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Investigation of A Potted Plant (*Hedera helix*) with Photo-Regulation to Remove Volatile Formaldehyde for Improving Indoor Air Quality

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ABSTRACT

Formaldehyde is the most common volatile organic compound (VOC) emitted from household materials and is associated with many health risks, including sick building syndrome. A potted *Hedera helix* was used as an air purifier to remove the gaseous formaldehyde. Development of a test platform is necessary to evaluate the indoor performance of air cleaning protocols. The box modulation with a novel volatile pollutant-emitting source was applied in an air quality monitoring experiment to mimic a non-ventilated workplace. The environmental conditions and the pollutant concentrations in the air were measured in real time, and the monitoring data was uploaded to cloud storage media by a wireless technique. Compared with natural dissipation, our results demonstrate a 70% decrease in the required time to achieve 1.0 ppm of gaseous formaldehyde using the biological purifier. In addition, the effect of photo-regulation was not significant in the use of potted plants to remove gaseous formaldehyde. Our study provides an accurate and available platform for the public to determine the health risks of VOCs in their buildings.

Keywords: Phyto-degradation; Ornamental plant; Gas sensor; Air cleaning; Photoreaction**.**

INTRODUCTION

Air quality is a global problem causing economic loss and human health threats (Seppänen and Fisk, 2006). Serious health problems are related to sick building syndrome, which is usually associated with the quality of indoor air (Mullen *et al.*, 2016; Mandin *et al.*, 2017). In urban areas, most citizens have long-term exposure to large amounts of harmful chemicals indoors, whether it's at home or working at the office (Zheng *et al.*, 2011; Shi *et al.*, 2015; Lukcso *et al.*, 2016). People are usually exposed to a higher intake or breathe in a greater concentration of air pollutants because these pollutants are more prevalent in indoor than outdoor environments (Zhang *et al.*, 2017).

However, increased industrial development and urban activities have brought about worsened outdoor air quality (Alam *et al.*, 2016). Air pollution in China and India has received a lot of scientific attention, even affecting the lives of people in neighboring countries in Asia (Venkatachalam, 2017). People spend more time indoors, while outdoor air pollution has caused serious hazards to health (Zhang *et al.*, 2017). Understanding and controlling indoor air quality can help reduce the risk of indoor health concerns, especially Legionnaires' disease (Sundell, 2017), respiratory allergy (Guan *et al.*, 2016; Lukcso *et al.*, 2016) and children's asthma (Huang *et al.*, 2016).

As shown in Fig. 1, indoor air quality is dominated by many dynamic processes, including air exchange, human activities, and pollutants transferring within the building, weather, and building occupants (Zheng *et al.*, 2011). People usually notice uncomfortable symptoms or illness after working for several hours, and feel better after leaving the building for some days. The amount of time they spend in the building is associated with the health effects (Francisco *et al.*, 2017). However, specific pathogens or causes cannot be identified in most cases. Therefore, a well-defined experimental platform needs to characterize the major components, distributions, boundaries, exchangeable rate, and loading between the system and surroundings (Freijer and Bloemen, 2000; Yang and Zhang, 2008; Demou *et al.*, 2009; Kim *et al.*, 2010). The indoor air quality is significantly influenced by infiltration into the building mainly through the ventilation system and to a lesser extent, through windows or cracks (Saraga *et al.*, 2017).

Common indoor air pollutants can be categorized as volatile organic compounds (VOCs), microbial contaminants, gaseous contaminants, and particulate matter (PM). The air

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pollutants related to the sources of air pollution are listed in Table 1. Thus, the pollution sources must be first identified for the removal of indoor air pollutants. Formaldehyde (HCHO) is one of the most common VOCs affecting indoor air quality and the health of occupants in buildings (Brown *et al.*, 2015). Recent observation also demonstrated that the HCHO is the most serious air pollutant in the decorated residences and public places (Chang *et al.*, 2017). Carbon dioxide (CO_2) levels can be used as an indicator of biotic odors, and a health risk should be considered at very high levels, greater than 5000 ppm (Rackes and Waring, 2013). The chemical contaminants exist in the indoor environment within the different dynamic behaviors and frequencies.

Ventilation is an effective way of ameliorating air quality that works by diluting the concentrations of indoor pollutants, but it increases energy use because the utilization of indoor air handling systems must increase (Ciuzas *et al.*, 2016; Francisco *et al.*, 2017). Besides, using effective means to reduce indoor air pollution and improve air quality are important issues for building occupants and users in non-ventilated places, like hospitals and laboratories (Brown *et al.*, 2015; Lucas *et al.*, 2016; Verriele *et al.*, 2016; Bradman *et al.*, 2017). Indoor air handling systems with HEPA filters control the ambient environmental conditions, including the temperature, humidity, air flow and air cleaning (Russell *et al.*, 2014). However, filtration does not reduce the levels of all indoor air pollutants, and some types can actually exacerbate the problem (Yu *et al.*, 2006). Chemicals or particles can penetrate indoors through the building envelope, affecting the indoor $PM_{2.5}$ levels in real housing units with a controlled indoor-outdoor pressure differences (Choi and Kang, 2017). Therefore, a well-defined performance metrics of air cleaner is need to developed for the indoor air quality management (Hodgson *et al.*, 2007; Yan *et al.*, 2008).

