Food Research International 53 (2013) 110–114

Contents lists available at SciVerse ScienceDirect

Food Research International

journal homepage: www.elsevier.com/locate/foodres

Short communication

Complexation efficiency of cyclodextrins for volatile flavor compounds

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ARTICLE INFO

Article history:
Received 11 January 2013
Accepted 30 March 2013

Keywords:
Flavors
Cyclodextrins
Stability constant
Static headspace gas chromatography

ABSTRACT

In the present study, the complexation between volatile flavor compounds and cyclodextrins (CDs) was investigated by static headspace gas chromatography (SH-GC). We focused on the complexation behavior of α-CD, β-CD, γ-CD, hydroxypropyl-β-cyclodextrin (HPBCD), randomly methylated-β-cyclodextrin (RAMEB), and of a low methylated-β-cyclodextrin (CRYSMEB) for 13 volatile flavor compounds (α-pinene, β-pinene, camphene, eucalyptol, limonene, linalool, *p*-cymene, myrcene, menthone, menthol, trans-anethole, pulegone and camphor). The obtained results indicated the formation of a 1:1 inclusion complex for all the studied compounds. α-CD and γ-CD gave generally lower stability constants than β-CDs. Moreover, the complexation efficiency of native β-CD is close to the modified β-CDs (HPBCD, RAMEB and CRYSMEB).

1. Introduction

Flavor, color, and vitamins play an important role in consumer satisfaction and influence further consumption of food. Manufacturing and storage processes, packaging materials, and ingredients in foods often cause modifications in overall flavor by reducing aroma compound intensity, producing off-flavor components and color changes, or reducing vitamin content (García-Segovia, Barreto-Palacios, Bretón, & Martínez-Monzó, 2011). To limit the degradation of flavor, color, and vitamins or their loss during processing and storage, it is beneficial to encapsulate the molecules that produce these effects prior to use in food and beverages (Madene, Jacquot, Scher, & Desobry, 2006).

Cyclodextrins (CDs) represent one of the simplest encapsulant systems (Marques, 2010). CDs are a family of cyclic oligosaccharides that are composed of α-1,4-linked glucopyranose subunits (Bender & Komiyama, 1978; Szejtli, 1998). The most common CDs are of three types: α-cyclodextrin (α-CD), β-cyclodextrin (β-CD) and γ-cyclodextrin (γ-CD) composed of six, seven and eight glucosyl units, respectively. CDs have a hydrophilic outer surface and a hollow hydrophobic interior (Szente & Szejtli, 2004). This cavity can receive another lipophilic molecule (guest) provided that it has the correct size and shape. Indeed, whereas the depth of the cavity for these CDs is ~0.8 nm, the diameters of the cavity are different (Fig. 1).

In food science CDs have been used to improve flavor retention in thermally processed foods (Reineccius, Reineccius, & Peppard, 2004), for the controlled release of garlic or thyme essential oil (Del Toro-Sánchez et al., 2010; Wang, Cao, Sun, & Wang, 2011), to improve the color and/or aroma of different fruit juices (Andreu-Sevilla, Carbonell-Barrachina, López-Nicolás, & García-Carmona, 2011; Astray, Gonzalez-Barreiro, Mejuto, Rial-Otero, & Simal-Gándara, 2009), as debittering agents (Binello, Robaldo, Barge, Cavalli, & Cravotto, 2008), or in food packaging to retain undesirable compounds (López-de-Dicastillo, Gallur, Catalá, Gavara, & Hernandez-Muñoz, 2010). Moreover, the microencapsulation of essential oils with β-CD was recently applied in gastronomy to improve the sensorial properties of food (García-Segovia et al., 2011).

In the practical application of CDs, attention should be directed towards the dissociation equilibrium and stoichiometry of the inclusion complex. When a CD complex is dissolved in water, it dissociates to free components in equilibrium with the complex. The stability constant (K_f) is a useful index to estimate the binding strength of the complex and the changes in the physicochemical properties of the guest molecule (Mazzobre, dos Santos, & Buera, 2011).

Different techniques such as UV–Vis spectroscopy (Astray, Mejuto, Morales, Rial-Otero, & Simal-Gándara, 2010; Decock et al., 2006), static headspace gas chromatography (Decock, Landy, Surpateanu, & Fourmentin, 2008; Tanemura, Saito, Ueda, & Sato, 1998), or phase solubility study (Mazzobre et al., 2011) were used to determine the stability constant of CD/volatile flavor compound inclusion complexes. These studies mostly focused on α-CD, and β-CDs.

