI) according to Bartled equation described by Hartmann and Kester (1983) and vigour index (VI) as indicated by Selvaraju and Selvaraj (1994) in the following equation: $VI = G. \% \times \text{mean length of plumule (cm)}$. Moreover, the first leaf length (cm), leaf No./ seedling, root length (cm), root branchlets No. / seedling and aerial parts and roots fresh and dry weights (g) were also measured.

Immediately after treatment the bare seeds, the following determinations and analysis were conducted on the hard endocarp in the second season only:

- Endocarp thickness (mm) was measured at many positions using a steel caliper.
- Endocarp breaking strength (Kg. force) was monitored using an universal testing machine, Tinuis Olsen Testing Machine Co., Willow Grove, PA., USA at Mechanical Testing Lab., Fac. Engine., Cairo Univ., as the seeds were supported by fulcrum and force was applied to the midpoint of the seed (American Welding Society, 1988).

- The percentages of ash, cellulose, hemicelluloses, lignin and extractives%, as the usual main constituents of the hard endocarp were also determined according to McDonald and Kowng (2005).

The data were subjected to analysis of variance and the method of LSD was used to compare between means of treatments (Mead *et al.*, 1993).

RESULTS AND DISCUSSION

A- Effect of pre-germination treatments on germination characters :

Results in Table 1 show that germination (%) of doum seeds significantly increased when mechanically perforated with a drill or chemically scarified with concentrated H₂SO₄ for 6 and 12 hrs. in the two seasons, while clefting the bare endocarp with a handsaw reduced such parameter to the minimal values with non – significant differences when compared to the control in both seasons. This may be due to arrival of the handsaw to the embryo and causing harm to it during cracking the placental end where the embryo is found. The least No. days for GV and MGR was recorded by soaking in concentrated H₂SO₄ for 6 hrs. in the two seasons, whereas prolonging the duration of soaking to 12 hrs. did not cause additional improvement in these traits. This result coincides with that obtained by Khan (1997) who found that increasing the period of scarification with sulfuric acid progressively increased the germination % of Indian ricegrass seeds, but beyond a certain time, scarification adversely affects germination, presumably as a result of acid injury to the embryo. However, the MGR for control and endocarp clefting or removal was not calculated in both seasons because G. % then did not reach 50 %.

Similarly that trend of GRI, as it was significantly increased in response to acid scarification for 6 or 12hrs. in the two seasons, However, endocarp punching treatment gave a mean in the same rank of acid scarification in the second season only. The longest plumule (cm) of germinated seeds was found to refer to soaking in concentrated sulfuric acid for 6 hrs., which significantly raised such trait to 1.80 and 1.76 cm in the first and second seasons, respectively, whilst increment the period of soaking to 12 hrs., elevated this parameter with significant difference only in the first season. On the other hand, endocarp clefting treatment resulted the shortest plumule giving 1.00 and 0.93 cm with significant differences when compared to control averages in the first and second seasons, respectively.

Due to increasing of both germination % and plumule length, the vigour index (VI), as a real guide for germination flush was increased to reach the utmost high and significant means when bare seeds were soaked in concentrated H₂SO₄ for 6hrs., which followed by soaking for 12hrs. and then perforation of the bare endocarp treatment, as such treatments gave in general the greater VI values, which were 157.50, 148.75 and 123.75 in the first season and 176.00, 137.70 and 118.50 in the second one, respectively.

It seems, from the previous results that soaking in concentrated sulfuric acid for 6 hrs., treatment gave the best germination traits at all because its ability on reducing the thickness and strength of the sclera-endocarp to a level that permits the

ease permeable of water and gasses across this weakened endocarp without injury the embryo, and that finally resulted in swelling and expand of endosperm, and cotyledons with emergence of embryo. Suda *et al.* (2003) added that *Euphorbia heterophylla* endosperm surrounds the embryo and its cotyledons increases in area after one day from the start of imbibitions.

The activities of endo- beta- mannanase and beta- mannasidase were higher over the pre-emergence compared to the post-emergence period and they may be involved in the process of germination. The activity of hydrolyses over the post-emergence period may be related to the facilitation of cotyledon expansion by lowering endosperm resistance.

These results are in agreement with those recorded by Moussa *et al.* (1998) on *Hyphaene thebaica*, Broschat (1998) on *Butia capitata*, Shahin and El- Shakhs (2001) on *Nelumbium nucifera*, Dreesen (2003) on 3 species of *Salix* and Singh *et al* (2005) on *Pongamia glabra*.

Table 1. Effect of pre-germination treatments on germination parameters of *Hyphaene thebaica* L. Mart. seeds during 2005 and 2006 seasons.

