Building and Environment 46 (2011) 945–954

Contents lists available at ScienceDirect

Building and Environment

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

Influence of environmental conditions on production of volatiles by *Trichoderma atroviride* in relation with the sick building syndrome

Viviana Polizzi [a,b], An Adams [a], Anna Maria Picco [c], Els Adriaens [d], Joke Lenoir [d], Carlos Van Peteghem [b], Sarah De Saeger [b], Norbert De Kimpe [a,*]

[a] Ghent University, Faculty of Bioscience Engineering, Department of Sustainable Organic Chemistry and Technology, Coupure links 653, B-9000 Ghent, Belgium
[b] Ghent University, Faculty of Pharmaceutical Sciences, Laboratory of Food Analysis, Harelbekestraat 72, B-9000 Ghent, Belgium
[c] Pavia University, Faculty of Sciences, Department of Territorial Ecology and Environment, via S. Epifanio 14, 27100 Pavia, Italy
[d] Ghent University, Faculty of Pharmaceutical Sciences, Laboratory of Pharmaceutical Technology, Harelbekestraat 72, B-9000 Ghent, Belgium

ARTICLE INFO

Article history:
Received 12 July 2010
Received in revised form
1 October 2010
Accepted 24 October 2010

Keywords:
Trichoderma atroviride
Microbial volatile organic compounds
Sick building syndrome
6-Pentyl-2-pyrone
Slug mucosal irritation assay
Sesquiterpenes

ABSTRACT

A *Trichoderma atroviride* strain was isolated from a water-damaged office and the production of microbial volatile organic compounds (MVOCs) was investigated by means of headspace solid phase micro-extraction GC–MS. Different growth conditions (substrate, temperature, relative humidity) were selected, resembling indoor parameters, to elucidate a possible relationship between MVOCs, produced by *Trichoderma atroviride*, and the Sick Building Syndrome. In general, the range of MVOCs and the emitted quantities were larger on malt extract agar (MEA) than on wallpaper and plasterboard. Particular attention was dedicated to the volatile marker 6-pentyl-2-pyrone, a compound produced in high quantities on MEA, and its mucosal irritation potency was shown in a slug mucosal irritation assay. Some compounds characteristic for growth on specific building materials were detected, e.g. 2-ethyl-cyclopentanone, menthone, iso-menthone and *trans-p*-menth-2-en-7-ol on plasterboard and 4-heptanone and 1-octen-3-ol on wallpaper. Relative humidity and substrate had a more important effect on MVOC production than temperature.

1. Introduction

The Sick Building Syndrome (SBS) was first recognized by the World Health Organization (WHO) as a medical condition in 1983 and defined as an excess of work-related irritations of the skin and mucous membranes and other symptoms, including headache, fatigue, and concentration difficulties reported by workers in office buildings [1]. These symptoms are usually associated with a particular building by their temporal pattern of occurrence and clustering among inhabitants or colleagues [2] and characteristically occur in tight buildings, designed to reduce heat loss, with windows that do not open and heating and cooling ducts that originate from a common source. Usually, the specific illness or its cause cannot be identified but moulds and their metabolites together with dampness have often been indicated as possible causes of the SBS [3,4]. Besides other components, such as allergens, antigens, β(1→3)-glucans, and mycotoxins, microscopic fungi also emit microbial volatile organic compounds (MVOCs). The SBS has been associated with the presence of (M)VOCs [5,6]. Some (M)VOCs have adverse effects on the respiratory system, blood vessel system, nerve system and may be carcinogenic [7]. A possible, more general explanation for a (M)VOC-SBS correlation is that barely perceptible odours of the emitted organic compounds cause mental and cognitive distraction of the subjects from work, which results in reduced performance [8]. In addition, the detection of (M)VOCs may indicate the presence of fungal growth [9]. The most common fungal genera reported to be present in water-damaged environments are *Penicillium, Aspergillus, Cladosporium, Stachybotrys, Alternaria, Chaetomium* and *Trichoderma* [3,10,11]. Among these fungal genera, *Trichoderma* is known to cause allergic fungal sinusitis [12] and to produce allergens [13–16] provoking immediate hypersensitivity [17,18], strong sensitizers [19] and eukaryotic membrane-damaging substances [20]. Moreover, *Trichoderma* may induce histamine release from human bronchoalveolar cells [21].

Abbreviations: MVOCs, Microbial Volatile Organic Compounds; SPME, Solid Phase MicroExtraction; SBS, Sick Building Syndrome; SMI, Slug Mucosal Irritation (assay).

* Corresponding author. Tel.: +32 9 264 59 51; fax: +32 9 264 62 43.
E-mail addresses: viviana.polizzi@ugent.be (V. Polizzi), an.adams@ugent.be (A. Adams), annamaria.picco@unipv.it (A.M. Picco), els.adriaens@UGent.be (E. Adriaens), Joke.Lenoir@UGent.be (J. Lenoir), Carlos.VanPeteghem@ugent.be (C. Van Peteghem), sarah.desaeger@ugent.be (S. De Saeger), norbert.dekimpe@ugent.be (N. De Kimpe).

0360-1323/$ – see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.buildenv.2010.10.024