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Pot-plants really do clean indoor air

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The aesthetic value of indoor pot plants is easily seen. However, the unseen ability of indoor plants to improve indoor air quality has never been conclusively shown or, until now, quantified. This Nursery Paper explains what the latest research, funded by HRDC, HSNA and associated industry bodies, has shown regarding indoor pot plants.

Research at the University of Technology, Sydney, has shown that indoor pot plants do improve air quality and demonstrated how this occurs. As a result, clear claims can now be made as to how indoor plants improve air quality, and development of varieties with an even better capacity for cleaning indoor air can begin .

Why worry about indoor air quality?

Most Australians live in cities, where vehicle-polluted outdoor air enters buildings and is further polluted, mostly by Volatile Organic Compounds (VOCs) from furnishings, fittings and occupants. Trace amounts of over 300 VOCs have been identified in indoor air. A 1994 CSIRO review found that air inside homes could be 5 to 7 times more polluted than outside. City-dwellers spend 90% of their time indoors, so indoor air quality becomes a major health consideration.

Plants as decontaminators

'Outdoor' plants are known to absorb air and soil pollutants and detoxify them. Plants and soil micro-organisms are used in the remediation of contaminated soils. Previous screening studies have shown that some 'indoor' plants can reduce concentrations of air-borne VOCs and suggested that the micro-organisms of the soil might also be involved.

The VOC removal performance of three top-selling species, *Howea forsteriana* (Kentia palm), *Spathiphyllum wallisii* var. Petite (Peace Lily), and *Dracaena deremensis* var. Janet Craig was compared. Benzene (a carcinogen) and *n*-hexane (a neurotoxin) were chosen as the test VOCs because they are common in indoor air.

Pot Plants, such as Kentia Palms, have now been proven to improve the quality of indoor air.

Findings

Overall all three species were found to be effective removers of both VOCs. There were strong similarities in response among the plant species and with both VOCs, although differences between species were also found (Fig.1 and Fig.2).

