

A Study on Improvement of Indoor Air Setting by Korean Native Plants

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SUMMARY

This study conducted the experiment of concentration reduction effect of indoor air pollutants to Korean native plants, *Fatsia japonica* Decne. et Planch. and *Ardisia pusilla* DC. The two plants are advantageous in that they are highly available as they grow wild, and being easy to get. *Fatsia japonica* Decne. et Planch. is a plant of its wide and large leaf diverged 7 or 8 parts, which is thought to have a high effect of air purification. *Ardisia pusilla* DC. has a smaller leaf than *Fatsia japonica* Decne. et Planch., which is characterized by more leaves and beautiful. Field measurements were performed in models where the plants were placed and were not. The dimensions of the two models were equal. The concentration of Benzene, Toluene, Ethylbenzene, Xylene, Formaldehyde were monitored, since they were known as most toxic materials. The concentration of VOCs was monitored three hours after the plants were placed and three days after the plants were placed. As a result, they had all an effect of reducing pollution. Especially, *Fatsia japonica* Decne. et Planch. was more excellent in reducing Toluene and Formaldehyde with a lot of pollutants.

INTRODUCTION

The experiment purifying air using plants was conducted by NASA since 1980s. Of late in Korea, as concern about well-being has risen, there has appeared a movement to make clean air, and improve residential environment using already purified air. This study attempts to the most Korean and effective plant by which we feel beauty growing and maintain pleasant indoor air. For this, the study grasped VOCs reduction effect produced indoors to *Ardisia pusilla* DC, and *Ardisia pusilla* DC, Korean native plants. To grasp the effect, the study compared the room with and that without plants, and measured VOCs concentration. Also to compare the effect of the two plants, the study alternated the planting and growing volume and placement, and experimented it.

METHODS

This experiment measured the concentration change of VOCs in the room with plants, and that without them in order to seize the VOCs reduction effect by plants. The kinds of measured VOCs were Benzene, Toluene, Ethylbenzene, Xylene, Formaldehyde on the measured results of which for three days reduction effect was grasped. The experiment room

measures 3.5m wide, 5m long, and 2.4m long in a form of reduced apartment, which had a living room and a veranda, with the plants arranged based on the veranda part.

In the experiment regarding planting and growing amount, the plants were divided by 10% and 5% of the experiment space, and that to the placement of planting and growing, sunny spot placement close to the veranda part, and scattered placement were measured respectively. The measurement was made on the apartment measuring method (process testing method) at three in the afternoon for three days in a row after 5 hour closed state for 5 hours after ventilation for 30 minutes in the morning. The experiment room was not operative with an air-conditioner, with the condition of both rooms in all the same. BTEX was sampled with a Charcoal tube, and analyzed using GC-FIID, and HCHO was sampled with a DNPH-cartridge, and analyzed using HPLC.

Figure 1 shows the ground plan of the laboratory, and Figure 2 shows the planting amount and placement.