Pre-germination treatments	G %	G.V. (day)	M.G.R (day)	G.R.I.	Plumule length (cm)	V.I.
2005						
Control	37.50	124.00	-	0.33	1.40	52.50
punching	75.00	89.17	88.00	0.33	1.65	123.75
Endocarp clefing removal	12.50	118.00	-	0.12	1.00	12.50
	25.00	87.50	-	0.46	1.50	37.50
Soaking in concentrated H ₂ So ₄ for 6 hrs.	87.50	86.29	79.75	0.58	1.80	157.50
H ₂ So ₄ for 12 hrs.	87.50	94.50	83.75	0.56	1.70	148.75
L.S.D. at 0.05	30.00	33.76	5.28	0.21	0.30	36.30
2006						
Control	33.33	126.33	-	0.27	1.43	47.66
punching	75.00	88.43	87.27	0.56	1.58	118.50
Endocarp clefing removal	12.50	121.00	-	0.13	0.93	11.63
	37.50	87.10	-	0.44	1.55	58.13
Soaking in concentrated H ₂ So ₄ for 6 hrs.	100.00	85.00	78.56	0.58	1.76	176.00
H ₂ So ₄ for 12 hrs.	85.00	96.26	85.31	0.58	1.62	137.70
L.S.D. at 0.05%	28.67	35.50	3.46	0.23	0.26	34.73

G%: Germination percentage, G.V.: Germination velocity, M.G.R.: Mean germination rate, G.R.I. Germination rate index and V.I.: Vigour index.

B. Effect of pre-germination treatments on seedling growth:

Data of seedling growth given in Table 2, as an aspect of development linked to G.V. and VI, indicated that most of treatments improved vegetative and root growth characters with various significant differences except for endocarp clefing treatment,

which declined growth traits in most cases of the two seasons. However, the superiority was for soaking in concentrated sulfuric acid for 6 hrs., treatment, which gave the highest records comparing with control and all other treatments in both seasons.

Such results may indicate the role of concentrated H₂SO₄ in increasing GV and VI, which led to early germination, and consequently giving the growing embryo the time enough for more growth and high quality. Such gains, however are in parallel with those results of Daquinta *et al.* (1996) on *Chamaedorea seifrizii*, Shahin and El-Shakhs (2001) on nelumbo seeds and Olmez *et al.* (2004) who mentioned that the optimum chemical treatment for seed germination and high quality of seedlings in *Capparis ovata* was obtained by soaking the seeds in 0.2 % KNO₃ for 8 hrs. after treatment with concentrated H₂SO₄ for 20 minutes.

Table 2: Effect of pergermination treatments on growth parameters of *Hyphaene thebaica* L. Mart. seedlings during 2005 and 2006 seasons.

Pre-germination treatments	1 st leaf length (cm)	Leaves No. per seedlin (g)	Root Length (cm)	Root	Aerial parts F.W. (g)	Aerial parts D.W. (g)	Roots F.W. (g)	Roots D.W. (g)
				branchlets No. per seedling				
2005								
Control	61.80	2.00	63.42	34.00	14.78	3.95	14.72	5.10
punching	60.75	2.33	70.33	42.50	16.43	4.46	16.31	5.86
Endocarp clefting	52.00	1.00	65.00	35.00	10.90	2.78	14.20	5.39
removal	70.50	2.50	67.36	38.33	15.36	3.16	15.10	5.50
Soaking in concentrated								
H ₂ So ₄ for 6 hrs.	79.50	3.00	85.50	49.00	19.20	5.27	19.36	6.38
H ₂ So ₄ for 12 hrs.	72.60	2.33	78.76	45.28	17.42	4.65	17.83	5.87
L.S.D. at 0.05%	10.50	0.88	7.33	5.76	1.56	1.23	1.50	0.81
2006								
Control	58.70	2.00	60.33	31.00	13.56	3.56	13.90	4.78
punching	70.50	2.33	73.50	43.80	16.50	4.45	16.50	5.93
Endocarp clefting	56.33	1.00	58.81	31.37	9.79	2.76	12.78	4.82
removal	62.50	2.40	62.30	35.18	12.58	2.63	13.86	5.00
Soaking in concentratec								
H ₂ So ₄ for 6 hrs.	72.86	3.00	79.66	46.50	17.70	4.89	17.35	5.63
H ₂ So ₄ for 12 hrs.	72.50	2.50	74.10	45.00	16.18	4.33	16.10	5.21
L.S.D. at 0.05	9.86	0.76	9.26	5.50	2.13	0.98	2.17	0.85

F.W.: Fresh weight and D.W.: Dry weight

C. Effect of pre-germination treatments on endocarp characteristics:

Strength, in general can be defined as the ability of a material to withstand an applied load (Wulpi, 1986). Such strength, however linearly decreased with the decrement in seed coat thickness (Khan, 1997).

In the current work, data in Table (3) show that punching or clefting operations had no effect on endocarp thickness, although they were decreased its breaking strength by about 15.33 and 31.72%, respectively.

