IDENTIFICATION OF ORNAMENTAL SHRUBS THAT ABSORB AIR POLLUTANTS AT GREEN OPEN AREA'S,CITY OF SAMARINDA, EAST KALIMANTAN, INDONESIA

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ABSTRACT

Avenue trees, ornamental plants and shrubsare capable of removing a significant amount of air pollutants from the atmosphere and hence should be considered an integral part of any sustainable plan intended at improving air qualityIncreasing the amount of vegetation also functions as a filter and neutraliser of air pollutants.This research uses the observation method with analysis and discussion based on a qualitative descriptive approach. the research location is in a green open area that is congested with traffic in the city of samarinda.The results of the research obtained several ornamental plants that are commonly planted in every green open area, especially parks in areas with heavy traffic. These plants have been recommended as ornamental plants that can absorb air pollutants.Among them, there are 21 ornamental plants that have been recommended by the government and research results as ornamental plants that can absorb air pollutants.

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Keywords: Open Green area, air pollutan, absorbtion. ornamental shurb,

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INTRODUCTION

In Samarinda City, there has been a significant development activity in the automobile sector, It has contributed on the city's carrying capacity of air pollutants like NOx, SO_2, CO, CO_2, Pb, particles and lead in terms of sharp increase in vehicular population.The number of motor vehicles that continue to increase with the increase in emissions will also continue to reduce air quality if it is not matched by an increase in the amount of existing vegetation that absorbs pollutants [1]. The vegetation in urban areas can improve air quality, moreover in some types of vegetation which have certain characteristics greatly affect the removal of urban pollutants such as Particulate Matter (PM) and nitrogen dioxide (NO_2) from the air [2].

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Public Green Open Space includes parks which is an open land with social and aesthetic functions as a means of recreational, educational activities in urban areas. Generally, it is composed of plant vegetation, which is very important because it has effective functions such as temperature reduction, city lungs, microclimate regulation, shading, windbreaks, air filters and noise absorbers. Green open spaces have a significant impact on citizens' well-being and quality of life. As a result, the accessibility, usability, and social function of open spaces (living, recreation, and integration space) in urban environments are critical factors in meeting the diverse needs of all city users [3,4,5]. The microclimate of a city is directly influenced by green open spaces. Therefore, green open space provision must be viewed holistically; a relationship between environmental and human well-being indicators must be established. Urban greening plays an important role in reducing ambient air pollution and the temperature in areas with greenery will be cooler [6], to identify tolerant plant species that can be useful for pollution removal using tool in air pollution monitoring and in decision making during urban development and urban greening [7].

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Insufficient green open space to plant trees makes the environment and air in the city less favourable for health. The existing green open area, whether natural or artificial, are expected to provide the following benefits [8]:

1. Direct benefits (in the sense of fast and tangible), namely forming beauty and comfort (shade, fresh, cool) and getting materials for sale (wood, leaves, flowers, and fruit).
2. Indirect benefits (long-term and intangible), namely a very effective air purifier, maintenance of the continuity of groundwater supplies, and preservation of environmental functions along with all existing flora and fauna contents (biological conservation and biodiversity).

Increasing the amount of vegetation or greening by planting trees is a solution to the problem of air pollution in the factory industry, so that the concentration of dust particles around the factory decreases. Increasing the amount of vegetation also functions as a filter and neutraliser of air pollutants so that it can be used as a bioindicator for monitoring air quality, as well as a producer of oxygen (O_2) which is needed by living things. Mitigation of air pollution by vegetation / plants can be done through 2 (two) processes, namely the process of absorption and adsorption [9]. Plants will absorb and adsorb pollutants produced through the leaves. Plants play an effective role in absorbing air pollutants and are able to clean these pollutants from the air [2,4].

Various studies prove that 1 hectare of green open space filled with large trees produces 0.6 tonnes of oxygen for 1,500 residents/day (other studies say 1 large tree produces 1.2 kilograms of oxygen/day), absorbs 2.5 tonnes of carbon dioxide/year, stores 900 m^3 of groundwater/year, transfers 4,000 litres of water/day, reduces temperatures by 5°C-8°C, reduces noise by 25-80 %, and reduces wind strength by 75-80 %. In a report shown by [3,6], plants can reduce particulate levels to 64.11 µg/m^3 in areas with plants from 448.76 µg/m^3 in areas without plants. [7] affirmed that plants could muffle noises, regulate microclimate, absorb air pollution such as gases (CO, NOx, SOx, Hydrocarbon), lead particle (Pb), and adsorb dust particles. Every plant has an unprecedented level of sensitivity in absorbing and accumulating pollutants.