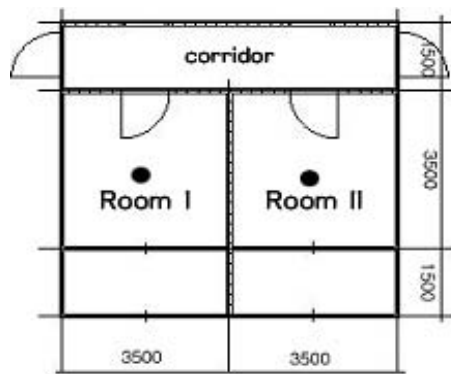


Figure 1. Plan of the space

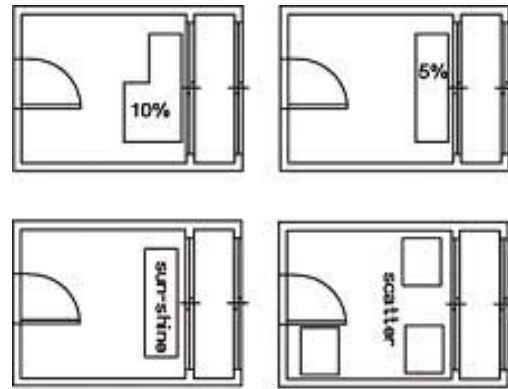


Figure 2. Layout of plant

RESULTS

3.1 Assessment to Planting and Growing Amount

1) *Fatsia japonica* Decne. et Planch

In case of *Fatsia japonica* Decne. et Planch, the reduction capability of Formaldehyde was excellent. The more plating and growing volume there was, the more reduced volume there was and as a result of plating *Fatsia japonica* Decne. et Planch by 10%, Formaldehyde was reduced to $212.33 \mu\text{g}/\text{m}^3$ in total from $251.00 \mu\text{g}/\text{m}^3$.

In planting *Fatsia japonica* Decne. et Planch by 10% in Toluene, Toluene was reduced by $12.90 \mu\text{g}/\text{m}^3$, which was less than that of *Ardisia pusilla* DC, showing a reduction effect.

In addition, Benzene was reduced by $6.20\sim 11.60 \mu\text{g}/\text{m}^3$, Ethylbenzene was by $3.40\sim 5.10 \mu\text{g}/\text{m}^3$, Xylene was by $10.40\sim 11.80 \mu\text{g}/\text{m}^3$, Styrene was by $7.80\sim 9.30 \mu\text{g}/\text{m}^3$. In case of setting up all plants, which was effective, where more plants, more effective.

2) *Ardisia pusilla* DC

Ardisia pusilla DC was excellent in reduction capability in Toluene. In *Ardisia pusilla* DC planted by 10%, Toluene was most reduced by $15.10 \mu\text{g}/\text{m}^3$, which was more effective than

Fatsia japonica Decne. et Planch. In Ardisia pusilla DC planted, Benzene was reduced by 9.00~12.80 $\mu\text{g}/\text{m}^3$, Ethylbenzene by 5.60~7.00 $\mu\text{g}/\text{m}^3$, Xylene by 7.90~10.00 $\mu\text{g}/\text{m}^3$, Styrene by 4.90~5.80 $\mu\text{g}/\text{m}^3$.

Also for Formaldehyde, it was less reduced than for Fatsia japonica Decne. et Planch, but in case of 5%, the reduced volume was great as 96.25 $\mu\text{g}/\text{m}^3$, in case of 10%, as 149.58 $\mu\text{g}/\text{m}^3$.

Figure 3 indicates the concentration change of Benzene in case of Fatsia japonica Decne. et Planch and Ardisia pusilla DC planted, Figure 4 does the concentration change of Toluene, Figure 5 does the concentration change of Ethylene Benzene, Figure 6 does the concentration change of Xylene, Figure 7 does the concentration change of Styrene, and Figure 8 does the concentration change of Formaldehyde, which is the comparative graph of the set-up case and not set-up case of all plants.

