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Use of Carob as a Potting Medium Component

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Abstract. **Due to the high price of imported sphagnum peat in Lebanon, olive pumace and two types of carob pumace, by-products of local industries, were tested as substitute materials in potting mixes. Their particle size distribution, bulk density, stability, and phase distribution were similar to the peatmoss; both were more alkaline and saline, although still within acceptable levels.** ***Nephrolepsis exaltata*** **(L.) Schott,** ***Pilea cadierii*** **Gagnep and Guillaum, and** ***Hedera helix*** **L. were grown in mixes of the pumaces with builder's sand at 1:3, 1:1, and 3:1 organic material by volume. Olive pumace-based mixes produced unsalable plants, apparently due to a phytotoxin present, whereas plants grown in media containing traditionally milled or mechanically chopped carob pumace were of equal or better quality than those grown in peatmoss-based mixes.**

Nurseries in the Mediterranean region produce large numbers of container plants using potting media comprised largely of ingredients other than soil. In many instances, sphagnum peat from Europe comprises a large proportion of the mixes, especially in the production of house plants. Since sphagnum peat is expensive and constitutes a drain on foreign exchange, development of mixes based on locally available materials is desirable. Similar research has been undertaken in other parts of the world using milled bark, peanut hulls, spent mushroom compost, and other by-products (3, 8, 9, 14, 15, 17–19); however, these products are not available in Lebanon. This study was conducted to devise by-product media ingredients from Lebanese sources.

Potting media can be evaluated in the laboratory on physical and chemical properties (3, 8, 10, 13), but also should be evaluated by plant performance (5, 9, 11, 15, 21). Of the physical properties, particle size is one of the most important, since it affects the other physical properties of the mix (5). Bulk density also is important, as it affects physical support of the plant as well as shipping and handling costs. The phase distribution (relative amounts of water and air in a medium) usually is determined by plotting the desorption curve as percentage of water by volume at suctions of 0, 10, 50, and 100 cm (7). From these curves, available water (the difference between percentage of water at 100 and 10 cm of suction), the air volume (the difference between water volume percent at zero suction and the value on the curve corresponding to the suction level in question) and the noncapillary pore space (the difference between the total volume of water at saturation and the water volume at 10 cm suction) can be determined.

Chemically, a potting mix is characterized by pH, salinity level, and cation exchange capacity (CEC). Generally, a pH of 5.5 to 6.5 is desirable (1, 16). Low salinity is important because buildup of soluble salts can decrease plant growth by increasing the magnitude of the osmotic potential and adding to the water stress on the plant. Finally, a high CEC level will affect the ease of maintaining fertility in a mix and its buffering capacity.

Initially, five materials were screened. These were sugar beet pulp, which is often used as cattle feed; 'Karanteena garbage'', a commercially ground and composted product derived from Beirut city garbage; olive pumace, which consists primarily of ground olive pits from the olive oil industry; milled carob pumace, which is a by-product of the traditional carob molasses industry in which the pods of the carob (*Ceratonia siliqua* L.) are stone-ground and the molasses made by boiling in water; and chopped carob pumace, another by-product from the carob molasses industry but with pods mechanically chopped rather than stone ground. Sugar beet pulp and Karanteena garbage were rejected in early tests because of excessively rapid decomposition in the former and a persistent objectionable odor in the latter. Since olive pumace and both carob pumaces appeared promising, laboratory and subsequent greenhouse tests were conducted on them.

Particle size distribution was determined by passing air-dried samples through a series of U.S. standard sieves by manual shaking for 2 to 3 min and then weighing the fractions. The procedure was repeated on three samples of each ingredient and the average reported.

Mixes were prepared by combining each organic component with builders sand to reach 1:3, 1:1, and 3:1 organic matter to sand (v/v) in each mix. Bulk densities were determined by uniformly packing a 2-liter measuring cylinder and weighing the contents. Bulk densities reported are the average of three samples of each mix. Ingredients were analyzed for pH and salinity using the saturated paste extract technique described by Warncke (20).

