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Physical and Micromorphological Properties of Organic and Inorganic Materials for Preparing Growing Media

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Keywords: physical properties, particle size, water retention capacity

Abstract

The production of crops in containers is related to the selection of growing media which is based upon water retention capacity and drainage. However lack of knowledge of the type, form and arrangement of the particles makes it difficult to predict its structural behavior in the container. Within this context, the objective of this study was to evaluate physical and micromorphological properties of organic material such as *Sphagnum* peat, coconut fiber, compost and vermicompost and inorganic materials such as pumice, perlite, zeolite and volcanic scoria. The particle size distribution of the materials was 3.36 mm, 2.00, 1.00 mm, 0.50 mm, 0.25 mm and <0.25 mm. The description of pores and particles was conducted though thin sections with resin impregnation. The parameters evaluated were size, abundance, shape, surface roughness, orientation and distribution patron.

The micromorphological analysis showed that organic materials pores exhibiting compound packing voids that the storage and percolation function while inorganic materials had pores of simple packing. The total porosity varied depending on the nature of material and its particle size distribution. In materials with 1 at 2 mm particle size, the total porosity values were 94.3% (coconut fiber), 94.2% (*Sphagnum* peat) and 85% (perlite); while those for 2 at 3.36 mm particle size were 71.9% (compost), 67.7% (vermicompost) and 67.5% in volcanic scoria, and 0.25 at 0.50 mm particle size were 72.2% (pumice) and 70.18% in zeolite. The total porosity values for other particle sizes were lower. In case of volcanic scoria and perlite, then internal pores are disconnected vessels and only the external pores contributed to the percolation. Coconut fiber, *Sphagnum* peat, vermicompost, compost and pumice and are characterized by internally connected porosity due to which they have a higher water retention capacity. It concluded that particle size distribution, the type and number of pores determine the physical and micromorphological properties of the studied materials as growing media.

INTRODUCTION

The physical properties of growing media desicive for relationship retention and movement of water. The use some techniques for determination the internal and external porosity of growing media are imagen analysis (Burés et al., 1993b; Chen et al., 1980), pycnometer or unaltered samples (Martinez et al., 1991); and the other methods have been conducted to relate particle size distribution to pore size distribution, scanning electron microscopy (Pokorny and Wetzstein, 1984), nuclear magnetic resonance and computer simulation (Burés et al., 1997) and micromorphology that provide information of particle and pores size and distribution. The objective of this work is to evaluate physical and micromorphological properties of organic and inorganic materials to determine the retention and movement of water in growing media.

MATERIALS AND METHODS

Organic Materials

Coconut fiber, *Sphagnum* peat (canadian), vermicompost (prepared from animal manure of goat, kitchen trash and straw) and compost (kitchen trash, garden residues and animal manure from goat).

Inorganic Materials

Volcanic scoria, perlite, pumice and zeolite.

Physical Properties

The bulk and real density were determined according to Ansorena (1994) and water release curves with the method employed by De Boodt et al. (1974). The materials were passed through sieve of >3.36, 2.00, 1.00, 0.50, 0.25 and < 0.25 mm and the results were presented as percentage by weight of each fraction (Table 1).

Micromorphological Properties

PVC tubes of 3½ x 2½ inches diameter were used, which were polished with abrasives up to 30 μm and thin sections of 2½ x 3 inches size were made. The thin sections were analysed with a petrographic microscope and size and shape of particles and pores were described on the basis of Bullock et al. (1985).

RESULTS AND DISCUSSION

Physical Properties

1. Bulk and Real Density. Differences were found in both types of densities depending upon the particle size, although highest values were related to particles less than 0.25 mm. It was also noted that the porosity was reduced with an increase in the bulk density of a particular material, due to the fact that the smaller particles tend to be compressed.

2. Total Pore Space. The highest values were found in coconut fiber (94.3%), peat moss (94.7%) and perlite (85%) in particles of 1 to 2 mm; in compost (71.9%), vermicompost (67.7%) and volcanic scoria (67.5%) in particles of 2 to 3.36 mm and pumice (72.2%) and zeolite (70.2%) in particles of 0.25 to 0.50 mm.

