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Indoor Air Pollution and Bio-Monitoring Device

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Abstract:
The air is primarily polluted due to anthropogenic sources like combustion, sewage and waste disposal, mining, agricultural practices (use of pesticides, fungicides, fertilizers etc.) and vehicular wear and tear. All of these generated pollutants include heavy metals, NO_2, CO, SO_2 and SO_3 etc. These pollutants disrupt the structure of the ecosystem, endanger the health of people and animals and cause plant diseases. The use of bio-monitors, make it simple to study important primary data about diversity, as they are able to detect the quantity and quality of pollutants. Many organisms are used to monitoring air pollution as bio-indicators. Lichen is an excellent bio-indicator for monitoring air pollution. This study investigates the use of lichens as bio-indicator and bio-monitor of air pollution. No chemical testing is necessary in this procedure; the air quality is ascertained solely by physical examination (the size and color intensity of lichens). The monitoring kit makes it simple to measure the indoor air quality. It is important to take preventative steps to keep individuals healthy, especially the elderly and children.

Keywords: Air pollution, Indoor air quality, Lichen, Bio-monitoring.

Introduction:

Air pollution is continuously rising as human civilization advances. The degree of this pollution has surpassed the tolerance of living organisms at the beginning of the third decade of the 21st century. This pollution is not only limited to the outdoors, but it is also polluting our life-giving breath inside the room, from which we are suffering from respiratory disease, skin disease etc. Air pollution is mostly caused by combustion, mining and melt process, industrial waste, smoking, sewage and waste disposal, uncontrolled use of pesticides and fungicides, agricultural fertilizers and vehicular wear and tear. These fields emitted pollutants that reduce the quality of the air. In our country, urban dwellers are more affected by air pollution than those in rural areas. The majority of air quality research has been conducted in outdoor environments, whereas very little research has been done on indoor air quality (IAQ) and its effect on human health and wellbeing. Many individuals believe IAQ is better than outdoor air quality (OAQ) in cities. Sometimes, indoor concentrations of certain pollutants and the resulting human exposures are higher than their outside counterparts, greatly impacting the air we breathe. IAQ is characterized by a number of compounds that can come from both indoor and outdoor sources. Among these, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), SO_2, SO_3, NO_2, CO, heavy metals may have an effect on human health. Indoor air pollutants are the cause of health problems, particularly for infants, the elderly and persons with disabilities. In a day, these individuals spend over 90% of their time at home.

Lichen at a glance: Lichens are a tiny group of plants with composite thalloid characteristics. It is composed by filaments of a fungus encircling a simple photosynthetic organism, typically a cyanobacterium or green algae. The fungus is referred to as a mycobiont and the photosynthetic organism is referred to as a photobiont. We refer to cyanobacterial phycobionts as cyanobionts and algal photobionts

as phycobionts. The fungal companion absorbs and retains water and the photosynthesizing partner produced carbohydrate by photosynthesis. Around 400 genera and 15000 species of lichens are found all over the world. Lichens have thalloid plant bodies that vary in shape. Typically, they are grey or grayish green, but some are brown, orange, yellow or red in color. The plant body develops on various surfaces, such as leaves, dead logs, tree bark, naked rocks etc. They thrive in forest areas with plenty of moisture and less or free pollution. They do not grow in places with a lot of pollution like industrial sites. Lichen grows quite slowly. It can grow in places where most other plants cannot since they lack roots and does not require constant water sources like most higher plants do. Four major types of lichens are distinguished based on the external morphology, general growth and nature of attachment. 1) Their branches may be small and leafless (fruticose); 2) Flat structure resembling a leaf (foliose); 3) Crust-like growth that sticks firmly to a surface like a thick layer of paint (crustose); 4) Appear as though it is powder (leprose); or other forms of growth. On the other hand, lichens can broadly categorized into three groups based on their capacity to endure in areas with polluted air such as i) Sensitive to the pollutants: These lichens can only thrive in a air pollution free place i.e. a) *Parmelia caperata* (foliose), b) *Physcia aipolia* (foliose) or any other lichens which can thrive only air pollution free place. ii) Moderately tolerant to the pollutants: These lichens can thrive only in a place of low air pollution i.e. a) *Plastimatia glauca* (foliose), b) *Ramilina farinacea* (fruticose) or any other lichen which can thrive in a place of low level air pollution, iii) Highly tolerant to the pollutants: These lichens can live in places with relatively high air polluted area i.e. a) *Arthopyrenia nidulans* (crustose), b) *Diplaicia canescens* (crustose) or any other lichens which are tolerant to high level of air pollution.

Use of lichen as bio-monitor of IAQ: Lichens cannot prevent accumulation of pollutants if they are exposed to polluted air. Lacking a cuticle and stomata, lichen may absorb gases and aerosols across the entire surface of the thallus from which it can easily diffuse to the photobiont layer. Since lichens lack roots, its principal elements come from the air and the elemental levels in lichens frequently reflect the accumulated composition of ambient air. Dry deposition, gaseous absorption, fog and haze are the process that leads to atmospheric deposition. Lichens are therefore used in environmental research and it emphasize their potential as efficient bio-monitors of atmospheric quality. Different lichen species exhibit varying degrees of sensitivity to particular air pollutants since single lichen is not equally sensitive to different pollutants. Lichen's sensitivity to air pollution is directly correlated with the energy requirements of the mycobiont. Therefore, the more dependent, the mycobiont is on the photobiont, the lichen is more sensitive to air pollution. When the lichens are exposed to polluted air, the photobiont may expend metabolic energy to repair its cellular structure otherwise using that energy to maintain its photosynthetic activity, therefore, the mycobiont has less metabolic energy available. When the balance between the mycobiont and the photobiont is altered, the symbiotic relationship may break down. As a result, the accumulation of toxic chemicals and altered nutrition that favors one symbiont over another may both contribute to lichen deterioration. The relationship between air pollutants and lichens has been utilized to monitor the quality of the air.