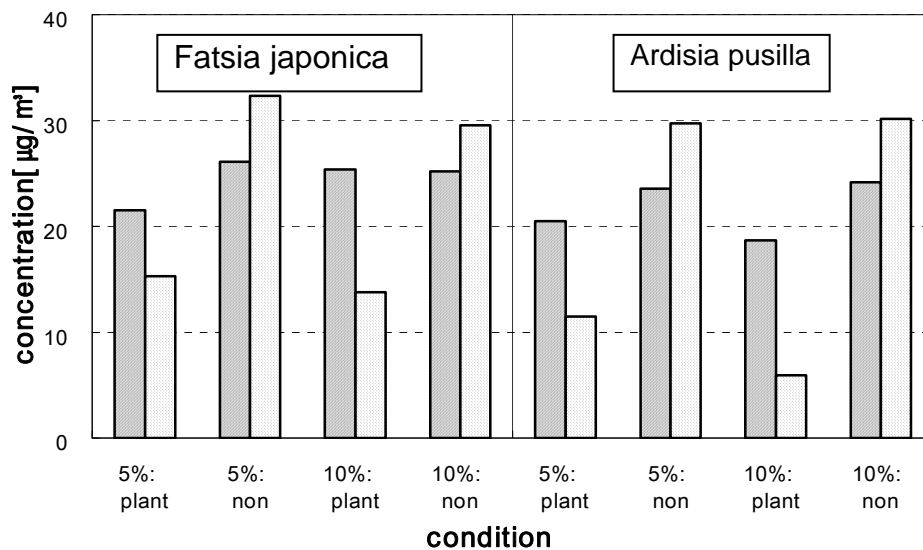


Figure 3. Variation of Benzene concentration according to the amount of plant

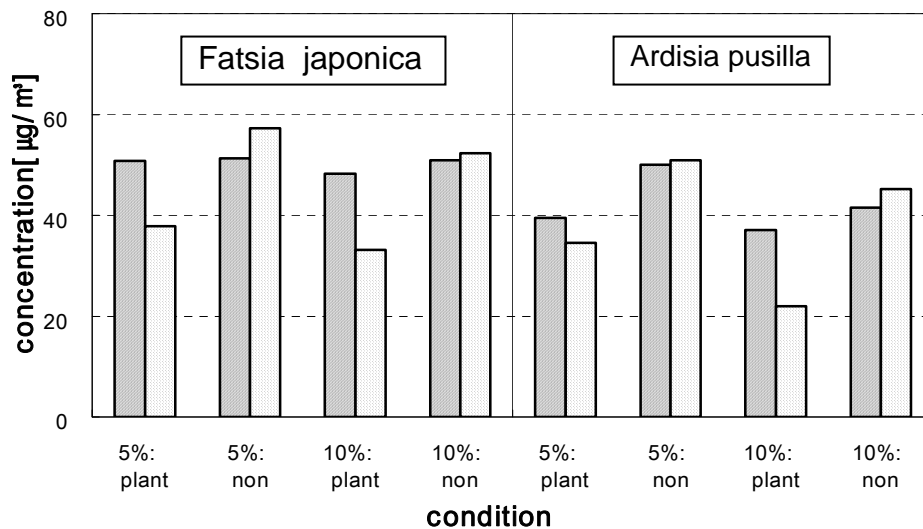


Figure 4. Variation of Toluene concentration according to the amount of plant

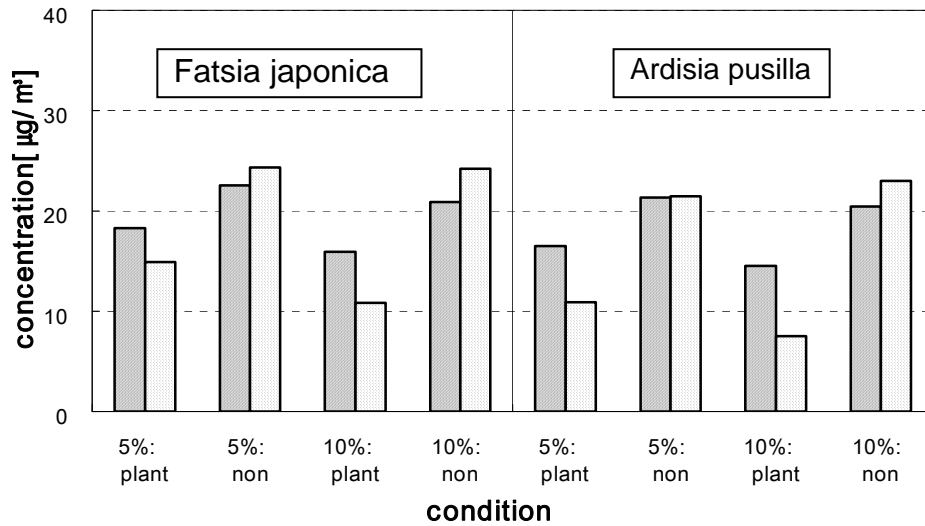


Figure 5. Variation of Ethylbenzene concentration according to the amount of plant