The use of plants to improve indoor air quality was investigated by the U.S. National Aeronautics and Space Administration (NASA) to explore the possibilities of long-term space habitation for closed environments in space missions (Wolverton *et al.*, 1989). The pioneering screening studies by Wolverton and colleagues showed over 50 species

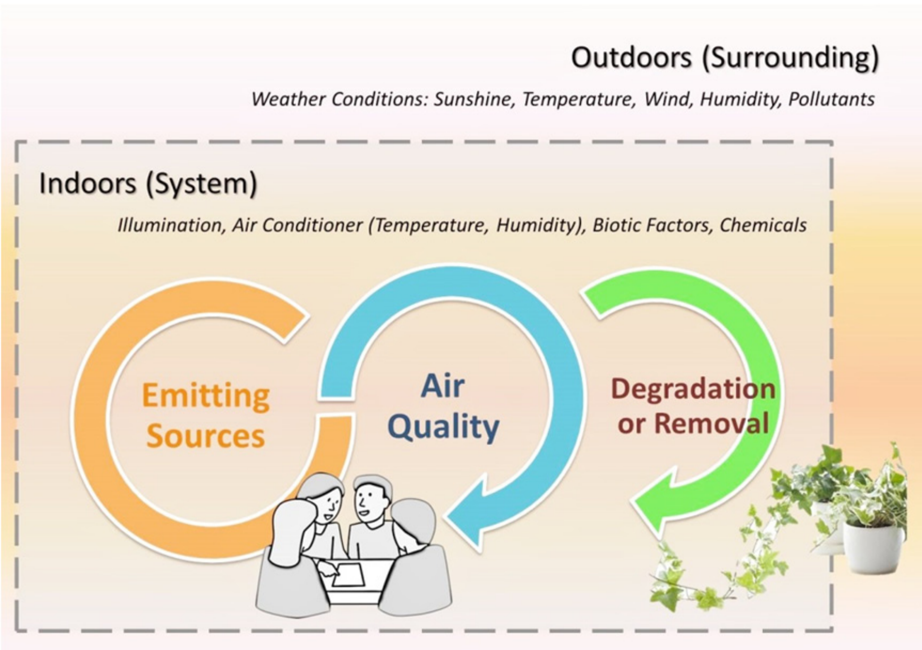

Fig. 1. Schematic assessment framework of indoor air quality, including a series of dynamic life cycles of chemicals, biological activities, as well as the physical factors and exchange with the outdoor air (surroundings).

Table 1. Sources and types of pollutants in the indoor air.

Source	Major Pollutions
Outdoor air exchange	PM, Ozone, Nitrogen oxides, Dust, Pollen, Carbon oxides
Building materials, paint, glues, upholstery, wallpapers	Benzene, Toluene, Insects, Formaldehyde, Alcohols
Furniture and decorative supplies, televisions, refrigerators, carpets, heater	Formaldehyde, PM, Fungi, Insects, Benzene, Ethyl acetate, Carbon oxides, Ammonia, Acetone, Fungi
Office equipment, printer, paper, photocopiers, inks, computers, fax, cosmetics	PM, Ethanol, Formaldehyde, Carbon oxides, Ozone, Nitrogen oxides, Ammonia, Acetone, Ester, Bio-aerosol
Activities of households, cooking, cleaning, smoking, foods	Carbon dioxide, PM, Benzene, Ether, Acetate, Fungi, Alcohols, Eater, Bio-aerosol
Pets and planting	PM, Ammonia, Sulphur compounds, Carbon dioxide, Methane, Ethyl acetate, Insects, Bio-aerosol

of houseplants had air-cleaning capacity and reduced VOCs levels in the air (Wolverton *et al.*, 1989; Wolverton, 1996). English ivy (*Hedera helix*) is an evergreen climbing plant that is well adapted to indoor conditions. *Hedera helix* climbs by means of aerial rootlets with matted pads which cling strongly to the substrate. The leaves are of two types, with five-lobed juvenile leaves on creeping and climbing stems, and unrobed adult leaves on fertile flowering stems exposed to sun. Different varieties of *Hedera helix* are widely cultivated as ornamental plants, preferring moist, shady locations and avoiding direct exposure to sunlight. *Hedera helix* is also usually listed as a top 10 houseplant air cleaner for VOCs removal (Yang *et al.*, 2009).

Thus, the potted *Hedera helix* and HCHO were used as model plants and air pollutants to appraise the green technique of improving indoor air quality in this study. Two sources of air pollution in different emitting modes were first utilized in a well-defined test box. The impacts of biological factors on environmental conditions were also evaluated by observations with quantitative data in real time. A wireless air quality monitoring system was conducted with field studies to verify the feasibility of prediction models and estimate the exchange between the system and its surroundings (Kang *et al.*, 2016). The multiple boxes-modeling was used in a laboratory-type test to describe the performance of planting on the cleaning of indoor air. Although the earlier laboratory studies have demonstrated the ability of bioremediation technologies to remove VOCs (Kim *et al.*, 2008; Xu *et al.*, 2010; Xu *et al.*, 2011; Dela Cruz *et al.*, 2014; Gawronska and Bakera, 2015; Pandey *et al.*, 2016; Hong *et al.*, 2017), no experimental field-study has been made to investigate the potted-plant can bring about significant reductions of VOC pollution in the real environments. Our study might provide an accurate and relatively accessible platform for the public, interior designers and engineers to determine if the health risks of VOCs in their building space. The phyto-remediation not only is able to remove the VOCs from air but also stabilize the temperature and humidity, to improve people's mental health.

EXPERIMENTAL METHODS

Plants Materials

Four potted plants (*Hedera helix*) were purchased from the Jian-Kuo flower market in Taipei, Taiwan. All plants were chosen to be free of insects and pathogens and cultured in 8-cm-diameter pots with sterilized media. Before use in experiments, clean water would be poured into the pot, which was covered by aluminum foil to avoid withered planting and infiltration of gaseous pollutants.

