MACROFLORA AS A BIO-TRAP FOR AIRBORNE PARTICULATE MATTER

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Abstract
Malaysia has already witnessed numerous tragedies in which a lot of people suffer or died because of breathing bad air quality. As an example, during the haze phenomena in 1997, numerous people suffer from respiratory problem. Despite countless preventive measures the airborne particulate matter (APM) is still a contact and credible threat. New approach should be considered to resolve such problems. One of an alternative way that is believed could alleviate the atmosphere of APM and other air pollutants are by using trees. This study presents a feasibility study on trees as a bio-trap for APM. Road-side areas were chosen as the site of interest. Traffic counting was done on the site in order to investigate the loading density of APM during the sampling day. Cumulative deposited dust of tree leaves then were weighted in order to assess their suitability as a bio-trap. Air sampling by MiniVol was carried out to check the concentration of total suspended solid (TSP) at the site. Leaves surface characteristic then being asses by Topper Metallurgical Microscope. Results show that leaves with rougher surface is more appropriate to trap APM compare to the smooth one.

Introduction
Air pollution can be defined as the degradation of air quality, departure from purity, and adverse environmental effects (Godish, 2004). It develops as the consequences of human activities as well as natural process which affect the atmosphere negatively. Five pollutants that get most attention and already listed as criteria pollutant in Malaysia Ambient Air Quality Guideline (MAAQG) are nitrogen oxides (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), ozone (O_3) and particulate matter with a diameter less than 10μm(PM_{10}). Malaysia has already witnessed numerous tragedies in which a lot of people suffer or died because of breathing bad air quality. As an example, during the haze phenomena in 1997, numerous people suffer from respiratory problem and the General Hospital Kuala Lumpur observed an increase from 250 to 800 cases daily (WHO, 1998). *Airborne particulate matter (APM)* was identified to contribute most on the degradation of the air quality during that incidence (Awang *et. al*, 1997). During the hit, concentration of PM_{10} was 500 g/m^3 which was five times higher than the unhealthy level (Afroz, 2003).

Despite countless preventive measures the *APM* is still a contact and credible threat. New approach should be considered to resolve such problems. One of an alternative way that is believed could alleviate the atmosphere of *APM* and other air pollutants are by using trees. In countries, elsewhere a lot of studies is already being carried out to gauge ability of their local macroflora to trap or absorb the air pollutants. However in Malaysia, study on the capability of the local trees to remove the air pollutant still scarce. One of the advantages of using trees is that it inexpensive and *widely spread*. Appropriate trees can be planted along the *road side* to trap *APM* emitted by the vehicles. While house settlements also should reserve some space or *buffer zone* that being planted with suitable trees as a shield to *APM* so that the residents will enjoy better air quality. Industries also should take similar action by planting trees in their zone to make sure not much of coarse *APM* being transported away from their territory.

Literature Review
The International Atomic Energy Agency (IAEA) has been supporting work on biomonitoring of air pollution using plant since 1997. Only 14 countries actively involve and being supported by IAEA to conduct projects with report to the bio-monitoring of air pollutants (Smodis. B and Bleise. A, 2002). A lot of projects have been carried and exhibited with excellent results. In Beijing, the trees in the central part of the city had removed approximately 1261.4 tons of pollutants from the air in 2002. The interesting part is, the air pollutant that was most removed was PM10 with the reduction amounted to 772 tons (Jun Yang *et. al.*, 2005).

A study was conducted to investigate the total removal of air pollutants by the urban trees in USA demonstrated that urban trees remove large amounts of air pollutant and improve the urban ambient air quality. Total removal of air pollutants from the cities estimated at 711, 000 metric tons (Nowak D. J., *et. al.*, 2006). Apart from trapping the *APM*, trees are already widely use in other country such as in Italy, Germany, India and China as a biomonitoring for air pollutants especially for *APM* and PM10 . The leaves of *Pittosporum tobira* are being use as indicator of airborne trace element and PM10 distribution in central Italy (G. Lorenzini et al., 2006). While in Austria, dust distribution around industrial sites was mapped by measuring the magnetic parameters of trees leaves (M. Hanesch *et. al.*, 2003).

Generally there are few mechanism involve in order for the trees to remove the air pollutant. The trees remove the air pollutants mainly by uptake via leaf stomata. Inside the leaf, gases diffuse into intercellular spaces and maybe absorbed by water films (Nowak D. J., *et. al.*, 2006). While *APM* are remove from the ambient atmosphere due to the sedimentation, impaction and precipitation process which caused the *APM* to deposit on the leaf surface (Virginia and Caroline, 1995) and reduce the concentration of *APM* in the ambient air. During rainy condition, *APM* will be washed out from the leaf surface, hence provide fresh surface to *APM* entrapment. However the total accumulated *APM* on the leaf surface varies according to the species. It is believe that the efficiency of trapping the *APM* is dependent on the *anatomical features* of the tree leaves.

