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INTERNATIONAL LABORATORY OF PLANT NEUROBIOLOGY

Executive Summary

Clairy and its ability to filter volatile compounds of indoor air*

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The context

In modern times, indoor air quality (IAQ) has become a serious concern as buildings have been increasingly sealed in an effort to reduce energy consumption: reduced ventilation and leakage rates lower the energy required to treat incoming air to ambient indoor conditions.

Indoor air characteristically contains a large consortium of volatile organic compounds (VOCs); they are produced by many sources, both natural and artificial (building materials, detergents, combustion, tobacco, electronics, human activities, paints, adhesives, deodorants, cosmetics, etc.). Although they are generally found in low concentrations, their mix can produce synergic and additive effects (World Health Organization, 2000). Moreover the Environmental Protection Agency (EPA) has stated that indoor pollution can be up to 5 times higher than outdoor pollution, defining it a huge threat for our health.

Plants as biofilters

The positive influence of green plants on the air quality of occupied indoor environments was stated, for the first time, by Joseph Priestley (1771), who profoundly influenced modern chemistry, particularly concerning studies on the nature of atmosphere constituents and interactions with living organisms.

Living plants and their associated microcosms (soil and microbiome) could have the potential to improve IAQ using many different mechanisms, such as (1) adsorption of gaseous contaminants and particulate (dust and bioaerosols) onto leaf surfaces; (2) absorption of gaseous contaminants through stomata and accumulation in various internal structures; (3) degradation of gaseous contaminants through various metabolic pathways; (4) removal of CO_2 and production of O_2 through photosynthesis; (5) increasing humidity levels through leaf transpiration and evaporation from rooting media; (6) reducing airborne concentrations of dust and bioaerosols.

Wolverton and his colleagues, in 1984, have pioneered this field of study, in conjunction with NASA's research on biological life support systems for space travel; since then, many other studies have been conducted, aiming at investigating the role of different VOCs concentrations of plant species, of soil, of the soil microbiome, and of the possibility to use forced-air systems to promote convective gas exchange in the rhizosphere. Concerning the latter, many scientists believe in the potentiality of a forced-air system to improve air filtering efficiency, although more studies are needed to fully describe such theories, also using a real setup [see References 1-6 for more in deep details].

* *Please be advised that this is an Executive Summary of the analysis, for the full report please contact us.*

Executive Summary

Aim

The purpose of this study was to examine if and how a new system for growing indoor plants (Clairy) could improve the interactions between biological systems and IAQ, thus favouring the reduction of potential indoor air pollutants.

Methods

For the assessment of the effect of the Clairy system on air VOCs quality and quantity we used a PTR-TOF-MS (proton transfer – time of flight – mass spectrometer). PTR-TOF-MS (Ionicon, Innsbruck, Austria) is a technology that allows real-time measurement of VOCs with fast acquisition times (eg. 100 ms), with high sensitivity (> 200 cps/ppbv) and high mass resolution (<8000 m/Δm) [7, 8]. This innovative technique, developed to monitor environmental volatile pollutants, allows a wide variety of analysis of organic species (such as alkenes, alcohols, aldehydes, aromatic compounds, ketones, nitriles, sulfides and many others), even in complex matrices. Analysis can be performed in real time without sample pre-treatment. Such unique characteristics make the PTR-TOF-MS an efficient and widespread technology used in different fields of analysis.

Tests have been performed by comparing an empty Clairy systems (as control) with a system complete with a common apartment plant (Sansevieria) (using commercial potting mix). For the PTR-TOF-MS measurements of the air entering (IN) and exiting (OUT) the system, the superior part of the vase was sealed in a transparent cylinder of inert material, while the opening of the fan was sealed using an inert bag (Fig. 1). The potential filtering effect was estimated subtracting VOCs found in IN air *minus* OUT air.

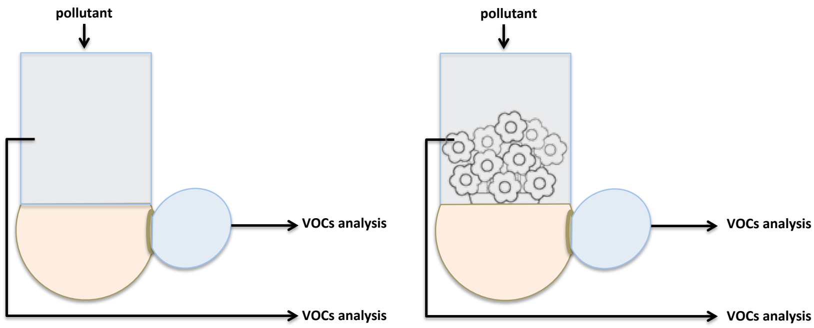

Figure 1 – schematics of the test setup.