Setup of Experimental Box for Air Quality Monitoring

As shown in Fig. 2(A), the experimental platform of air quality monitoring was designed as a controlled box to mimic the indoor space and operations in this study. A quasi-closed box was made of acrylic polymer in 90(L) × 50(W) × 50(H) cm and equipped with two recirculating fans; one illumination unit; and two exchangeable ports. The recirculating fans were used to promote the composition uniform of air quality in the experimental box. Two fluorescent tubes (T5/2FT 14W, daylight, Wellypower Optronics Corporation, Taiwan) were used to meet a specification of 16(D) × 549(L) mm, with 1200 lm and color temperature of 6500K, and were placed on the upper layer of the box to meet the illumination requirement. The spectrum of the fluorescent tube was measured by a UV/visible/infrared micro-spectrometer (GREEN-Wave UVNb-25, StellarNet Inc., USA) and characterized as shown in Fig. 2(B). The irradiation intensity was also validated using a multi-sense optical radiometer (MS-100, Ultra-Violet Products Ltd., UK).

The monitoring instruments were installed for air quality and environmental conditions in real time. An illuminometer (TENMARS YF-1065, TECPEL Co., Taipei, Taiwan) and combo air quality sensors (AQM-100 and APM-200, AIGO TECH Co., Taipei, Taiwan) were used in the study. Each of the major sensors used in this work was characterized and listed in Table 2.

Exposure to Gaseous HCHO with Different Emission Modes

Two types of emission source of gaseous HCHO were used to examine the removal efficiency of HCHO pollution in indoor environments. One was the spraying of 2 ml of 14% HCHO liquid into the experimental box and using an atomizing nozzle to make the molecules vaporize and rapidly disperse. The emission mode of the volatile pollutant was termed the "fast discharge". The other emission mode was termed "slow release", whereby 1 ml of 14% HCHO liquid was poured in a glass dish with a porous material. In the slow release mode, the HCHO molecules were vaporized and diffused into the box space.

The 14% HCHO liquid was purchased from First-Chemical Works (Taipei, Taiwan). Ultrapure water produced by a Milli-Q system (Millipore, USA) was used as a solvent.

Experimental Design and Observation

Several preliminary studies were carried out for observation requirements, such as the maximum detectable level, the background level, and the time required for natural decay under the experimental conditions. The air quality of the experimental box was conditioned to the background standards before every treatment. For the target pollutant, the HCHO concentration should be less than the 0.1 ppm of DNEL in the air (Johansson *et al.*, 2016). Therefore, the active ventilation would make the HCHO level decrease to 0.03 ppm for 1 hour.

Every six hours, the illumination system was toggled automatically between light and dark environments. The observations without a planting were considered a control for the system under an indicated emission mode of air pollutant. The eight parameters listed in Table 2 were measured and collected in real time. Once the HCHO level in the air was attenuated to 0.05 ppm as the low removal efficacy, the observations were ended. The time series of experimental data per minute were recorded on a computer and uploaded to a cloud storage media by Wi-Fi router.