CEC was determined by saturating the exchange sites with Na, displacing the sodium with ammonium ions, and measuring the sodium concentration by flame photometry. The carbon : nitrogen ratios were determined using the Walkley–Black method (4) for carbon and the Kjeldahl method (4) for nitrogen.

Physical analysis revealed particle size distribution in milled carob similar to that of the moss peat (Table 1). Particle size distribution after the 5 months of incubation (Table 1) generally showed a decrease in the percentage of particles in the 2- to 4- and 4-mm size categories. The 1- to 2- and 0.6- to 1-mm categories slightly increased or maintained their initial percentages. The proportion of particles <0.6 mm increased in all organic mix components.

Bulk densities of the organic components of the mixes were higher than the bulk density of moss peat (Table 2); however, mixes became similar in density as the sand portion increased to greater than the 0.4 to 0.5 $g \cdot cm^{-1}$ range proposed by Bunt and Adams (6) as ideal. The bulk densities increased slightly after 5 months (Table 2), reflecting breakdown. However, rate of breakdown did not correlate with the carbon : nitrogen ratio presented in Table 3. In summary, the mix components tested can be considered nearly as stable as peatmoss during the period of growth of a greenhouse crop.

The water desorption curves of the different mixes are similar at the corresponding levels of the organic amendment. The desorption curves of the chopped carob, milled carob, and milled olive at the 1:1 and 3:1 levels in mixes are closer to the optimum range of phase distribution given by de Boodt and Verdonck (7) than the 1:1 peatmoss mix.

The pH, salinity, and CEC of the various mix components are presented in Table 3. The pH values of the carob and olive are just slightly acid. The salinity of peatmoss is low, whereas carob and olive are much higher. However, when these materials are mixed with sand, the soluble salt concentration of which is very low, the resulting medium will not have a salt level dangerous to crops, according to the acceptable levels set by Joiner and co-workers (12). The CEC for carob and olive is more than twice that of the peatmoss, which would increase buffering capacity, and mixes using these components would hold more nutrients than peatmoss-based mixes, facilitating management.

Nephrolepis exaltata (L.) Schott var. Teddy junior, *Pilea cadierii* Gagnep and Guillaum, and *Hedera helix* L. var. variegata, were chosen for their different requirements for substrate air capacity—high-requiring, medium-requiring, and tolerant to lower air per-

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Table 1. Particle size distribution of mix components newly mixed and after 5 months.

	Percent by wt				
	Particle size (mm)				
Mix components	4	2–4	1–2	0.6–1.0	<0.6
Dutch peat	26.0 (78)[z]	22.9 (98)	18.4 (126)	11.5 (100)	20.5 (110)
Milled olive	5.3 (91)	45.1 (89)	27.4 (116)	9.3 (116)	12.6 (106)
Chopped carob	48.9 (74)	25.7 (130)	12.9 (116)	4.7 (118)	7.7 (122)
Milled carob	27.0 (64)	28.6 (96)	24.2 (131)	10.4 (112)	9.4 (162)

[z]Percent of original value after 5 months indicated in parentheses.

Table 2. Bulk densities of mixes and components

	Bulk density ($g \cdot cm^{-3}$)				
	Organic to nonorganic ratio of mix				
Component	1:3	1:1	3:1	100% component	Increase after 5 months (%)
Dutch peat	1.3	0.9	0.6	0.1	18
Milled olive	1.3	1.1	0.8	0.4	9
Chopped carob	1.4	1.1	0.7	0.3	6
Milled carob	1.3	1.1	0.7	0.4	5
Builder's sand	--	---	---	1.5	---

Table 3. Chemical analyses of mix components.

