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Low-value production residues from the cork industry: potential raw materials for the growing-media industry?

FREITAS D.[1,2], GOMINHO J.[2], RIBEIRO H.[1*]

[1]University of Lisbon, School of Agriculture, Research Centre LEAF, Tapada da Ajuda 1349-017 Lisboa, Portugal.
[2]University of Lisbon, School of Agriculture, Forest Research Centre (CEF), Tapada da Ajuda 1349-017 Lisboa, Portugal.

*corresponding author:
e-mail: henriqueribe@isa.ulisboa.pt

Abstract

The cork industry produces several low-value production residues unsuitable for high-end applications due to properties like high density and mineral contamination. This study explores the potential use of two residues: high-density cork granulates (CG) and cork inner bark (CI) as components in growing-media for soilless culture. Their physical and chemical properties were characterised following European Standards. Both materials showed high porosity and low water retention, making them suitable for improving aeration and drainage in substrates. They also contributed essential nutrients, which may reduce the need for additional fertilisation. These results highlight the potential of these raw materials as sustainable, renewable alternatives in growing-media, supporting circular economy strategies and enhancing resource efficiency.

Keywords: Cork, residues, growing-media, soilless culture.

1. Introduction

Several low-value production residues are generated throughout the cork industry chain, mainly due to properties that render them unsuitable for high-value applications. These include high density caused by mineral contamination and the presence of wood tissue (Gil, 1997; Gil, 2015; Freitas et al., 2025).

The limited information available on the use of cork as a component of growing-media, particularly regarding the potential valorisation of production residues, highlights the relevance of this study. Given the scarcity of literature, characterising the properties of these residues is essential to ensure the effectiveness and success of the growing-media (Rego et al., 2023; Freitas et al., 2025).

Given the above, the present study aimed to characterise the physical and chemical properties of two low-value production residues from the cork industry, namely, high-density cork granulates (CG) and granulated cork inner bark (CI), for potential use as components in growing-media for soilless cultivation.

2. Materials and Methods

The physical properties as defined by Wallach (2019), were determined according to the European Standard (CEN, 2011): bulk density (BD), total porosity (TP), air-filled porosity (AFP), easily available water (EAW), water-buffering capacity (WBC) and available water (AW). The dry mass (DM) content was assessed by oven-drying at 105 °C for 24 h, and the ash content was determined by combustion of the oven-dried sample at 550 °C for 5 h in a muffle furnace. Afterwards, the difference between DM and ash was considered the organic matter (OM) content.

pH (CEN, 1999a) and electrical conductivity (EC) (CEN, 1999b) were measured in the water extract (1:5 v v^{-1}). Water-soluble minerals N (NH_4^+-N and NO_3^--N), potassium (K), calcium (Ca), magnesium (Mg) and sodium (Na) were quantified in water extract 1:5 (by volume), following European Standards (CEN, 2001).

All results were analysed using Statistix 9 software (Analytical Software, Tallahassee, FL, USA).

3. Results and Discussion

The physical characterisation of the materials revealed total porosity (TP) values above 85%, specifically, 89.8% for CG and 86.7% for CI, and notably high air-filled porosity (AFP), exceeding the optimal range of 20–30% (vv^{-1}) typically recommended for growing-media (Tables 1 and 2). These results indicate a strong potential for improving aeration, suggesting their suitability as aeration-enhancing components in the growing-media industry. However, the extremely low values of easily available water (EAW), water buffer capacity (WBC), and available water (AW) point to a limited water retention capacity, implying that these materials should be blended with more water-retentive components to formulate well-balanced substrates (Tables 1 and 2).

From a chemical perspective, both materials exhibited low electrical conductivity (EC) and pH values close to the lower threshold of acceptability, indicating a low risk of salinity. Notably, they contained appreciable amounts of macronutrients, particularly potassium (K) (especially CI: 420.3 mg L^{-1}), as well as phosphorus (P) and calcium (Ca), which can contribute to plant nutrition and potentially reduce the need for chemical fertilisers during the early stages of growth (Tables 1 and 2).

Table 1. Physical and chemical properties of high-density cork granulate (CG).

Property	Parameter	Average	Acceptable range
Physical	BD (g dm^{-3})	160.9	<400
	TP (%vv^{-1})	89.8	>85
	AFP (%vv^{-1})	65.1	20-30
	EAW (%vv^{-1})	0.4	20-30
	WBC (%vv^{-1})	0.8	4-10
	AW (%vv^{-1})	1.2	24-40
Chemical	pH	5.2	5.5-6.5
	EC (mS cm^{-1})	0.13	0.35-0.65
	N_{min} (mg L^{-1})	5.6	50-250
	P (mg L^{-1})	9.4	19-75
	K (mg L^{-1})	219.9	51-400
	Ca (mg L^{-1})	17.7	16-80
	Mg (mg L^{-1})	1.7	16-80
	Na (mg L^{-1})	12.5	<100

Table 2. Physical and chemical properties of cork inner bark (CI).

Property	Parameter	Average	Acceptable range
Physical	BD (g dm^{-3})	203.3	<400
	TP (%vv^{-1})	86.7	>85
	AFP (%vv^{-1})	63.0	20-30
	EAW (%vv^{-1})	1.2	20-30
	WBC (%vv^{-1})	0.3	4-10
	AW (%vv^{-1})	1.5	24-40
Chemical	pH	5.4	5.5-6.5
	EC (uS cm^{-1})	195.5	350-650
	N_{min} (mg L^{-1})	5.2	50-250
	P (mg L^{-1})	34.8	19-75
	K (mg L^{-1})	420.3	51-400
	Ca (mg L^{-1})	36.3	16-80
	Mg (mg L^{-1})	10.7	16-80
	Na (mg L^{-1})	8.1	<100

4. Conclusions

The results suggest that these production residues have significant potential for use as components in growing-media formulations, as they enhance aeration, improve drainage, and contribute essential nutrients. Furthermore, this study underscores the relevance of these low-value residues from the cork industry as sustainable alternatives in substrate formulation, promoting resource efficiency through the incorporation of renewable materials.

References

CEN, 2011. EN13041 – Soil improvers and growing media – Determination of physical properties – Dry bulk density, air volume, water volume, shrinkage value and total pore space. European Committee for Standardization, Brussels.

CEN, 1999a. EN 13037 - Soil Improvers and Growing Media. determination of pH, European Committee for Standardization, Brussels.

CEN, 1999b. EN 13038 - Soil Improvers and Growing Media, Determination of Electrical Conductivity. European Committee for Standardization, Brussels.

CEN, 2001. EN 13652 - Soil Improvers and Growing Media, Extraction of Water-Soluble Nutrients and Elements. European Committee for Standardization, Brussels.

Freitas D., Gominho J., Ribeiro H. (2025), Valorisation of production residues from the cork stoppers industry: potential use as a growing-media component fo potted plants, *Cleaner and Circular Bioeconomy*, **11**, 100148.

Gil L. (1997), Cork powder waste: an overview, *Biomass and Bioenergy*, **13**, 59-61.

Gil L. (2015), New Cork-Based Materials and Applications, *Materials*, **8**, 625-637.

Wallach R. (2019), Chapter 3 - Physical characteristics of soilless media, *Soilless Culture*, 33–112.