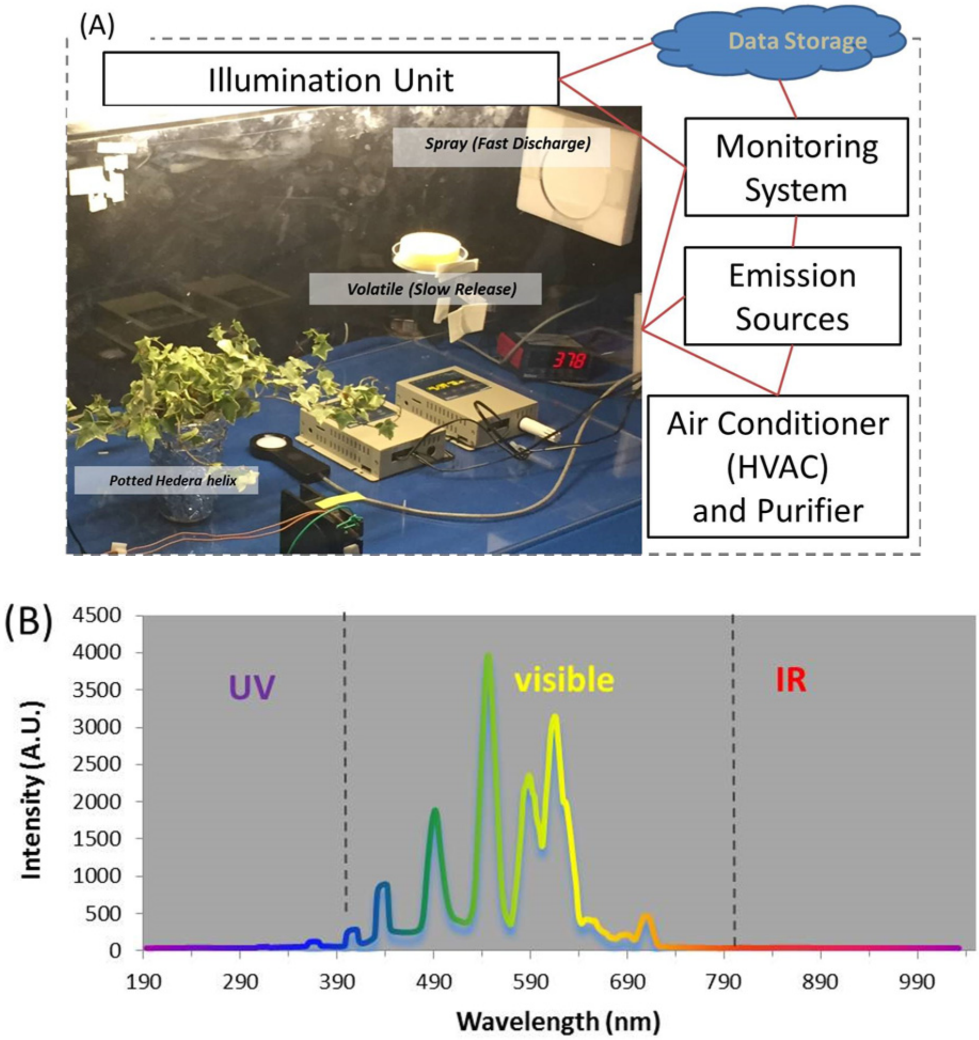

Fig. 2. Illustration of an experimental system for air quality monitoring. (A) The modeling box was used with a potted *Hedera helix*, an illumination unit and the data acquired network in this study. (B) The emission spectrum of fluorescent lamps used in this study was measured at a wavelength range of 190–1050 nm.

Table 2. Sensors and their specifications.

Parameters		Measurement	Response Range	Sensitivity	Symbol (Unit)
1.	Illumination	Si Photodiode	0.1–20000	± 0.1	Luminance (Lux)
2.	Temperature	e-Resistivity	–30–100	± 0.1	Temp. (°C)
3.	Relative Humidity	e-Conductivity	0–90	± 3%	RH% (%)
4.	Formaldehyde	Electrochemistry	0–5.000	± 0.001	[HCHO]air (ppm)
5.	Carbon Dioxide	NDIR	0–5000	± 5%	[CO_2]air (ppm)
6.	Carbon Oxide [nd]	Electrochemistry	0–100	± 5%	[CO]air (ppm)
7.	Total Volatile Organic Chemicals [nd]	Semiconductor	0.125–0.6	± 5%	TVOC (ppm)
8.	Ultrafine Particles [nd]	Photometer	0–999	± 10%	$PM_{2.5}$ (ppb)

The superscript of “nd” is indicated the non-detectable data monitored by the sensor, which was used in this study.

Statistical Analysis

All data represent the mean with a standard deviation of independent experiments. Only the control experiment of slow release mode was executed once, because the observation was time-consuming. The results were analyzed using the unpaired, two-tailed Student’s t-test.

RESULTS AND DISCUSSION

Characterization of Indoor Air Quality Changes

The air quality of the experimental box to mimic indoors is a constantly changing interaction of complex factors affecting the types, levels and importance of pollutants in a controlled environment. Indoor temperature, relative humidity, and illumination are the environmental factors affected and controlled by the ambient surroundings and the observer's activities. As shown in Fig. 3, only five environmental and air quality parameters were available and detectable for this observation on March 4, 2017. In addition, illumination was an operating factor for photo-regulation. Luminance, carbon dioxide, temperature and relative humidity were immediately affected by opening the box with the air exchange at Event (1). The box air was rapidly cooled and humidified while the spraying of HCHO liquid atomized the water molecules and absorbed heat from the air at Event (2). The raised level of carbon dioxide