On the other hand, soaking in concentrated H₂SO₄ for either 6 or 12 hrs., greatly reduced the thickness of endocarp by about 32.50 and 41.75%, and consequently the strength by about 46.63 and 64.80%, respectively. That of course could help the embryo to go out through the weakened endocarp without resistance. Owing to removing of the endocarp, data of thickness, strength and chemical constituents for endocarp removal treatment were not recorded.

Concerning the chemical compositions of the hard endocarp, data in Table 3 reveal that ash, cellulose, hemicelluloses, lignin and extractives percentages were not affected by either endocarp punching or clefting treatments, whereas soaking in concentrated sulfuric acid for 6 or 12 hrs., markedly decreased such constituents with the exception of extractives, which clearly increased. Such gains, however indicate the role of concentrated H₂SO₄ in softening and enfeeblement the concrete(solid) endocarp of doum seeds through reducing thickness and strength coupled with dissolving the complicated compounds consisting the endocarp such as cellulose, hemicelluloses and lignin to simple and soluble extractives, and that will finally lead to raising and accelerating germination process. On the same line were those findings mentioned by Shahin and El- Shakhs (2001) on *Nelumbium nucifera*, Dreesen (2003) on 3 species of *Salix* and Singh *et al.* (2005) on *Pongamia glabra*.

From the foretasted results, it could be recommended to soaking doum (*Hyphaene thebaica*, L. Mark) bare seeds in concentrated H₂SO₄ for 6 hrs., to get the highest and fastest germination associated with good quality of seedlings.

Table 3: Effect of per-germination treatments on endocarp characteristics of *Hyphaene thebaica* L. Mart. seeds during 2006 season.

Pre-germination treatments	Endocarp thickness (mm)	Endocarp breaking strength (Kg. Force)	Endocarp constituents (%)				
			Ash	Cellulose	Hemi.	Lignin	Extr.
Control	4.00	1647.5	4.33	66.31	13.29	12.85	3.22
Punching	3.92	1395.0	3.96	66.26	13.20	12.80	3.78
Endocarp clefting	3.98	1125.0	3.98	66.09	13.17	13.00	3.76
removal	-	-	-	-	-	-	-
Soaking in concentrated							
H₂So₄ for 6 hrs.	2.70	879.2	2.76	44.28	8.86	6.89	37.21
H₂So₄ for 12 hrs.	2.33	580.0	2.10	32.94	6.70	5.21	53.05

Hemi. = Hemicelluloses Extr.= Extractives.

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أجريت تجربة حقلية بحديقة الأورمان النباتية، الجيزة، مصر وذلك خلال الموسمين المتتاليين: ٢٠٠٥، ٢٠٠٦ لدراسة تأثير بعض معاملات الخدش على صفات الإنبات، مكونات الإندوكارب الصلب وجودة الشتلات الناتجة لنخيل الدوم (L. Mart.) (*Hyphaene thebaica*).

ولقد أوضحت النتائج أن معالمتي ثقب الإندوكارب أو إزالته بالكامل أحدثتا تحسناً طفيفاً في صفات الإنبات وجودة الشتلات الناتجة، والتي وصلت إلى مستوى المعنوية في بعض القياسات، خاصة نتيجة لمعاملة التثقيب، بينما أدت معاملة شق الإندوكارب العاري إلى خفض جميع صفات الإنبات وجودة الشتلات الناتجة، مسجلة بذلك أدنى القيم في معظم الحالات بكلا الموسمين.

لم تؤثر المعاملات الثلاثة السابقة بشكل ملموس على سمك وقوة الإندوكارب، أو المكونات الكيميائية له. وعلى الجانب الآخر •

أحدث النقع في حمض الكبريتيك المركز، خاصة لمدة ٦ ساعات زيادة معنوية في نسبة وسرعة الإنبات، متوسط معدل الإنبات، معامل سرعة الإنبات، دليل قوة الإنبات، وكذلك في جودة الشتلات الناتجة (المقدرة على أساس طول أول ورقة، عدد الأوراق/ شتلة، طول الجذر، عدد التفريعات الجذرية/ شتلة والأوزان الطازجة والجافة للنموات الخضرية والجذرية).

أدت معاملات النقع في الحمض إلى خفض سمك وقوة الإندوكارب وكذلك النسبة المئوية للمواد الكيميائية الداخلة في تكوينه (مثل: الرماد، السليلوز، واللجنين) إلى أقل قيم ممكنة مقارنة بالبدور الغير معاملة أو التي عوملت بالمعاملات الأخرى.

وعليه .. فإن نقع بدور الدوم في حمض الكبريتيك المركز لمدة ٦ ساعات قبل زراعتها يمكن التوصية به كأبسط وأرخص وأسرع وسيلة للإنبات الجيد والحصول على شتلات عالية الجودة.