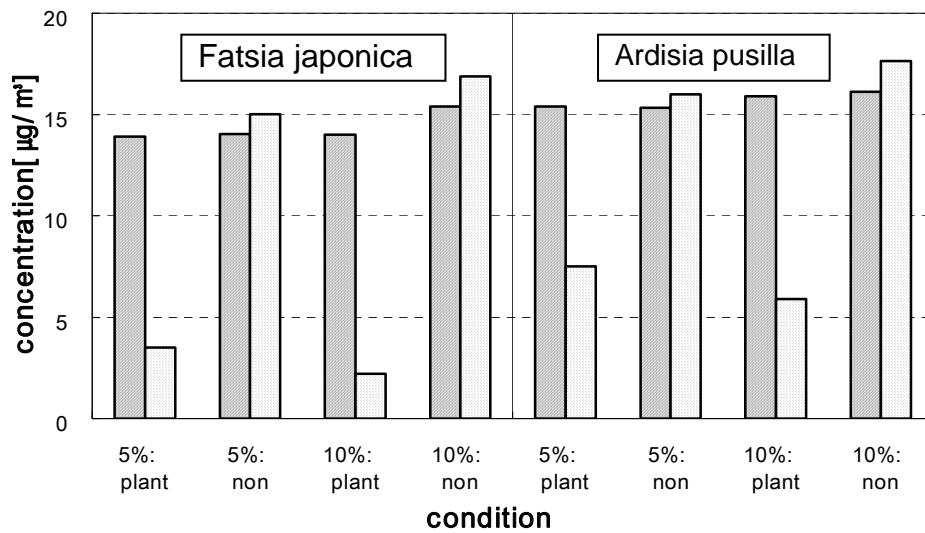


Figure 6. Variation of Xylene concentration according to the amount of plant

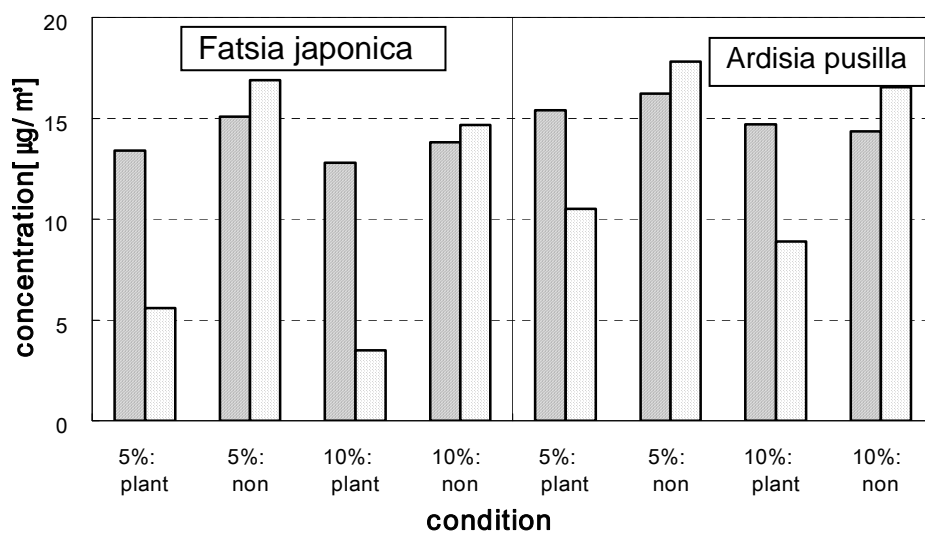


Figure 7. Variation of Styrene concentration according to the amount of plant

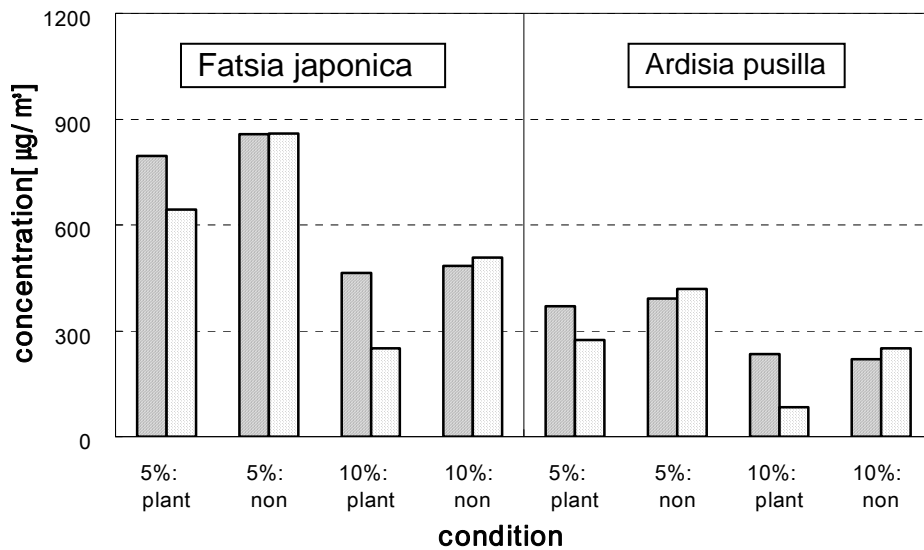


Figure 8. Variation of Formaldehyde concentration according to the amount of plant

3.2 Assessment to Planting and Growing Placement

1) Fatsia japonica Decne. et Planch

In case of planting Fatsia japonica Decne. et Planch, placing it at sunny spot was more effective than that at scattered planting. Benzene was reduced by $6.20 \mu\text{g}/\text{m}^3$ in case of placing at sunny spot, Toluene was reduced by $12.90 \mu\text{g}/\text{m}^3$, which was a bit less than Ardisia pusilla DC. Ethylbenzene was reduced to $1.80\sim 3.40 \mu\text{g}/\text{m}^3$, and Xylene was reduced by $10.40 \mu\text{g}/\text{m}^3$, and Styrene was reduced by $6.00\sim 7.80 \mu\text{g}/\text{m}^3$. Formaldehyde was more effectively reduced in Ardisia pusilla DC and $150.83 \mu\text{g}/\text{m}^3$ was largely reduced in sunny spot placement, and $107.92 \mu\text{g}/\text{m}^3$ was reduced in scattered placement.

2) Ardisia pusilla DC