To absorb air pollutants, plants must accomplish the following criteria: (a) having fast growth,

(b) growing along the year, (c) having dense leaves mass and stem, and (d) possessing haired leaves. Moreover, plants can effectively decrease the pollutant particles as long as they have high trichomes or furry, jagged, or scaly leaves. Furry leaves having rough surfaces could adsorb dust particles flying in the air [3, 8,10]. Meanwhile, the surface of hairy leaves could trap dust and soot effectively, as indicated by dirty leaves in some areas with air pollution cases. Plants with coarse or furry leaves could deposit lead better than the ones with slick leaves. Evergreen plants are recommended for adsorbing particles and dust[1,3].

METHODE

This research is a type of qualitative research, process of research uses the observation method is an investigation that is carried out deliberately systematically using the senses of several events that occur or take place captured at the time the event occurs. with a discussion based on a qualitative descriptive approach. The data used in this study were obtained by making direct observations to the areas that were used as objects of research. In addition, observation of libraries that support research activities is also carried out. Analysis and discussion are descriptive with literature studies through the study of literature that supports the discussion.

Research Location

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Comment [DO25]: I suggest that the authors redo and revise the introduction. Let them begin with global , regional and national studies before zeroing on the site of current study and giving background information about the site of study

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Comment [DO27]: This method is not clear and relevant for this type of study. If the method is not clear it gives the impression that no research was done. How can you observe plants absorb and adsorb pollutants from the atmosphere using observation through senses? To prove to the readers that shrubs in the park absorbed air pollutants , the authors must show us the laboratory experiment that was carried out on possibly plants leaves or other parts to show pollutants uptake or removal. This experimental exercise is what can be supplemented with long term observation with proper monitoring tools. If the authors wants to maintain this narrative then let them revise the title of this study. The first impression of the title is that the study followed some quantitative approach which is not the case.

Samarinda Cityas the provincial capital, East Kalimantan Province has several public green open spaces, which are built in areas of heavy traffic including Samarendah Garden, Smart Garden, True Garden, Urban Forest, Lantern Garden. The park is which as a whole covers <0.2% of the urban area of the city of samarinda. The Google Review application, created a rating system called Rating Review, according to open reviews by Google Review in 2018-2021 Samarendah Park scored 4.3 out of 5. 62% of total reviews gave 5 points, 21% of total reviews gave 4 points, 12% of total reviews gave 3 points, 2% of total reviews gave 2 points, and 2% of total reviews gave 1 point..

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RESULT AND DISCUSSION

Nationally, urban trees and shrubs (hereafter referred to collectively as "trees") offer the ability to remove significant amounts of air pollutants and consequently improve environmental quality and human health. Trees remove gaseous air pollution primarily by uptake via leaf stomata, though some gases are removed by the plant surface. Once inside the leaf, gases diffuse into intercellular spaces and may be absorbed by water films to form acids or react with inner-leaf surfaces [10]. Trees also remove pollution by intercepting airborne particles. Some particles can be absorbed into the tree, though most particles that are intercepted are retained on the plant surface. The intercepted particle often is resuspended to the atmosphere, washed off by rain, or dropped to the ground with leaf and twig fall. Consequently, vegetation is only a temporary retention site for many atmospheric particles.Accordingly, planting trees becomes the solution for controlling the number of dust particles and gas pollutant concentrations. Linden et al [2] proved that Trichome was a type of plant that could absorb particulate matter (PM) within the size span of 2.5–100µm. The number of particles being adsorbed per area unit of the leaf differs depending on the sample collection location. The leaves in a relatively unpolluted area indicated the lowest density of particles [5].Plant leaves will absorb and adsorb the resulted pollutants [11]. Thus, plants hold influential roles in absorbing air pollutants and clean up the air from certain pollutants. Therefore, plants that will be used as the bioindicator of air pollution must effectively absorb the relatively significant number of air pollutant gases without physiological disturbances.