Component	C : N ratio	pH	Salinity (ppm)	CEC (meq/100 cm^3)
Dutch peat	100 : 1.15	4.0	1860	0.05
Milled olive	100 : 1.35	6.6	4900	0.13
Chopped carob	100 : 3.0	6.1	4400	0.11
Milled carob	100 : 2.65	6.4	3500	0.12
Builder's sand	---	8.0	370	---

centage, respectively, as classified by Johnson according to Joiner (12). All mixes were enriched with 115 $g \cdot m^{-1}$ of fertilizer 17–7.4P–14K), a mixture of chelated trace elements, and $MnSO_4$. The pH of sphagnum-based mixes was adjusted with slaked lime. Plants were grown in 15-cm pots containing mixes (organic fraction : sand) of 1:3, 1:1, and 3:1 chopped carob, milled carob, milled olive pumice, or Dutch sphagnum peat. Each observation was four pots, and there were four replicates. Plants were grown in an unheated plastic greenhouse from 1 Jan. until 3 June 1985, watered by capillary meat, and fertilized twice using a 400 ppm N, 175 ppm P, and 330 ppm K solution plus chelated micronutrients. At the conclusion of the experiment, plants were rated visually on a 0 to 10 scale with 0 representing death and 10 an excellent-quality plant. In addition, root and shoot fresh and dry weights, leaf area, and number of branches were recorded.

To evaluate stability of the materials independently, pots containing only media were treated the same as those containing plants, and bulk density and particle size distribution were determined.

Nephrolepis exaltata showed the highest quality in the milled carob 3:1, chopped carob 3:1, and peatmoss 3:1 mixes, in that order (Table 4), followed by plants in mixes of the same components at the 1:1 ratio and then at the 1:3 ratio. These results corresponded to the porosity of the mixes and were anticipated for this high porosity-requiring species. The performance of *N. exaltata* in olive mixes was very poor and could be attributed to a phytotoxin in the olive. This theory is supported by the decline in quality as amount of olive increased. No attempts were made to ascertain the nature of the toxin.

The increased stunting with increasing olive in the mix was obvious in the reduced number of leaves and leaf area of plants in the olive-containing mixes (Table 4). Number of leaves and their area were highest in the chopped carob 3:1 mix, whereas at the 1:1 organic matter level, the two traits were highest for plants in the milled carob-containing mixes. The poor performance of *N. exaltata* in the nontoxic 1:3 mixes could be a result of the combined effects of low fertility, higher porosity, and less available water than in the mixes containing more organic matter.

P. cadierii produced the highest quality plants in the milled carob 3:1, milled carob 1:1, chopped carob 3:1, and chopped carob 1:1 mixes in that order, and the quality of plants in the other mixes was significantly reduced (Table 4). The quality difference in these plants did not correlate with the phase distribution of the mixes, although the species is classified as requiring medium porosity.

The olive mixes proved to be toxic also to the *P. cadierii* plants, which were of very low quality and, at the end of the experiment, were practically defoliated (Table 4). This defoliation started 1 week after transplanting into the olive mixes at a time when plants in the other mixes were increasing in size. This defoliation, together with the observation that roots did not extend beyond the rooting medium that clung to the root system at the time of transplanting, supports

Table 4. Plant characteristics in tested media.

Substrate[z] organic : sand ratio	Visual quality rating (1–10)			Leaf no. per plant			Average leaf area per plant (cm^2)		
	N. exaltata	*P. cadierii*	*H. helix*	*N. exaltata*	*P. cadierii*	*H. helix*	*N. exaltata*	*P. cadierii*	*H. helix*
DP 1:3	8.0	7.5	5.8	43.3	97.3	58.7	396	342	172
DP 1:1	8.5	7.8	7.0	45.6	98.8	73.6	485	321	230
DP 3:1	9.0	8.0	8.0	53.5	118.8	85.1	620	386	268
CC 1:3	6.2	6.8	5.8	28.8	58.0	47.2	183	169	142
CC 1:1	8.5	8.5	8.0	48.1	93.3	104.0	481	326	339
CC 3:1	9.2	8.5	7.0	59.8	107.3	62.5	778	400	199
MC 1:3	7.2	7.3	5.5	38.5	69.8	45.4	246	184	131
MC 1:1	8.8	8.8	8.8	49.4	108.0	124.6	591	402	387
MC 3:1	9.4	9.0	8.5	51.9	105.0	113.8	704	462	379
Duncan's LSD	0.2	0.3	0.4	2.8	7.9	7.0	41	33	20