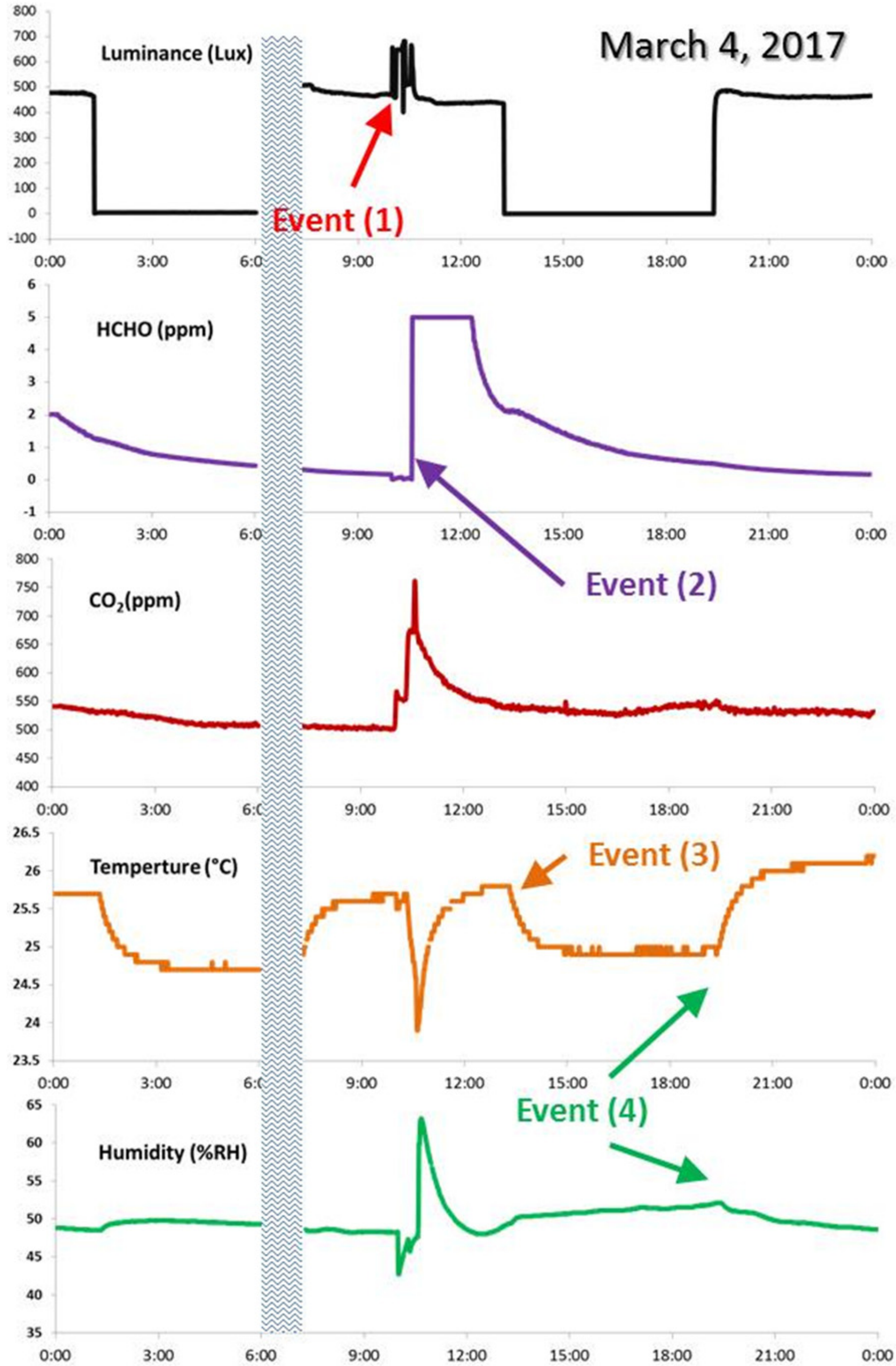

Fig. 3. Example of the time courses of environmental and air quality parameters in the box by the monitoring data in March 4, 2017. The blue-lined area represents a period of data loss. The numbered events indicate the effects of the processes, the box opening and plant setting were carried at Event (1); the 2 ml HCHO liquid was injected into box at Event (2); the illumination unit was turned off at Event (3); the illumination unit was restarted at Event (4).

was caused by the breathing of the observer. With the molecular diffusion and heat exchange between the system and surroundings, these parameters gradually returned to a stable range. The alterations in illumination at Event (3) and Event (4) made subtle changes in the relative humidity and carbon dioxide.

The harmful gaseous pollutants, such as carbon monoxide, total volatile organic chemicals and fine particles were non-detectable and less than the toxic levels in these observations. A good indoor environment establishes the range of environmental conditions acceptable to achieve healthy and thermal comfort for human occupancy (Xiong *et al.*, 2015; Sundell, 2017). For thermal comfort purposes, the air temperature and the relative humidity should be held in the range of 22–26°C and 40–60%, respectively. After spraying pollutants into the box, the gaseous HCHO level in the air was raised over the upper limit level of sensor measurement (5 ppm) and was then reduced with time.

In this observation, the removal of gaseous HCHO presents an exponential decay curve with complicated regulations and multiple mechanisms via illumination and plants. Note, a slightly increased signal was present in the attenuated curve after the occurrence of Event (3) while the illumination was turned to dark. The phenomenon reveals an emitting source contributes gaseous pollutants into the box air more than the removal amount from the box air. We believe the plants play an important role in the removal of gaseous HCHO and were regulated by illumination.

Effects of Pollutant Emitting Modes on Indoor Air Quality

HCHO occurs naturally and is an important industrial chemical. Workplaces in health care facilities, research institutes, and mortuaries may present the high exposure risks due to the use of chemicals (Demou *et al.*, 2009). However, many studies have investigated the removal kinetics of VOCs with a short-term exposure in a controlled space. Studies based on long-term exposure are rare in the literature review (Hun *et al.*, 2010; Nielsen *et al.*, 2017). Thus, we presume different types of emission sources of VOCs and their degradation patterns in Fig. 4(A) from the life experiences. A combination of slow discharge and cyclical release modes mimicked the long-term emission source of indoor VOCs in this study. The performance of the emission sources should be validated and characterized for different experimental requirements. The emission source in the fast discharge mode was applied in this short-term study (less than ten hours), and one of the slow release modes was used for the long-term study, such as the botanic filter application and health risk assessment. Urea-formaldehyde (UF) is a non-transparent thermosetting resin or plastic used in adhesives, finishes, particle board, and molded objects (Broder *et al.*, 1991). These UF resins are a class of thermosetting resins of which resins make up 80% produced globally for improving tear strength, in molding electrical devices. Thus, the emission source with porous material could mimetic the dynamics of indoor VOCs production (Hun *et al.*, 2010).

In Fig. 4(B), the gaseous HCHO level in the air was rapidly reduced to a safe level in the fast discharge mode; but the other observation needed more time to achieve a similar level in the slow release mode. Our previous study demonstrated the temperature and relative humidity of indoor air are not sensitive to HCHO removal via natural dissipation and photo-degradation (Lin *et al.*, 2017). However, the time course of gaseous HCHO removal presented a photo-regulated phenomenon by switching the illumination environment. The lighting would increase the air temperature and indirectly enhance the vaporized rate of HCHO from the supported material into the air. Real absorbents have pores of various sizes; the diffusion plays an increasingly important role to decrease the observed activation energy, and the reaction order approaches unity (Lin *et al.*, 2017).

Otherwise, the positive effect of illumination would also contribute to the removal of gaseous HCHO through photo-degradation. Due to the exponential decay curve of gaseous HCHO removal, the apparent kinetic equation was proposed as follows: $[HCHO]_{air}$ (t) = $[HCHO]_{air}$ $(0)\cdot e^{-K+(t-0)}$, and the removal rate of gaseous HCHO was derived from the logarithmic plot in Fig. 4(C). The slope of the logarithmic curve with time presents an apparent rate constant, K^{+}. With Arrhenius temperature dependencies for the reaction and diffusion, the observed activation energy would be approximately one-half the true activation energy by strong pore resistance, $E_{obs} \approx E_{true}/2$. The results of the kinetic observations clearly demonstrate an approximated one-stage matter in the slow release pollution and a two-stage mechanism depended on the concentration for the fast discharge pollution.