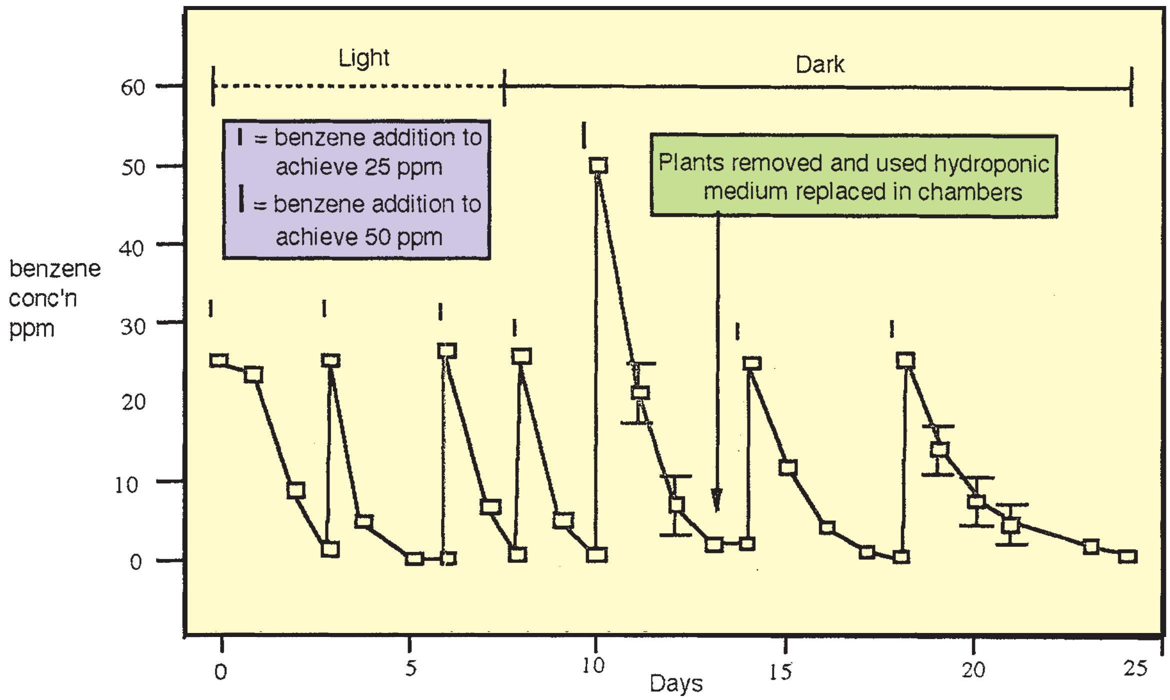

Fig.1. Benzene levels in air of test chambers containing *Spathyphyllum* var Petite plants maintained in hydroponic medium.

What happens with the first dose of VOC? Experiments were comenced in continuous light (such as in offices, hotels or shopping malls). Immediately after the first dose, the VOC removal rates were very slow, however within a fairly short time (1-2 days for benzene; 4-5 days for *n* -hexane), they had accelerated considerably. These increased in rates were in response to a 'taste' of the VOC. They involve the 'switching on' of a biochemical system to deal with the chemical compound (ie absorbing and metabolising it). With further top-up doses of either VOC, the higher removal rates were maintained, or even increased further. That is, they get better with practice!

Is light necessary for VOC removal? To test this the chambers were put into continuous dark. Under these conditions plant photosynthesis stops, and metabolic activity is largely reduced to baseline 'dark' respiration. Stomates are also shut, so there can be virtually no gaseous absorption into the leaves. What happens? Does VOC removal slow down? No! The process kept on going at about the same rates as in the light (Fig. 1 and 2). Also, when new doses of VOC were injected (still in the dark), at even higher concentrations, (ie raised to 50 ppm benzene, and 150 ppm *n*-hexane), the removal rates usually increased further. This indicates that the system is not only remaining fully operative in the dark, but can cope with even higher doses of each VOC.

Since it's just as active in the dark, what are the relative roles of plant and growth medium micro-organisms in the removal process? To test this the plants were removed and the potting mix put back into the pots and the pots back into the chambers. Result? The removal rates remained high comparable with, although generally slightly less than, those found with the plant present (Fig. 1 and 2). Experiments were sometimes continued for a further 7-10 days after the plant's removal, and the activity was maintained in every case.

This sustained activity with further dosing in the absence of the plant, tells us two things. First, the continued VOC removal activity confirms that this is a true biological response, not merely an adsorption / absorption process. Secondly, it shows that it must be the micro-organisms of the potting mix that are the 'rapid-removal agents' of the system. However, the plant is also involved, as revealed below.

What happens when the plant is transferred to hydroponics? This was done to test the plant itself, in the absence of potting mix. Roots were first thoroughly washed in sterile water to remove particles of potting mix, and if possible micro-organisms that might be clinging to the root surfaces. Nevertheless, some removal activity always remained (Fig. 1), and sometimes the system achieved the same removal rates as in the potting mix. This indicates that some micro-organisms are still present, so they must be pretty firmly attached to (or inside) the roots. The differences in response among the plant species suggest different relationships between the plant and its root-associated micro-organisms.

Can 'virgin' potting mix remove VOC? Well yes, but the tests showed that the final activity was generally lower than with plants and there was evidence of the system becoming exhausted after 9-10 days. The results are in line with what is known of potting mixes generally, namely that they contain a supply of micro-organisms before the plants are planted. However, the results also suggest that any organic nutrients suitable for microbial growth and reproduction will not last very long in the absence of a growing plant.