In planting Ardisia pusilla DC, placing it at sunny spot was more excellent. Benzene was indicated by $9.00 \mu\text{g}/\text{m}^3$ at sunny spot placement, by $5.60 \mu\text{g}/\text{m}^3$ at scattered place, Toluene was indicated by $15.00 \mu\text{g}/\text{m}^3$ at sunny spot placement, by $5.40 \mu\text{g}/\text{m}^3$ at scattered place. Ethylbenzene was indicated by $5.60 \mu\text{g}/\text{m}^3$ at sunny spot place, by $3.90 \mu\text{g}/\text{m}^3$ at scattered placement, and Xylene was indicated by $7.90 \mu\text{g}/\text{m}^3$ at sunny spot, by $4.50 \mu\text{g}/\text{m}^3$ at scattered placement. Ardisia pusilla DC was more excellent than Fatsia japonica Decne. et Planch in Benzene, Toluene, Ethylbenzene. Formaldehyde was more effective in sunny spot placement than scattered placement, where the former was indicated to be $96.25 \mu\text{g}/\text{m}^3$, and the latter was $86.25 \mu\text{g}/\text{m}^3$.

Figure 9 indicates the concentration change of Benzene in case of Fatsia japonica Decne. et Planch and Ardisia pusilla DC planted, Figure 10 does the concentration change of Toluene, Figure 11 does the concentration change of Ethylene Benzene, Figure 12 does the concentration change of Xylene, Figure 13 does the concentration change of Styrene, and Figure 14 does the concentration change of Formaldehyde, which is the comparative graph of the set-up case and not set-up case of all plants.