1. Chinese Evergreen (*modestumaglaonema*) often called perennial herbs. It will grow even better with less water and minimum light. It is an excellent air purifier, filtering out air toxins such as benzene and formaldehyde.
2. Snake Plant (*Sansevieria trifasciata*), this plant has an amazing ability to absorb formaldehyde, nitrogen oxides and various other chemicals present in the air. One mature plant with 4/5 leaves can refresh the air in a 20 sq m room. This plant can absorb 107 types of toxins including air pollution. Sansivieria is able to absorb 107 elements in air pollution, compounds that can be absorbed by this plant includeah formaldehida, chloroform, bennea, xylene, dan trichloroethylene.
3. Marginata (*Dracaena marginata*),This plant, which has thin, shiny leaves with red edges, is mesmerising. Not only does it remove formaldehyde and benzene from the air, it can also filter out other toxins present in the air.
4. Sirih BelandaThis monocotyledonous plant is capable of absorbing toxins and pollution indoors, and is well known for its benefits as an absorber of toxins found in cigarette smoke. Dutch betel is very effective in absorbing Benzene. In just one day, this plant can absorb 54% formaldehida and benzene from a total of 0.156 ppm.
5. Lidah Buaya (*Aloe barbadensis*)atau Aloe Vera capable of filtering gaseous emissions of toxic hazardous materials,as an absorbent of indoor pollutants. Formaldehyde is one of the three main compounds of harmful indoor toxins that are the largest in

number, according to research by the United States Space Agency (NASA) two other compounds of indoor pollutants are bensene and trichloroethylene.

6. Peace Lily (*Spathiphyllum*)helps eliminate benzene and formaldehyde, and is known to reduce indoor toxins that can cause cancer. Peace Lily is great at cleaning the air.
7. Silver birch (*Betula pendula*) can remove PM2.5 with an effectiveness of 78.60% with a measurement frequency of 3 hours.
8. Pucuk merah (*Syzygium oleana*) known to have an APTI (Air pollution tolerance index) value of 16.6, this means that red shoots have a sensitive response and can be used as an environmental bioindicator.
9. Paku Pedang (*Nephrolepis exaltata*)is one of the plants known as a useful plant to help make indoor air clean and remove pollutants. This plant is able to neutralise pollutants absorbed by its leaves. Based on the results of research by Rahardja (2017), it is stated that Paku Pedang has the ability to filter exposure to chemicals, especially Volatile Organic Compound (VOC).
10. Bunga Kertas (*Bougainvillea*) this plant has a high adaptability to air pollution. The APTI score for Paper Flower absorption touches 28.2, which means that this plant can relatively tolerate and fall into the category of plants that can survive in fairly polluted conditions.
11. Lidah Mertua (*Sansevieria*sp)can absorb harmful pollutant gases such as carbon monoxide, benzene, formaldehyde, and carbon dioxide up to 46%. Tongue-in-law leaves are able to absorb 107 types of harmful elements including chloroform, benzene, xylene, formaldehyde, and trochloroethane, this plant is naturally able to combat Sick Building Syndrome.
12. Sirih gading (*Epipremnum aureum)*also called golden pothos or devil's ivy is a flowering plant of the Araceae family. This plant is native to Australia, Malenesia (including Indonesia), Indochina, Japan, China, and India. So it can be said that this is a plant native to Indonesia. Although it is an emphytic and semi-vasive plant, it is good at being an indoor air purifier and absorbing formaldehyde toxins and various other pollutants.
13. *Philodendron oxycardium*, has the ability to clean the air of pollutants. Although its leaves are poisonous, it has the ability to absorb almost all types of pollutants in the air.
14. Sri rejeki (*Aglaonema* sp.) also known as Chinese fir, is a plant that is easy to maintain. It has leaves with a variety of attractive patterns and colours. The leaves are lance-shaped with variations in grey, green and silver. Sri rejeki plays a role in cleaning the air and removing air pollutants such as Carbonmonoksida, benzena, formaldehida dan trikloetilen.
15. Bougenvil merah (*Bougainvillea glabra*) is an ornamental plant that can absorb various pollutants that cause air pollution. This plant is included in the accumulator plants because it can accumulate lead by 29,060 mg/kg, besides that it also has a high potential to absorb NO2 toxins that cause pollution. In addition, it functions as an absorber of air pollution, such as dust and other harmful particles produced by motorised vehicles.
16. Wali songo (*Schefflera*)able to neutralise air pollution in the surrounding environment, reducing air pollutant particles in the room so that it can be used as an air biofilter.
17. Bunga Tasbih (*Canna indica* L) used as a phytoremediation plant to remove several heavy metals such as Pb (lead), Zn (zinc), and Cr (chromium), and through a phytostabilisation process to remove Ni (lead) and Cd (cadmium).