Methodology

In this research, urban landscaping and road side area are given most attention. Hence four species of trees have been chosen namely Hibiscus Rosa Sinensis, Bougenvillea spectabilis, Javanica and Duranta Gold. Selections on trees/plants are base on the commonness in urban and road side area in Perlis. Apart from that, the selected trees are also in the list of National Landscape Department which has been planted throughout the country *(http:// www. kpkt. gov.my/ jln/ eng/ prog_land_dev.asp)*. Sampling area is along the road side of Persiaran Jubli Emas located in Kangar Town, Perlis. From each plant, 30 matured leaves were selected for study. The upper dorsal surface were cleaned using fine brush and marked for identification. All the leaves were left for 24 hours, 48 hours and 72 hours to allow *APM* to accumulate on their surface. At each interval, 10 leaves was detached from the trees and placed into petri dish and brought to the lab for analysis purposes. Samples of *APM* accumulated on the tree leaves will be calculated using the equation:

$W = (w1-w2)/A$,

Where W = *APM* concent (mg/cm^2),

w1 = initial weight of tracing paper,

w2 = final weight of tracing paper with dust and

A = total area of the leaf.

The individual leaf area in (mm^2) was calculated by tracing out the leaves on the graph paper. An electronic balance was used to weight the leaves while microscope was used to observe the surface image of the leaves.

Result and Discussion

The variation in dust accumulation on leaves of different plants under study is presented in Table 1. It shows that, after 24 hours of sampling time, Duranda Gold showed the lowest dust deposit followed by Hibiscus Rosa Sinensis, Ixora Coceanea and Bougainvillea. *APM* deposited on the leaves were 21.66 g/m^2, 28.02 g/m^2 71.48 g/m^2 and 73.00 g/m^2 respectively. This trend maintain after 48 hours of sampling time where Duranda Gold showed the lowest *APM* deposit. The *APM* deposited on the Duranda Gold was increased to 26.35 g/m^2 on the second day. While for Ixora Coceanea and Bougainvillea, APM deposits were increase to 71.93 g/m^2 and 111.28 g/m^2 respectively. On the third day of sampling, *APM* accumulated on the leaves of the plants were still increase. However, Bougainvillea showed the highest ability to trap *APM*. After 72 hours of sampling time, APM deposits was up to 126.80 g/m^2 which is 73.7% increase from the first day of sampling. Hence, the trend of dust accumulation among the species was Bougainvillea > Ixora Coceanea > Hibiscus Rosa Sinensis > Duranda Gold.

Table 1: Variation of *APM* fall on leaves

Species	Day 1 (g/m^2)	Day 2 (g/m^2)	Day 3 (g/m^2)
Duranda Gold	21.66	26.35	34.33
Ixora Coceanea	71.48	71.93	88.81
Bougainvillea	73.00	111.28	126.80
Hibiscus Rosa Sinensis	28.02	30.35	33.03

Ability to trap *APM* will be different for different type of species. Physical properties of trees especially the leaf plays an important role in determining the ability of a plant to trap the *APM*. Some of the physical properties of leaf are leaf shape, leaf area, petiole length and leaf surface feature. Table 2 shows the leaf shape and petiole length of the selected sample.

Table 2: leaf shape and petiole length

Species	Leaf shape	Petiole length
Duranda Gold	Rhomboid	3.71 ± 2.41
Ixora Coceanea	Lance-shaped	1.6 ± 0.5
Bougainvillea	Spear-shaped	5.65 ± 1.55
Hibiscus Rosa Sinensis	Spear-shaped	51.09+- 13.61

From the result, it shows that petiole length of a leaf plays an important role to entrap *APM* from the air. However, excessive petiole length will decrease the ability of the leaf to trap *APM*. It happens because excessive petiole length will allow the leaf to be in great motion when the wind blows. Hence, some of the APM which already deposited on the surface tend to blown away. Moderate length of petiole seems helps a lot to trap the *APM*.

Conclusion

The physical properties of leaf of few plants were investigated in order to determine their ability to trap *APM* form the environment. Moderate length of petiole helps the leaf to trap more APM compared to the long or short petiole. We consider that instead of using macro-flora as landscaping purposes, it also can be applied as a trap for *APM* presence in the air which indirectly reduces the *APM* concentration in the ambient air.

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