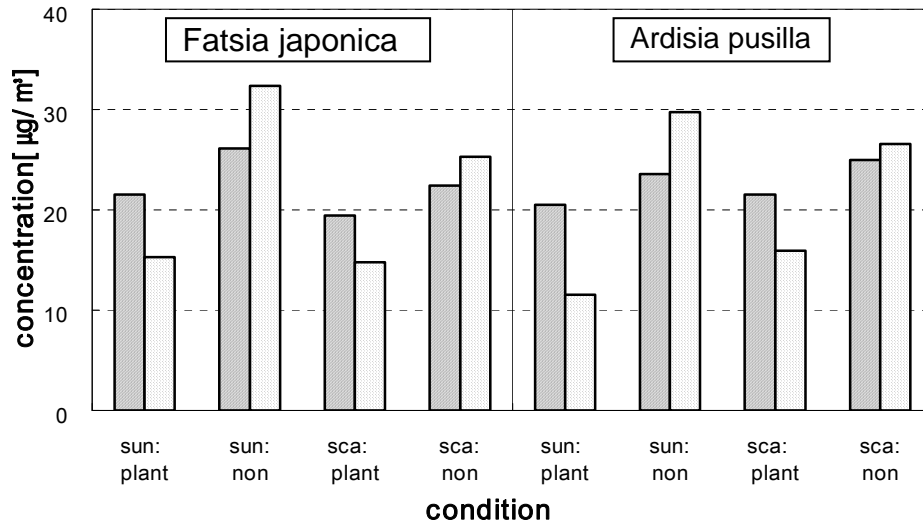


Figure 9. Variation of Benzene according to the positioning of plant

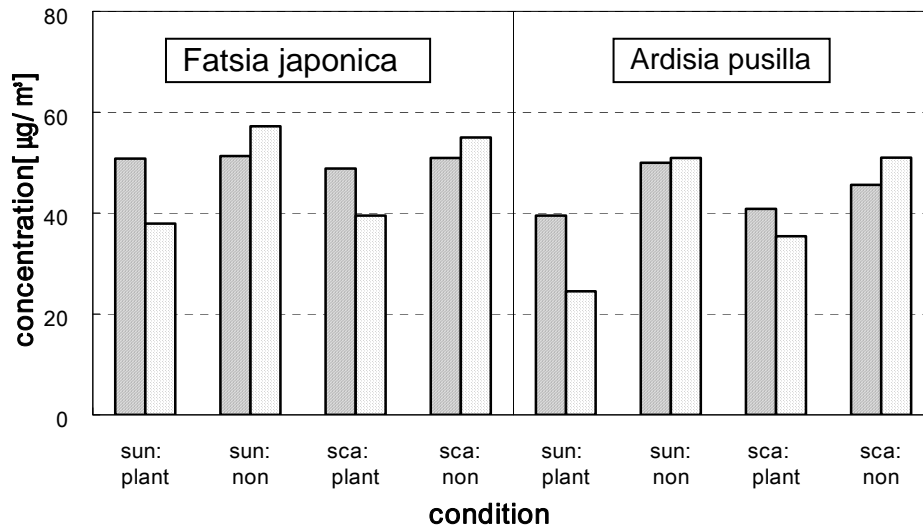


Figure 10. Variation of Toluene according to the positioning of plant

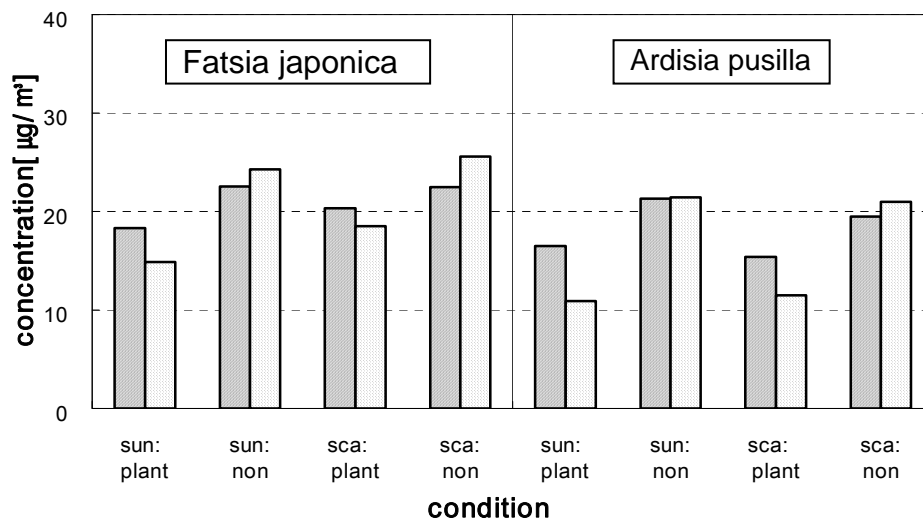


Figure 11. Variation of Ethylbenzene according to the positioning of plant

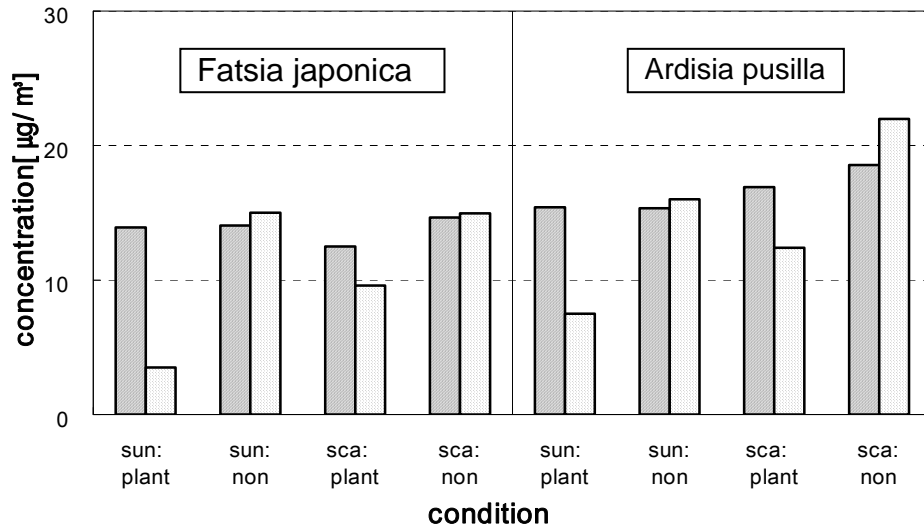


Figure 12. Variation of Xylene according to the positioning of plant

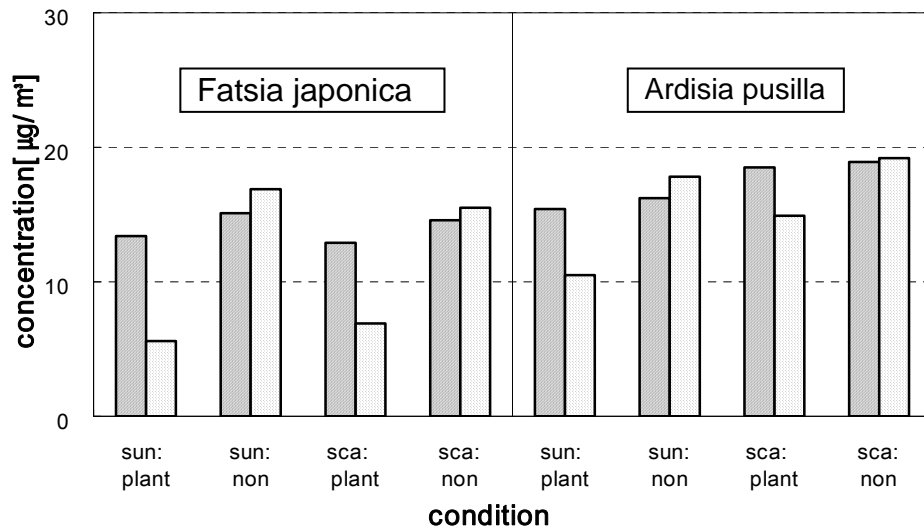


Figure 13. Variation of Styrene according to the positioning of plant

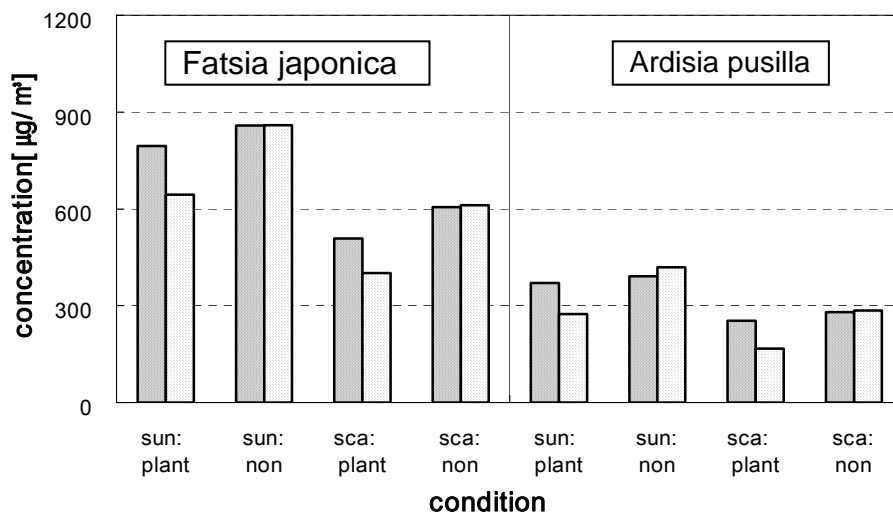


Figure 14. Variation of Formaldehyde according to the positioning of plant

DISCUSSION

This explored the effect of planting and growing volume and placement of Korean native plants, *Fatsia japonica* Decne. et Planch and *Ardisia pusilla* DC. whose findings are as follows.