Performance Evaluation of Plants on Volatile HCHO Removal

Current performance assessment of the air cleaning primarily has been occurred in laboratories, often using high challenge concentrations of chemicals, low airflow rates, and single contaminant species in a controlled environment (Yu *et al.*, 2015). In generation, a performance of air cleaning was determined by two ways including a direct upstream versus downstream measurement and empirical determination with a single zone mass balance model (Thunyasirinon *et al.*, 2015; Ciuzas *et al.*, 2016). The air purification performance could be assessed by the removal amount, the removal rate, and the required time to achieve the acceptable values of air quality. For short-term assessments, the removal of contaminants is the most used indicator in quantitation.

However, the World Health Organization (WHO) established an exposure limit of gaseous HCHO of 0.08 ppm for 30-minute periods (Salthammer *et al.*, 2010; Nielsen *et al.*, 2017). The main human exposure pathways of HCHO are inhalation of gaseous HCHO from the air or transdermal absorption of aqueous HCHO (Gelbke *et al.*, 2014). Therefore, the required time is more available as the indicator to evaluate the performance of a biological method for indoor HCHO removal (Darlington *et al.*, 1998; Xu *et al.*, 2011; Dela Cruz *et al.*, 2014).

For comparison, the control experiments were performed in the box system without household plants. As shown in Fig. 5(A), treatment with potted *Hedera helix* could slightly

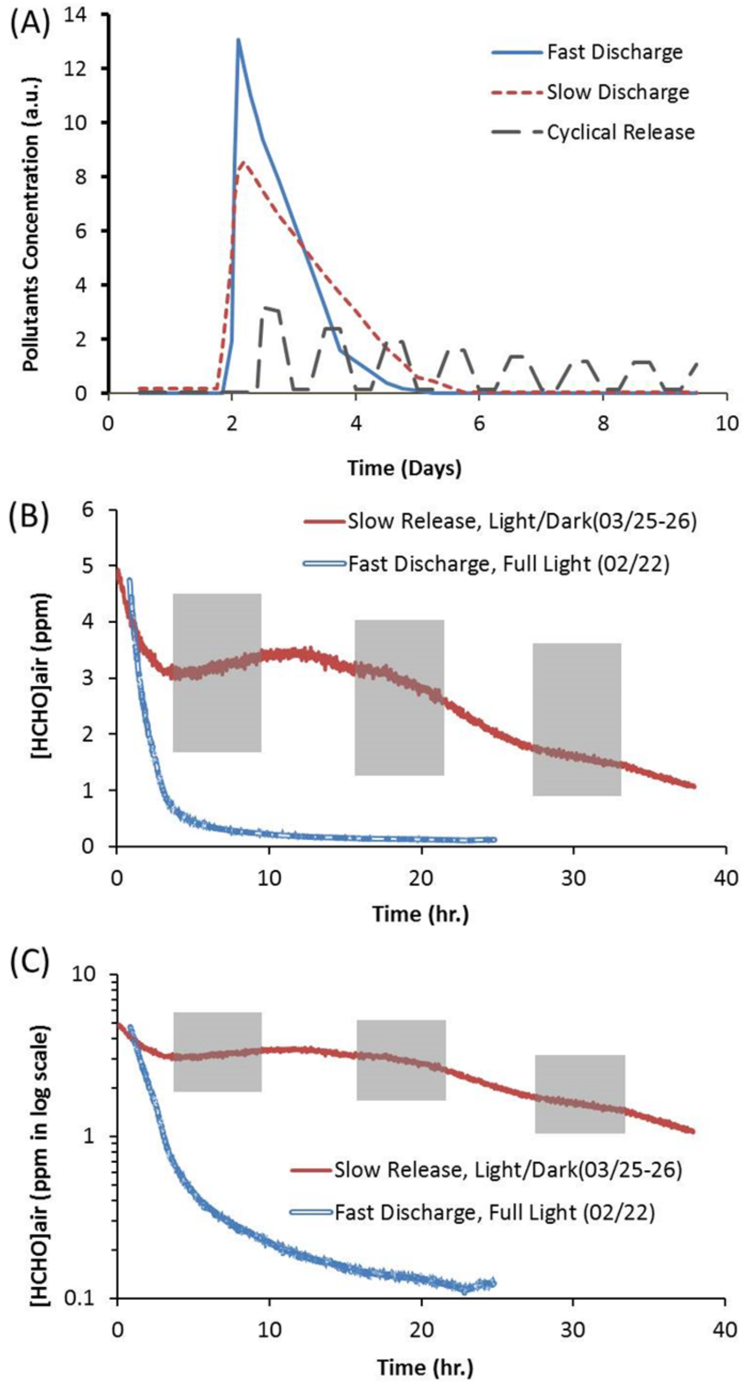

Fig. 4. The effect of emitting sources with different modes on gaseous pollutants removal without plants. (A) Patterns of gaseous pollutant concentration are proposed with the three types of emission sources. (B) The time courses of HCHO concentration were recorded with the fast discharge mode and the slow release mode. (C) Plotting of the logarithmic concentration of gaseous HCHO versus the time was used to characterize the removal rate of HCHO. The grey block means the experiments were performed without illumination (in dark).

accelerate the removal of gaseous HCHO from the air under the fast discharge mode of the emission source. The efficiency of potted *Hedera helix* was greater at lower levels of gaseous HCHO, at less than 1 ppm. This result shows the botanic filters are not suitable to treat acute exposure to VOCs. However, the efficiencies of potted *Hedera helix* were significantly improved for gaseous HCHO removal under the slow release mode of the emission source, as shown in Fig. 5(B). The required times to achieve 1.0 ppm HCHO were 58.5 hours and 17.1 hours using natural dissipation and the biological purifier, respectively. The required times to achieve 0.5 ppm HCHO were 67.6 hours and 20.9 hours using natural dissipation and the biological purifier, respectively.