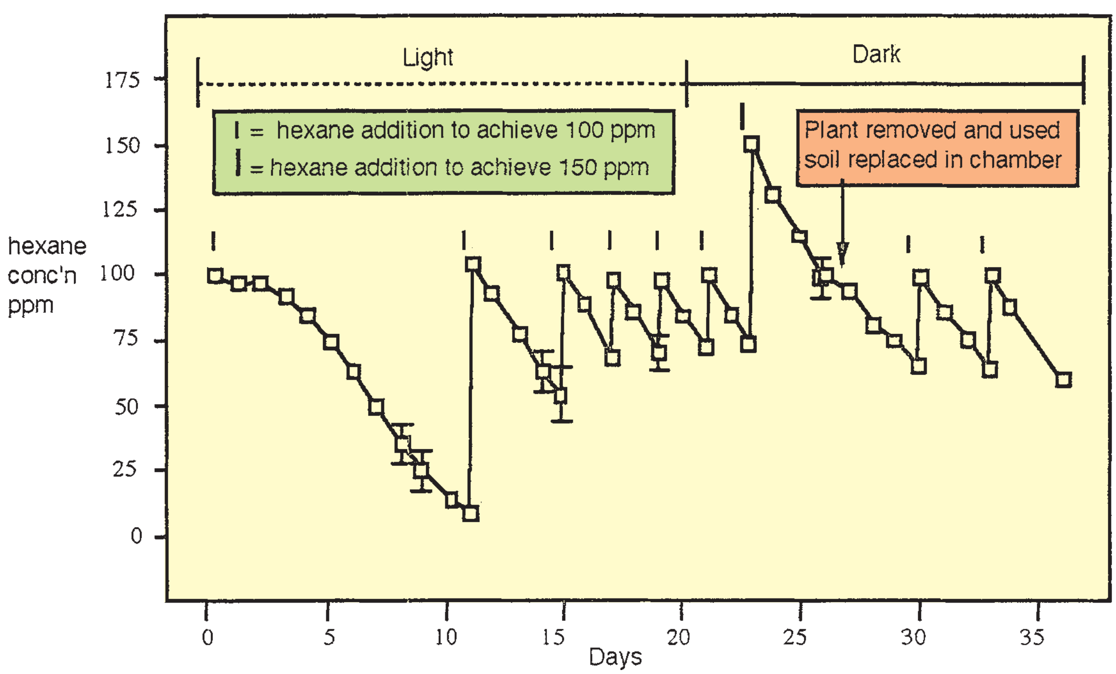

Fig.2. *n*-hexane levels in air of test chambers containing *Dracaena* var Janet Craig plants maintained in potting medium (soil).

The bottom line - a new and improved marketing message!

Indoor pot plants can now be confidently promoted as helping to improve the quality of the indoor environment. The way of the future will certainly be to use them routinely for that purpose, and to ensure that buildings are designed to exploit their usefulness for clean air as well as for their living beauty! In summary, we can safely state that:

1. The pot plant system really does remove VOCs from indoor air!
2. The system gets better on exposure to VOCs, and maintains performance with repeated doses.
3. From three to 10 times the maximum permitted Australian occupational indoor air concentrations of each compound can be removed within about 24 hours, under light or dark conditions, without saturating the system.
4. The pot plant system can also remove very low residual VOC concentrations as well.
5. This is apparently a general plant-potting mix phenomenon. That is, it can be expected with any plant species.
6. It is the micro-organisms of the potting mix which are the 'rapid response agents' in VOC removal.
7. But the plants are also directly involved. Different species develop unique soil microflora around their roots, producing a species-specific symbiotic microcosm for growth. Plants sometimes expend from 25 to 45% of the net photosynthetic product of their leaves, via their roots, to keep the microbes growing!

Further research

Work is now continuing on:

a) an investigation into exactly which micro-organisms are involved, and
b) the testing of these three plant species, and others, under flow-through conditions, to simulate better the 'real-world' of air-conditioned buildings.

Results will help answer crucial questions about how much plant material, of which species, best improves indoor air quality, and how to tackle horticultural development for this capacity. These two new projects are being conducted by the Department of Environmental Sciences at UTS and in collaboration with CSIRO research laboratories, Melbourne.

Ralph Orwell and Ronald Wood adjusting lights and seals on two sets of plant test chambers, containing Spathiphyllum, (left) and Kentia Palms.

Acknowledgements

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