3. Air Capacity. The highest percentage of air volume was obtained in vermicompost and perlite (44.9% and 49.2%) in particles higher than 3.36 mm; peat moss, volcanic scoria, pumice and zeolite the highest percentage was found in particles of 1 to 2 mm (59.2, 50.3, 46.2 and 38.1% respectively); compost (41.1%) in particles of 0.25 a 0.50 mm and coconut fiber (50.7%) in particles less than 0.25 mm.

4. Easily Available Water. The organic and inorganic materials analysed showed highest values in particles of less than 1 mm, while in bigger particles the smallest values were observed.

Micromorphological Properties

1. Pore Type and Shape. They are related to the water percolation and storage.

In organic materials like coconut fiber, peat moss and vermicompost, complex packing pores and abundant interparticle pores were dominant resulting in higher water percolation and storage (90%) (Fig. 1).

In inorganic materials like volcanic scoria, perlite and pumice have simple packing pores in more than 50% (Fig. 2) which help percolation; however, they differ in storage capacity due to vesicle pores they have. In the first materials, the vesicles are not connected and there is a lower moisture retention (<10%), while in pumice the vesicles are of capillary size and are interconnected (40 to 70%) allowing moisture storage (21%) (Fig. 4).

The inter and intra particle pore percentages have an inverse relationship; the former increase while the latter reduce. For example, there is an increase in coconut fiber while a decrease in peat moss due to loss of its microporosity (Fig. 3). This explains the increase in particle density but not in moisture retention capacity, which is related to the type of pore and material (Fig. 4).

CONCLUS
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Tables

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CONCLUSIONS

The physical properties (bulk density and moisture retention) combined with the micromorphology (pores and particle) permit to explain the water retention and movement in organic and inorganic materials. The water-air relationship is not only determined by the particle size but also by the size and shape of pore in addition to type of material.

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<u>Tables</u>

Table 1. Percentage of particles of organic and inorganic materials.

Materials	Particle size (%)					
	< 0.25 mm	0.25-0.50 mm	0.50–1 mm	1–2 mm	2–3.36 mm	> 3.36 mm
Organics						
Coconut fiber	32.3	7.54	22.6	16.5	6.51	14.5
Sphagnum peat	27.1	0.62	13.2	7.49	7.66	43.9
Vermicopost	26.1	8.73	16.8	21	12.4	14.9
Compost	10.3	4.24	3.94	21.3	19.3	40.9
Inorganics						
Volcanic scoria	2.21	0.12	0.12	2.53	19.7	75.3
Perlite	4.7	2.02	28.2	29.2	17.6	18.2
Pumice	3.4	3.51	0.87	17.3	12.9	62
Zeolite	2.9	0.05	0.1	0.59	17.6	78.8

