Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 40 (2013) 499 – 506

Energy Procedia

European Geosciences Union General Assembly 2013, EGU

Division Energy, Resources & the Environment, ERE

Bio-susceptibility of materials and thermal insulation systems used for historical buildings

Katja Sterflinger[a], Jörg Ettenauer[a]*, Guadalupe Piñar[a]

[a]*University of Natural Resources and Applied Life Sciences, ACBR, Muthgasse 18, Vienna 1190, Austria*

Abstract

Several indoor insulation systems based on ecological materials as cellulose, perlite, wooden softboard and reed board with loam, were tested for their susceptibility against fungi under natural- and laboratory conditions. Fungal growth was evaluated by cultivation- and molecular methods. The materials showed a different bio-susceptibility: whereas insulations made of wood and reed with loam had high cell counts, perlite did not show any fungal growth. Therefore, from the microbiological point of view, plaster and board made of perlite are most suitable for thermal insulation. Furthermore, for future applications we suggest a DNA-extraction protocol for microbial ecology studies of construction materials.

Selection and peer-review under responsibility of the GFZ German Research Centre for Geosciences

Bio-susceptibility; building materials; colony forming units; DNA extraction; fungi; insulation materials

1. Introduction

The signs of the ongoing climate change on our planet are clearly visible and the need for changes of human behaviour and -living are urgently necessary. In Northern European regions and the colder climate zones, thermal insulation of newly built houses is more and more becoming self-evident to reduce the necessary amount of energy for heating of those buildings. Exterior insulation systems are frequently applied on modern, newly built houses and styrofoam is the most common exterior insulation material on the market. However, a very high percentage of our living houses are historical buildings and are under

* Corresponding author. Tel.: +43-1-47654-6935; fax: +43-1-369-7615.
E-mail address: joerg.ettenauer@boku.ac.at.

1876-6102
Selection and peer-review under responsibility of the GFZ German Research Centre for Geosciences
doi:10.1016/j.egypro.2013.08.057

preservation order. These buildings are now also included in country specific regulations and ordinances to enhance the "energy efficiency". Since an exterior insulation is incompatible with monument protection, alternative insulation techniques have to be applied. Various different indoor insulation systems are on the market and in the past years historical, organic and ecological insulation materials, such as cellulose, loam, weed or wood, have been exploited from construction companies.

The risk of these ecological materials is a possible contamination through microorganisms (bacteria and fungi). Microbial growth on building materials is a problem that has been known for a long time, but in the recent years it has drawn more attention. Floods, wet years, thermal modernization of residential buildings, air-conditioning systems, construction or material faults, poor and improper ventilation are the major reasons for an increase of the relative air humidity and dampness of surfaces [1]. These climatic conditions foster microbial growth in our living environment, on building materials and increase the risks for fungi contaminations [2, 3 and 4]. The properties and the common occurrence of bacteria and fungi contribute to the fact that these microorganisms represent the most frequent cause of biodeterioration of building materials [5]. Biodegradation of buildings is caused by physical processes and also chemical processes through bio-corrosion. Furthermore, a worldwide phenomenon called sick building syndrome – SBS – [6] has been confirmed as a recognizable disease by the World Health Organization [7]. The sick building syndrome is a complex combination of nonspecific ailments associated with an individual's working place or residence that has become contaminated with any number of harmful agents. The causes for this syndrome are manifold and microorganisms can affect human health in different ways. All these properties and effects of microbial growth call for the need to gain more insight into the microbial communities inhabiting the different construction materials.

Nowadays, the isolation and identification of microorganisms, especially of fungi, still sticks to the use of traditional culture-based methods to estimate microbial contamination in buildings. These classical cultivation techniques allow a quantitative and qualitative assessment of the investigated environment and represent an important methodology in this field. Nevertheless, microbiology has dramatically changed over the past 20 years and developed new technologies that can be applied for studying microbial communities. Therefore, molecular DNA and phylogenetic techniques have provided means that allow the identification of organisms without the need for cultivation [8, 9, 10 and 11]. Fast and sensitive alternatives to classical cultivation techniques are polymerase chain reaction (PCR)-based techniques that offer an opportunity to analyse the full diversity of microbial communities. The first step for a successful and complete analysis of the inhabiting micro-biota of a certain environment is the choice of an appropriate nucleic-acid isolation method [12, 13 and 14].

In this study five different indoor insulation materials based on ecological materials were tested for their bio-susceptibility. The selected materials were investigated for their affinity to various fungi both under natural conditions - after 2 years of installation in an historical building - and under laboratory conditions with high levels of relative humidity. Therefore, samples items from all insulation materials were inoculated with three commonly indoors occurring fungi and treated in a climate chamber for half a year. After this incubation time, small sample amounts were taken for classical cultivation- and molecular biological analyses. The colony forming units (CFU) of each material were determined and DNA was extracted and evaluated by Nano Drop measurements. The same procedure was performed with samples taken from a historical house, in which the same insulation materials were already installed two years before.

In order to apply an appropriate extraction method to isolate DNA directly from insulation materials and to overcome any biases at the first crucial step of molecular analyses, we evaluated up to thirteen direct - in situ DNA extraction methods.

As basis, three commercial DNA extraction kits for soils and four standard DNA extraction protocols were chosen. These techniques incorporate a combination of mechanical, chemical and also enzymatic