Results

The evaluation of the filtering power of the Clairy system was performed after a common pollutant was added: an ingredient, known to contain a mix of pollutants linked to IAQ, was sprayed inside the cylinder (IN); PTR-TOF-MS measurements were performed immediately after the treatment for a few minutes. A large number of compounds (42 masses) identified as possible IAQ pollutants were found. The analysis of VOCs IN *minus* OUT highlighted that the complete system (Clairy with plant) was able to reduce the 85% of total pollutants (on average), while no reduction was found in the control system (empty Clairy) (Fig. 2 and 3). The same test was performed replacing the common soil with a non commercial potting soil (mix under study for filtering purposes) and the average reduction was increased by 8 points (93% average). In both cases, the reduction was detected immediately (a few seconds) after the introduction of the pollutant.

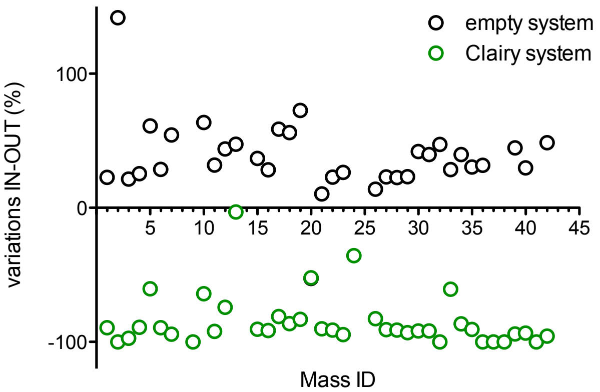

Figure 2 – variations (%) between VOCs entering (IN) and exiting (OUT) an empty (control, black dot) and a complete (green dots) Clairy system: a significant reduction in quite all VOCs can be seen.

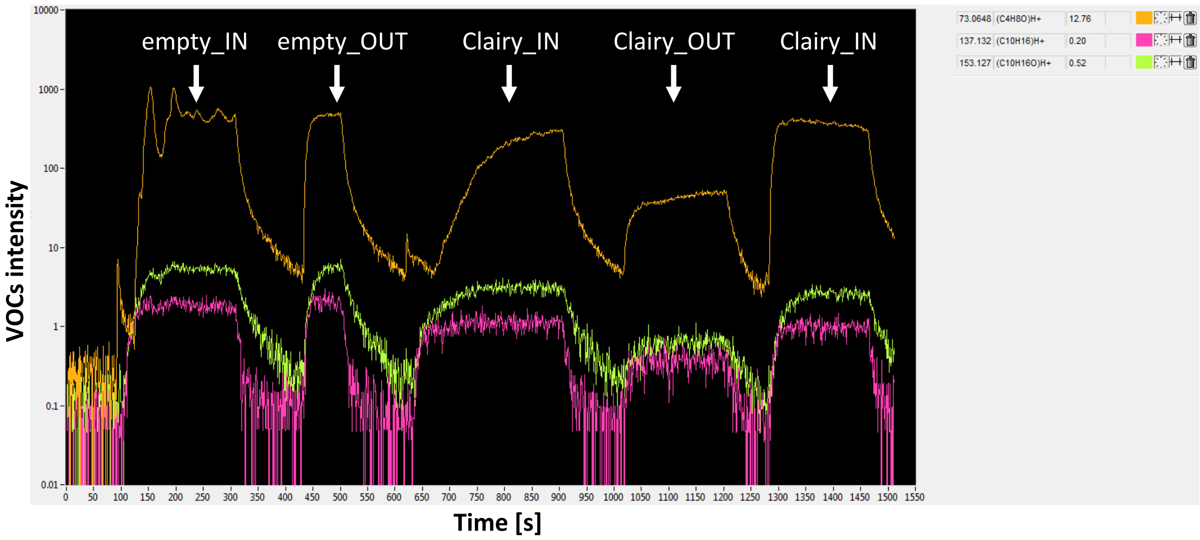

Figure 3 – VOCs profiles for three pollutants: air exiting the Clairy system (Clairy_OUT) significantly and immediately shows a reduction in VOCs intensities.

Conclusions

Results highlight that Clairy is able to reduce significantly and immediately the amount of pollutants of the air forced to pass through the system. Further studies will be conducted to assess whether the pollutants are physically retained or chemically degraded by the system.

References

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