Figures

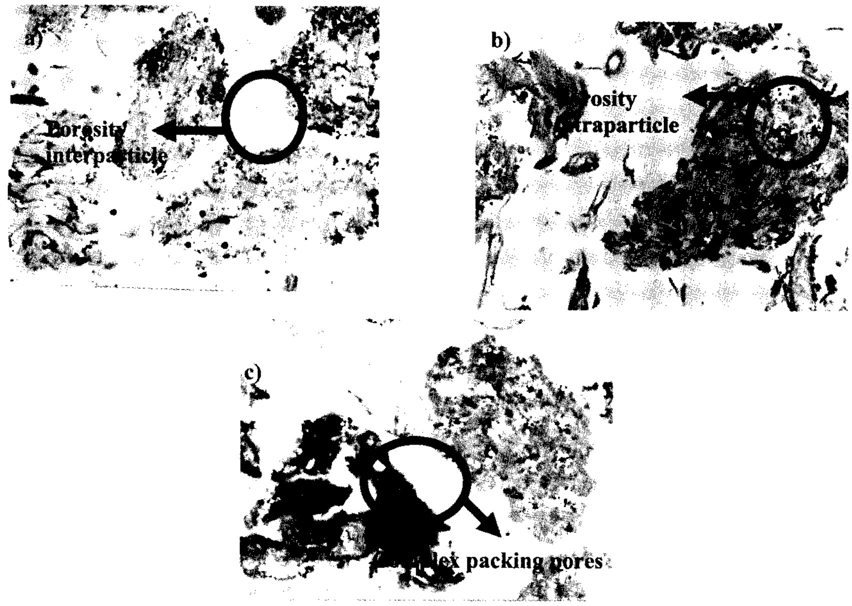

Fig. 1. Porosity of organic materials in particle size 2 to 3.36 mm. a) coconut fiber, b) *Sphagnum* peat and c) vermicopost. Frame length 5.3 mm, LPP.

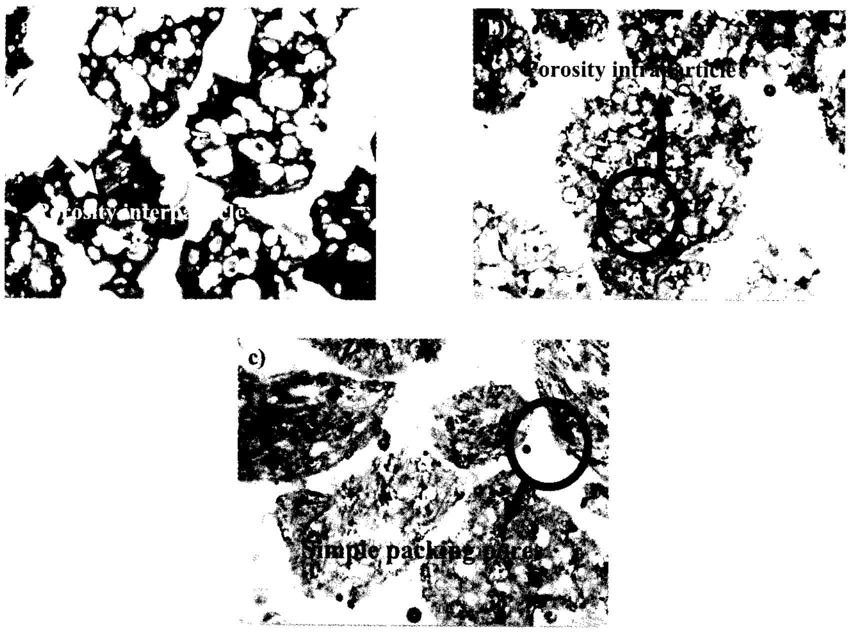

Fig. 2. Porosity of inorganic materials in particle size 2 to 3.36 mm. a) volcanic scoria, b) perlite and c) pumice. Frame length 5.3 mm, LPP.

Fig. 3. Porosity
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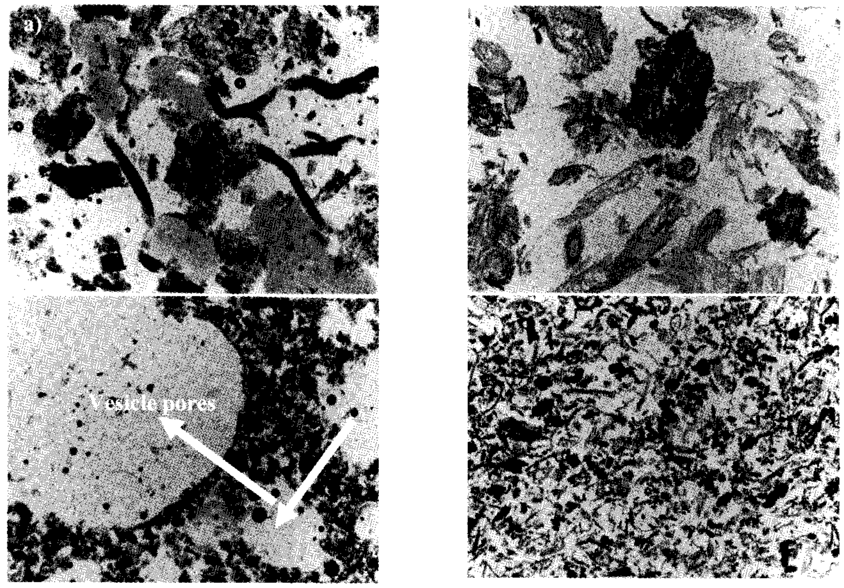

