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ScienceDirect

Ciência & Tecnologia dos Materiais 29 (2017) 65–72

http://ees.elsevier.com/ctmat

Ultimate use of Cork – Unorthodox and innovative applications

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Abstract

In this survey the untraditional practical applications of cork is presented. High-quality goods with improved performances have been developed by those who came up with creative ideas and develop them. From several types of industries to private entrepreneurs, cork has been calling the attention of many creative minds over the last decade. From surfboards or designer clothes to an outstanding work of art made from cork has proved that this natural material becomes a noble feedstock not only for those who appreciate a good beverage and high-performance materials but also for those who look for sustainable products from natural sources. A general overview of cork composition, origin, and industry is also briefly disclosed.

Keywords: cork; application; innovation; properties; materials; sustainable.

1. Introduction

The tree Quercus suber L., commonly known as a cork-oak tree, is widespread in western Mediterranean region (Figure 1), with higher prevalence in Portugal and Spain [1,2]. The bark of this oak tree is considered to be a source of an environmentally friendly and sustainable raw material, called cork [1].
The cork is harvested with the preservation of the tree, being its bark stripped without cutting it down. Thus, the tree can continue to live, growing and producing new barks for following extractions. These extractions are conducted every 9–14 years, with the improvement of corks quality, until the tree is approximately 200 years old [1].
Cork forests are extremely well adapted to Europe's southern semi-arid regions, preventing desertification and being the perfect habitat for many animal and plant species [3]. With more than sixty percent, Iberian Peninsula possesses the major cork tree area being Portugal the country that the biggest "Montado" area 34% (Figure 1).

The world's foremost producer of cork is the European Union. According to APCOR, Portugal produces almost 50 % of all cork (Figure 2b) and holds up to nearly 70 % of the cork industry market (Figure 2a) [4].

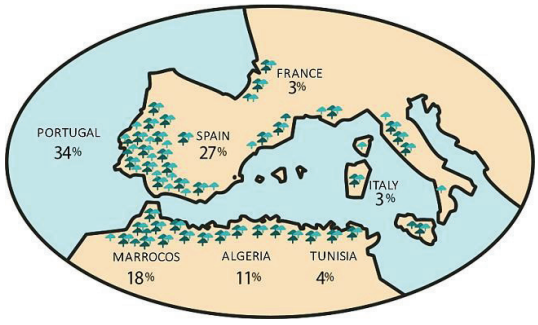

Fig. 1. World's distribution of Cork forest (adapted from APCOR).

Cork-based materials, durable products, are believed to play a role in the contribution to decreasing the amount of carbon dioxide in the atmosphere since they are considered to be "carbon neutral" [5]. The derived residues or by-products are classified mostly based on size, density (which is also related to the presence of woody parts) and moisture. An important amount of these residues is sent to granulation

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http://dx.doi.org/10.1016/j.ctmat.2016.03.005

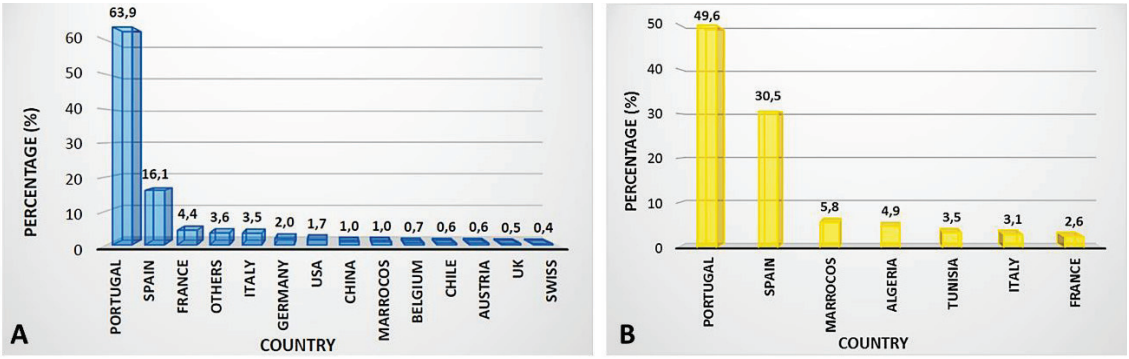

Fig. 2. A – Market share of cork industry; B – Production Share of cork (data source : APCOR).

originating granules used in a variety applications, mainly cork agglomerates, composites, cork pavement, insulation panels, lightweight structures and agglomerated wine closures among others [2,5-16]. On the other hand, the transforming industry generates a residue considered problematic, obtained from multiple production phases, including granulation: this is the so-called "cork dust" a substantial fraction of the total amount of wastes with no commercial value. As the name suggests, cork dust includes small size particles, usually a size too small (<0.5 mm) for any possible reuse, due to its high surface. According to the Portuguese standards NP-114 and NP-273 it has dimensions below 0.25 mm [17]. Even when used for agglomerates, the inclusion of the dust is only possible in small amounts, therefore not incorporating significant volumes compared to the production. Several efforts have been made to reuse the "cork dust". Currently, it is mostly applied as fuel for burning in furnaces: either in the cork industry or even in the ceramic industry, because it presents a high calorific value, which is between 18.9 and 29.3 MJ/kg [17].

In this brief survey, besides a short description of cork properties and characteristics, a summary of some of the most innovative applications of cork that overstepped from the usual ones (i.e., agglomerated composites, floor or wall .covering) will be described.

2. Cork characterization and properties

In this section, an overview of the cork composition, characterization and properties will be presented. For a more detailed data regarding this subjected surveys like those from Pereira [18] or Silva et al. [2] should be perused.

Cork, possessing a variable chemical profile dependent on geographic, climate and soil, genetic origin, and tree properties, is mainly, composed of suberin, lignin, polysaccharides (cellulose and hemicellulose), extractables (40%, 22%, 18%, 15%, respectively) and others minority compounds [2,19-21]. It is also worth mentioning that cork as a natural material has a strong similarity to the lignocellulosic material, like wood, despite its distinct chemical and structural character.

Regarding its unique cellular structure, corks pentagonal or hexagonal shape cells are the base of its most important features. As described by Duarte and Bordado, cork cells are filled with a gas mixture conferring cork the capability of resistance to compressibility, recovering it primitive shape after compression [21].

The high interest of the use of Cork in the most diverse forms and applications is bonded to its peculiar properties. Weighing about 0.16 grams per cubic centimeter this vegetal tissue can be compressed to around half its thickness without losing any flexibility, recovering its full shape and volume afterward. Possessing a Poisson's ratio of nearly zero, cork can adapt to temperature and pressures variations. Due to its great elasticity when one side is compressed the other is not affected, leading to its diverse applications [2]. Cork is also an excellent thermal and acoustic insulator due to its low conductivity to heat, noise, and vibration. Those properties result from the encapsulated of gaseous components in corks closed cells. Suberin and waxy components enclosed in the cell walls makes cork impermeable to liquids and gasses enabling it to age without decaying. Spite its soft feel to the touch, cork is embodied of an excellent resistance to impact or friction. This resistance is even higher than other hard surfaces, mostly thanks to its honeycomb structure. Since cork does not absorb any dust or other fine solids and has a stable composition over the years, it does not cause allergies not affecting, thus, those who suffer from asthma [17,21-24].