18. Puring (*Codiaeum varieggatum*) able to absorb significant amounts of Pb and SO_2 from air pollutants.
19. Melati jepang (*Pseuderanthemum retuculatum*) able to absorb toxins (pollutants) and CO_2 in the air and produce oxygen so that the air becomes fresher.
20. Kencana Ungu (*Ruellia simplex*)is a shrub type plant that has a high potential to be an absorber of lead (Pb) in the air because it is able to accumulate greater in absorbing Fe, Mn, Pb, and dust levels with the highest levels.

Plants that function as absorbers (into the stomata or leaf surface) and absorbers (attached to the leaf surface) of dust or pollutants in the air produced are needed to reduce the height of pollutants produced by motorised vehicles. The ability of plant leaves to absorb pollutants is influenced by leaf morphological characteristics, such as leaf size and shape, the presence of hairs on the leaf surface and also leaf texture [1,3,12]. The criteria for vegetation that can absorb dust well include having a rough, grooved, hairy and trichome leaf surface, leaves that are fragrant and also widened, dense and tight plant crowns, rough and prickly texture of the bark of stems and twigs, and a dense density of twigs [6,9,13].

Hairy and trichome leaf surfaces are able to absorb more dust than leaf surfaces that are not hairy and trichome. Airborne dust can adhere to hairs and trichomes located on the leaf surface. Fragrant and expanded leaves are more effective in absorbing pollutants because they have a larger leaf surface area.Plants that function as absorbers (into the stomata or leaf surface) and absorbers (attached to the leaf surface) of dust or pollutants in the air produced are needed to reduce the height of pollutants produced by motorised vehicles. The ability of plant leaves to absorb pollutants is influenced by leaf morphological characteristics, such as leaf size and shape, the presence of hairs on the leaf surface and also leaf texture [1.4.9.14]. The criteria for vegetation that can absorb dust well include having a rough, grooved, hairy and trichome leaf surface, leaves that are fragrant and also widened, dense and tight plant crowns, rough and prickly texture of the bark of stems and twigs, and dense twigs [15].

Hairy and trichome leaf surfaces are able to absorb more dust than non-hairy and trichome leaf surfaces. Airborne dust can stick to the hairs and trichomes located on the leaf surface. Fragrant and expanded leaves are more effective in absorbing pollutants because they have a larger leaf surface area [10,16].

The selection of plants for particulate adsorber in the air must consider the following characteristics: (1) the plant must be able to topple leaves in a certain period. This property is necessary because leaves shedding will encourage the growth of new leaves, which can filter particulate. As a result, the plants will not die because the particulates cover their leaves surfaces; (2) the plant must have shady and dense tree-crown; (3) the plant must have high resistance as the particulate accumulated on the leaf surface will disturb photosynthesis [2,5,17].

Ornamental plants have been found to accumulate heavy metals like cadmium and nickel, with different species showing varying levels of accumulation potential throughout the year. Furthermore, some ornamental plants have been identified as effective in absorbing air pollutants, with differences observed between plants growing in industrial areas and those in cleaner environments. Overall, ornamental plants can play a crucial role in phytoremediation efforts by absorbing and accumulating pollutants, thereby contributing to environmental health and sustainability [2,3,18].

CONCLUSION

Ornamental shrubs have been widely used as air pollutant cleaners, especially in motorised areas.Shrubs play important roles in monitoring and maintaining the ecological balance by actively participating in the cycling of nutrients and gases like carbon dioxide, Oxygen and also provide enormous leaf area for impingement, absorption and accumulation of pollutants to reduce the pollution level in the air environment.

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Comment [DO32]: Which ornamental plants were able to absorb air pollutants? And which air pollutants were these?

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