Fig. 3. Porosity in different particle size 1 to 2 mm (a and b) and particle less than 0.25 mm (c and d) in coconut fiber and *Sphagnum* peat respectibility. Frame length 5.3 mm, LPP.

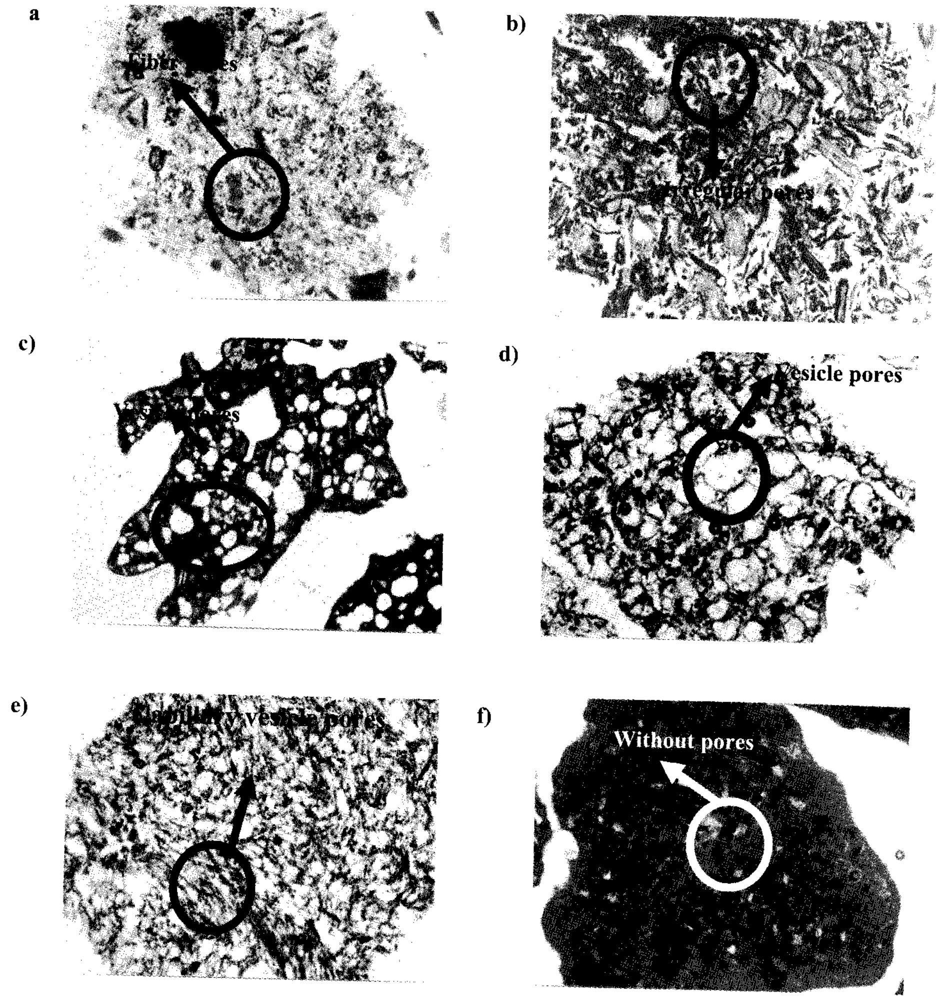

Fig. 4. Type of pores in different materials in particles higher than 3.35 mm. a) coconut fiber, b) *Sphagnum* peat, c) volcanic scoria, d) perlite, e) pumice and f) zeolite. Frame length 5.3 mm, LPP.

Utilization of
(*Picea oriental*

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Keywords: orien

Abstract

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