[z]Four or less = unmarketable; 10 = excellent.
DP = Dutch peat, CC = chopped carob, MC = milled carob.

the belief of the presence of a toxin in the olive.

H. helix plants showed the best quality in the milled carob 1:1 and the milled carob 3:1 mixes, the organic matter component of these mixes had the highest proportion of particles in the 1- and 2-mm size categories (Table 4). Following in quality were plants in the peatmoss 3:1, chopped carob 1:1, and chopped carob 3:1. The phase distribution of the mixes did not relate to the quality of the *H. helix* plants growing in them; however, plants in the mixes producing the highest visual quality rating generally had the most leaves, the most leaf area per plant, and were the most compact. *H. helix* plants were not affected by the suspected olive toxin as severely as the *P. cadierii* or *N. exaltata* and, although their quality was low, no defoliation or severe yellowing was observed. Also, their root systems were not as restricted as those of the other species.

Carob pumace can replace sphagnum peat in potting mixes, provided that it is ground to an appropriate particle size. The finely milled carob pumace performed well in all the species tested and outperformed the chopped carob on *H. helix*. This response suggests the choice of milled carob pumace as the replacement in a general potting mix. Olive pumace did not perform well, apparently due to the presence of a toxin. Additional studies should be undertaken to ascertain whether some simple treatment, such as leaching, could be used to remove the toxin and render the olive usable. Other possible uses for the olive pumace, perhaps as a weed-controlling mulch, also should be investigated.

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Temperature Affects Seed Germination of Four Florida Palm Species

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Abstract. **Temperature ranges for seed germination were determined for palm species *Acoelorraphe wrightii* (Griseb. & H. Wendl.) H. Wendle ex. Becc., *Coccothrinax argentata* (Jacq) L. H. Bailey, *Sabal etonia* Swingle ex Nash, and *Thrinax morrisii* H. Wendl. Total germination was highest with fewest days to 50% of final germination at 35°C. Temperatures 5° to 10° above or below 35° frequently caused delayed, irregular, and reduced total germination. Temperatures exceeding 10° from 35° generally were inadequate for germination.**

Many native palms frequently are used in landscapes and, until recently, have been moved from natural to urban locations for this purpose. Increased urbanization has caused several of Florida's native palms to be included in the list of endangered indigenous plants (9). Recent legislation protecting palm habitats has created interest in nursery propagation by seed.

Palm species used in this study, *Acoelorraphe wrightii, Coccothrinax argentata, Sabal etonia*, and *Thrinax morrisii*, are native to central and southern Florida. Limited research has been conducted using these genera. Stratification of *S. etonia* seeds for 30 days at 4°C in moist sand has been reported to increase the rate of germination at 30°, permitting 72% germination by 82 days (7). Research with other palm species indicate aqueous seed soaking for 24 to 72 hr prior to propagation shortens slightly the days required for germination (5, 6). Failure to remove the fleshy pericarp from seed delays and causes irregular germination (8). Maintaining relatively high germination medium temperatures from 25° to 35° promoted germination of *Sabal palmetto* (Walt.) Lodd, *S. minor* (Jacq.) Pers., and *Coccothrinax crinita* Becc. (4, 5). The objective of this work was to determine the temperature requirements for germinating seeds of four native palms of Florida.

Seeds of *C. argentata* and *S. etonia* were

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