However, because of α-, β-, and γ-CD have now the generally recognized as safe (GRAS) status and have been approved recently as

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0963-9969/$ – see front matter
http://dx.doi.org/10.1016/j.foodres.2013.03.048

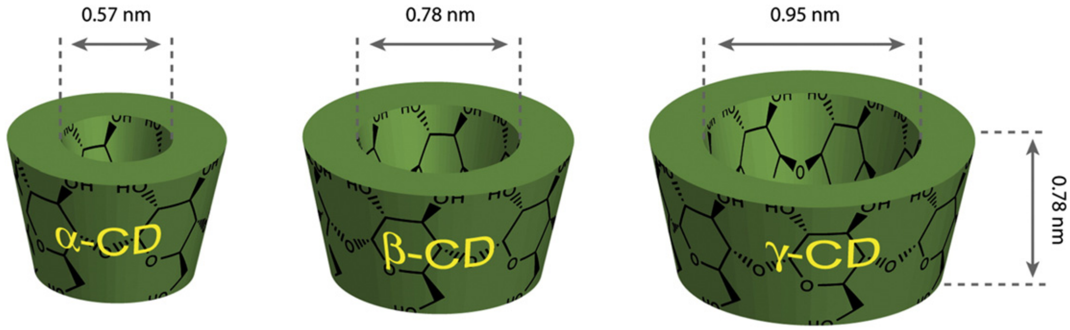

Fig. 1. Dimensions of α-CD, β-CD, and γ-CD.

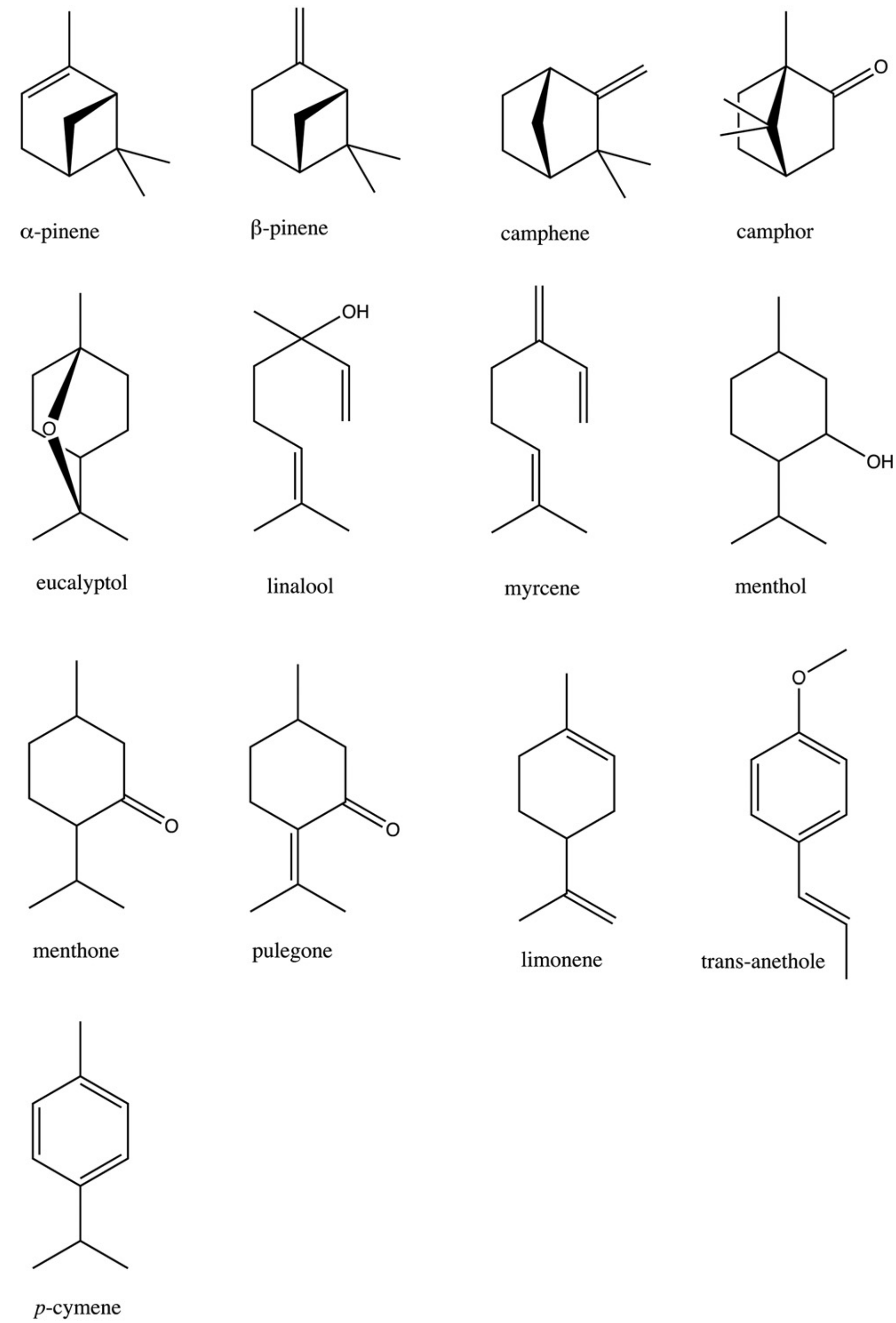

Fig. 2. Chemical structure of volatile flavor compounds.