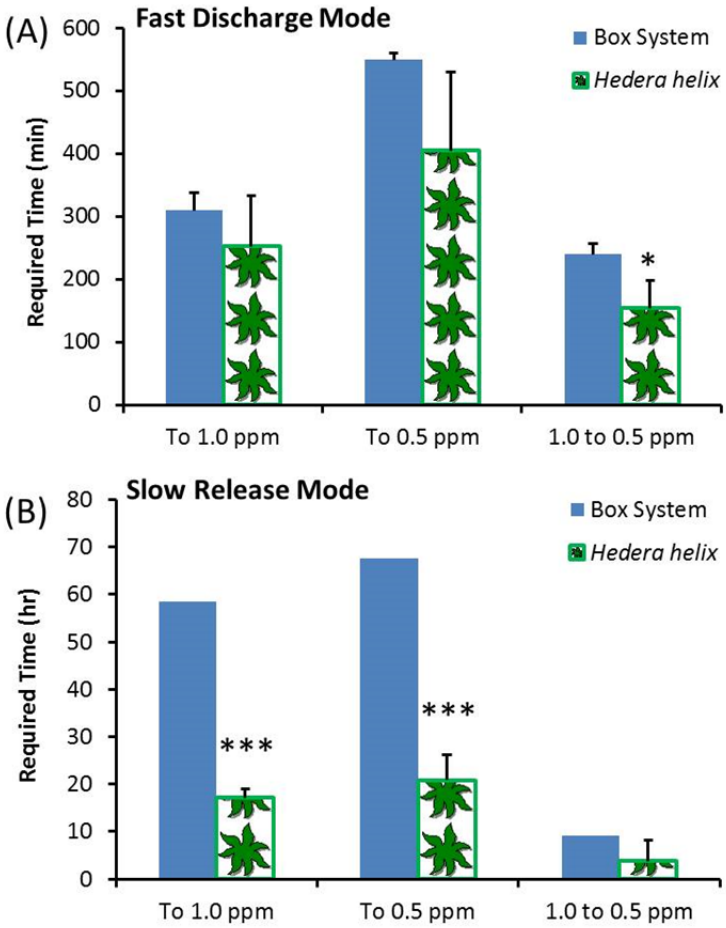

Fig. 5. The time efficacies of gaseous HCHO removal with a potted *Hedera helix*. Evaluation was based on the time required to achieve the indicated concentration (1.0 or 0.5 ppm) of gaseous HCHO under the emission source of (A) fast discharge mode, or (B) slow release mode. For comparison, the control experiments were performed in a box system without household plants. The difference was designated as the level of significance with * ($P < 0.5$), with ** ($P < 0.05$) or with *** ($P < 0.01$).

People are exposed to localized and accumulated doses of VOCs due to staying indoors for a long time (Wolkoff *et al.*, 1998). Usually, the most effective way to improve indoor air quality is to eliminate individual sources of pollution or reduce their emissions. However, most emission sources of indoor VOCs are continuous and slow release (Manoukian *et al.*, 2016). Gaseous HCHO can be removed by many pathways, including diffusion, adsorption, polymerization, photolysis and photocatalytic oxidation decomposition (Li *et al.*, 2014). Our results demonstrate plants have an advantage in treating chronic pollution and the residual pollutants in ambient air.

Photo-Regulated Effects of Hedera Helix on Gaseous HCHO Removal

Under proper light irradiation, the photosynthesis of green plants utilizes the carbon dioxide in air to provide carbohydrates and energy source for growth. The volatile chemicals are absorbed and metabolized by the physiological pathways of the plants, and the efficiency of pollutant removal depends on the plant species, time, light intensity and pollutant species (Kim *et al.*, 2008; Wang *et al.*, 2014).

The data set of long-term monitoring was chosen to investigate the photo-regulated effect on improving indoor air quality with plants. Thus, the emission source of gaseous HCHO was used as the slow release mode to provide a detectable level in the air. In Fig. 6(A), the gaseous HCHO level was decreased and the removal rate tended to slow after exposure of 8 hours. For high level region, the time course of gaseous HCHO is changed significantly in the removal rate. In addition, the system illumination was periodic switched every six hours. The time-lag effects were also observed in these irradiation events. The Fig. 6(B) shows illumination could assist the *Hedera helix* in removing gaseous HCHO at lower levels, at less than 1 ppm. Thus, gaseous HCHO removal by *Hedera helix* was again validated as a concentration dependent matter.