(1) In all experiments, the room with plants indicated higher reduction effect of VOCs compared to that without plants.

(2) In all cases of experiment of planting and growing volume, the more planting volume, the more excellent the effect.

Toluene was more effective in *Ardisia pusilla* DC planted, Formaldehyde was more effective in *Fatsia japonica* Decne. et Planch planted respectively.

(3) In planting and growing and placing experiment, the placement at sunny spot was more effective than that at scattered growing.

When *Fatsia japonica* Decne. et Planch was placed at sunny spot, the reduction effect of Formaldehyde was the most excellent, and when *Ardisia pusilla* DC was placed at sunny spot, the reduction effect of Toluene was the most effective.

(4) In all experiments, Toluene was effective in *Ardisia pusilla* DC, and Formaldehyde was effective in *Fatsia japonica* Decne. et Planch.

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REFERENCES

1. J.J.Cornejo, F.G.Munoz, C.Y.Ma, A.J.Stewart. 1999. Studies on the Decontamination of Air by Plants, *Ecotoxicology*.
2. Paige Hunter, S.ted Oyama.2000. Control of Volatile Organic Compound Emission, John Wiley & Sons Inc., Newyork.
3. S.M.Owen, P.Harley, A.Guenther, C. N. Hewitt. 2002. Light dependency of VOC emissions from selected Mediterranean plant species, *ATMOSPHERIC ENVIRONMENT*.
4. NASA.2004. The Importance of Plants in Space, http://www.nasa.gov/audience/forstudents/postsecondary/features/F_Importance_of_Plants_in_Space.html.
5. NASA.2004. NASA Research Enhances Benefits Of Plant Experiments, http://www.nasa.gov/home/hqnews/2004/jan/HQ_04018_plant_expmts.html
6. B.C.Wolverton.1989. Interior Landscape Plants for Indoor air Pollution. Abatement. NASA Report.