Monitor the indoor air quality with the help of lichen: There is a dearth of suitable measuring devices, which contributes to the challenge of long-term air quality monitoring and assessment in indoor environments. Though, the instrumental measurements based on chemical-physical procedures using stationary or mobile automatic gauges are actually the most significant sources of information on indoor pollution. These measurements undoubtedly provide useful information, but their usage is sometimes time-limited due to their high cost. In this regard, bio-monitors can help with long term monitoring in a

more economical manner. Bio-indicators function as early warning indicator of the rapid and straight forward impact of pollutants which provide growth of organisms and sensitive response to environmental changes. Being poikilohydric organism, lichens have the potential to be used as bio-monitor of IAQ. It is possible to make a monitoring device using lichen at a very low cost, and with the help of this device, the level of indoor air pollution can be easily determined. Temperature, humidity and pollution-free air is the fundamental requirements for growth of a lichen. It is possible to satisfy the first two of these conditions, the degree of growth of the lichen will depend on the intensity of the third condition (pollution of air). That is, if the degree of indoor air pollution is too high, the lichen will stop growing and due to lack of chlorophyll present in the cells of photobiont will either cause the lichen to die or its color to fade. If the indoor air quality is quite normal, the lichen will grow normally and its normal color will be maintained. On the other hand, lichen will develop very slowly and have a nearly normal color if the indoor air quality is intermediate.

The measuring kit and how to use the kit:

The Measuring Kit: The measuring kit consists of three parts; i) Measuring device ii) Hydrating bottle and iii) Measuring scale.

Measuring device: The apparatus is composed of a tray and selected lichens.

A) Tray: A 60cm long and 30 cm wide plastic tray has been encircled with a 2 cm thick and 5cm wide stripe of sponge.

B) Selected lichen: One lichen may be select from each of the 1st, 2nd, and 3rd groups (mentioned in the middle portion of the previous paragraph namely “Lichen at a glance”), which are separated based on the lichen’s capacity to endure in various air polluted environments. The three species of lichen should be collected from dead-bark of host plant of any pollution-free place along with substrates and then these three types of lichen should be stuck on the plastic tray side by side with the help of synthetic adhesive.

Hydrating bottle: A water-filled 200 ml bottle should be made suitable for spraying by attaching a spray nozzle.

Measuring scale: To measure the lichen’s length and color, there should be two kinds of scales used, i.e. A) color measure strip and B) length measure scale.

A) Color measure strip: A 30 cm long by 3 cm wide sheet of white color paper can be transformed from white to dark green by gradually increasing the green color’s density. Next, use a pencil to divide the stripe into ten equal sections, then write the digits 1 through 10 on each section.

B) Length measure scale: A lichen’s length can be measured using a 15 cm long scale that is graded in milimeter per centimeter.

How to use the Measuring Kit: The measuring device (tray and lichens) has been placed in the living room at a height of 1.5 meter or ranging from 1 to 2 meters above the ground/floor. The duration of exposure in an indoor environment is usually 8 to 10 weeks for the purpose of assessing indoor air quality. The lichens were periodically sprayed with water once a day to dehydrate them while they were exposed indoors. During the spraying, the sponge stripe that surrounded the lichens also hydrated to keep the temperature and humidity levels stable at the lichen’s immediate surroundings. Every lichen’s length and breadth should be noted in notebook on the day device is installed and then bi-weekly after that. Also, the color-band number should be listed next to the size of the particular lichen by matching the color of the lichens with the paper stripe. By calculated the severity of air pollution in the room, the following four

categories can be separated; A) Normal air quality, B) Low intensity air pollution, C) Moderate intensity air pollution, and D) High intensity air pollution.

A) Normal air quality: After the stipulating time period (eight to ten weeks), if it is found that every lichen is alive, has grown and has the same color of a higher concentration of green, then it should be understood that the air in that room is free from pollution and that living there won't be harmful to our health. In this condition repeat the same procedure for eight to ten weeks.

B) Low intensity air pollution: If the sensitive lichen dies within the specified time frame but both the moderately tolerant and tolerant lichens live and their growth and color is normal, it should be recognized that the room's air is somewhat polluted and this environment might lead to illness of a person.

C) Moderate intensity air pollution: If, after the considerable days it is found that the sensitive and moderately tolerant lichens have perished and only the tolerant lichen remains with normal color and growth, then it should understand that the air in the room is polluted enough. A room with such air pollution poses a health risk.

D) High intensity air pollution: If, all the lichens die within ten weeks or if only the tolerant lichen survives but stops growing and turn discolored, at that point it will be clear that the air in the residence is extremely polluted and not suitable for human occupancy.

Conclusion:

The level of air pollution is continuously rising in almost all developing countries. In some of the most populated cities of the countries, the degree of pollution is more than what human can tolerate. Villages in these countries are also not free from air pollution. These air pollutants are not only confined to the source but also polluted the indoor air. Mainly infants, old and disabled people are suffering from incurable diseases due to inhale this polluted air. It is costly to measure indoor air pollution using the physical-chemical method, and the government does not routinely monitor the indoor air pollution level. Thus, the aforementioned monitoring kit should makes it simple for general people to assess the level of air pollution in their dwelling, if needed. Long-term exposure to polluted air, various chemical pollutants that entire into the cells of the lichen remains free or in compound form. The physiological functions of lichen are hindered by these pollutants, which can also prevent them from growing normally and ultimately cause them to die. All these toxic chemicals present in lichen cells can be identified with the help of chemical tests and attempts can also be taken to prevent their emission and source. Therefore, pollution-free air will be easily accessible.

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