The carbon dioxide levels in the box air could be an indicator of respiration and were shown in Fig. 6(C). Lower levels of carbon dioxide were observed in the light environment, compared with the dark environment. The effectiveness of photosynthesis was inhibited by the high level of carbon dioxide in the air. The post-illumination CO_2 burst was observed after the illumination turned off

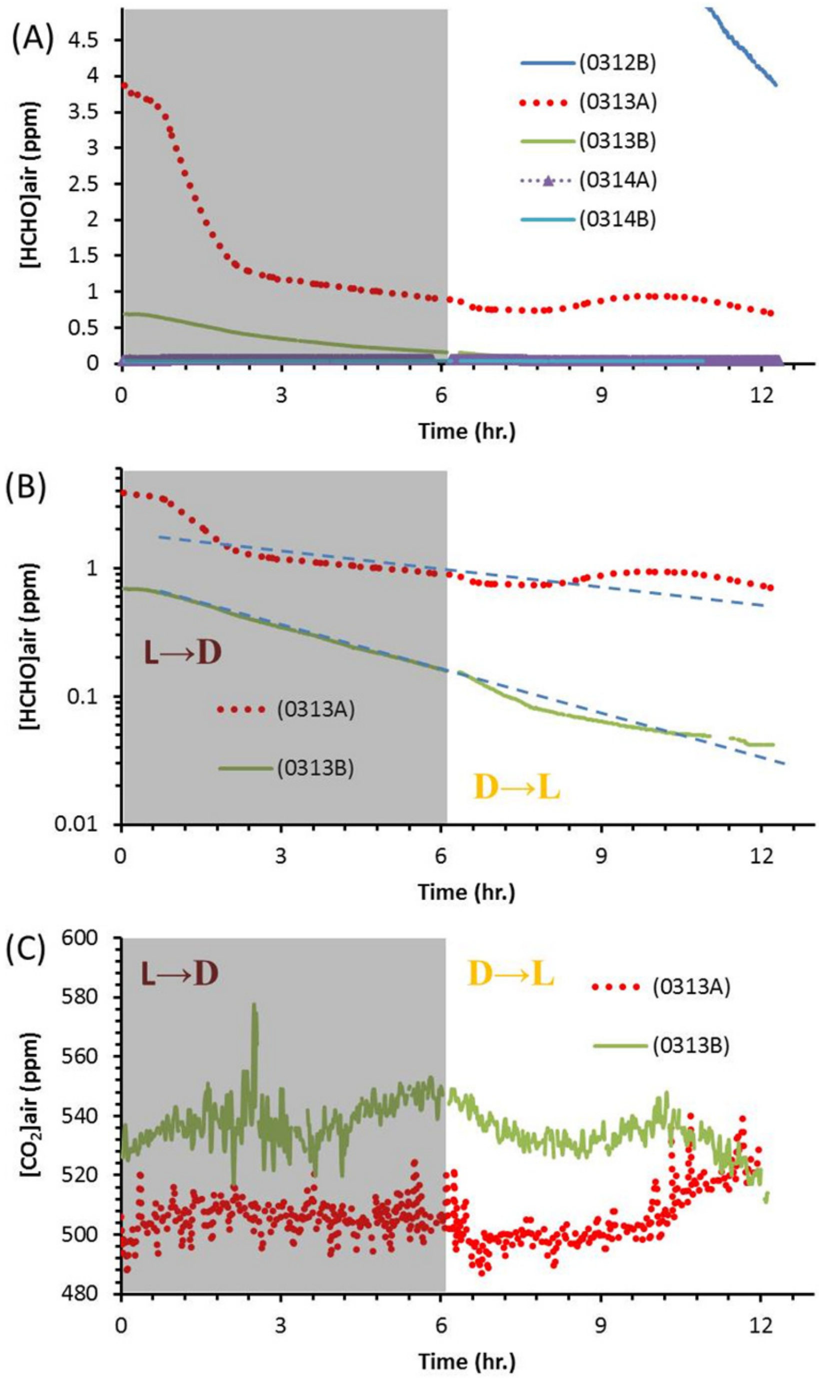

Fig. 6. Effects of illumination on HCHO removal, kinetic rate and carbon dioxide level in air. (A) The time courses of HCHO concentration were recorded in the slow release mode from March 12 to 15. (B) The kinetic rate of gaseous HCHO removal was evaluated for less harmful concentrations of HCHO on March 13. Plotting of the logarithmic scale versus the time was used to display the removal rate with *Hedera helix*. (C) The time courses of carbon dioxide concentration were recorded and compared to the HCHO removal at March 13. The grey block means the experiment was carried without illumination. The symbols of D → L and L → D show the experimental environments changed from dark to light and from light to dark, respectively.

(L→D). For C3 plants, light respiration will counteract about 30% of the photosynthesis. Oxygen is consumed during the process and generates carbon dioxide. Therefore, reducing light respiration is considered one way to improve the effectiveness of photosynthesis.

Biological regulation is a complex, adaptive and dynamic process, and the illumination and planting has a strong impact on the ecological stability of human life. Some studies reported the biogenic VOC has an indirect impact on the lifetime of greenhouse gases and the secondary organic aerosol formation in the atmosphere (de Oliveira and Moraes, 2017). However, the benefit outweighs of planting for improving the indoor air quality is larger than the hazard risk from biogenic toxins.

CONCLUSION

Air cleaning techniques with low-energy consumption and green properties are modern trends (Lu *et al.*, 2010). To gauge the potential benefits of these devices and techniques, metric tools based on indoor air quality modeling and performance data from field testing must first be applied (Ozturk, 2015). A well-defined experimental platform with an emission source of volatile organic chemicals was investigated to evaluate the performance of a potted plant in removing gaseous HCHO. The slow-release mode of emitted pollution was first utilized to fulfill the requirement of mimicking an indoor environment in a long-term monitoring experiment. The contributions of natural dissipation, photo-degradation and the botanic filter were assessed quantitatively. Volatile HCHO levels can be reduced using potted plants, which provide additional ornamental features. The experimental results show that potted *Hedera helix* can reduce 70% of the required time to reach 0.5 ppm of gaseous HCHO when compared with natural dissipation. Potted *Hedera helix* can also remove residual HCHO from the environment, thus improving indoor air quality.

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