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Accumulation of Sulphate and Nitrate in IMLI (Tamarindus indica L.) Tree Bark as Indicator of Atmospheric Pollution at Indore (M.P.) India

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***Abstract*—** Bio-monitoring of air quality in Indore city was investigated by analyzing the accumulation of sulphate and nitrate in the bark of *Tamarindus indica* L. by measuring their concentration using a double beam spectrophotometer. The samples were taken from different polluted areas (mixed (MPA), vehicular (VPA), industrial (IPA), and control sites (LPA)) in different seasons. The results of the present study show sulphate and nitrate accumulation more in the rainy season at all pollution areas while maximum sulphate accumulation was found at IPA i.e. 36.9 mg kg -1 whereas it was 27.3 mg kg -1 at MPA for nitrate in the rainy season. The minimum sulphate was 16 mg kg -1 at VPA in the summer season while it was 14.8 mg kg -1 for nitrate at MPA in the winter season. A maximum % increase for sulphate was found at IPA in the summer season i.e. 88.03 % while it was 67.48 % in the rainy season at MPA for nitrate respectively. The research also confirms the suitability of *the Tamarindus indica* tree as a suitable bio-indicator and will help to reduce the gaseous as well as particulate pollution in the city.

Keywords— Tamarindus indica L., Sulphate and Nitrate accumulation

I. INTRODUCTION

During last 12 to 15 years it has been felt seriously that ambient air quality has deteriorated at an alarming level. In many national and International reports, the capital of country, Delhi always remained in merit list of world polluted cities. Initially the problem of air pollution was confined to metro cities of country but a report of Env. forest and wildlife department (2004) showed that in 50 cities of country air pollution is rising rapidly and at present in more than 120 cities the air pollution is at dangerous level **[1].** A report of Central Pollution Control Board (2010) indicates that out of 88 industrial areas 75 are badly polluted **[2].** In 2016 WHO published a list of 20 most polluted cities of world in which 13 cities were from our country. State of Global air 2017 report mentioned that in the year 2015 about 42 lakhs of peoples were killed due to air pollution in which 52% were from India and China **[3].** More than 10 lakh of peoples dies every year in our country due to air pollution. In Env. Performance Index, among 180 countries, India is at 177 rank and it is among five most polluted countries in world.

A plant growing in its natural habitat is generally exposed to fluctuating levels of different pollutants. This level may exceed at any time to the level demonstrated to cause injury **[4].** In case of trees not only foliar surface but bark also absorb and accumulate the air pollutants. Monitoring using bark represents an interesting and economic alternative to other methods, particularly when large areas have to be covered and air monitoring is not frequent.

II. RELATED WORK

Many ecologists made use of tree bark as a bioindicator **[5 - 15]**. Studies on deposition of sulphate, nitrate and lead are getting importance in monitoring air quality. Many authors found a correlation between the level of SO_2 in air and bark pH **[16 – 18]**. Deposition of heavy metals in bark was also investigated by many workers. However, only few efforts have been made to assess and evaluate the impact of air pollution on plants at Indore city. Hence the present work is undertaken for quantitative analysis of sulphate and nitrate in *Tamarindus indica*.

III. METHODOLOGY

EXPERIMENTAL
STUDY AREA
Pollution areas

Pollution areas were selected on the basis of sources and nature of pollutants. Four areas were selected as mentioned below :-

- **Mixed pollution area (MPA) : -** This area is located in scheme No.78.
- **Vehicular Pollution area (VPA) : –** This sampling AREAS is a part of Eastern ring road between Khajarana to Bengali square.
- **Industrial pollution area (IPA) : -** Sanwer Road, Industrial cluster situated on Ujjain road.
- **Low pollution area (LPA) : –** Ralamandal village. It is located in Indore tehsil of Indore district and is situated 10 km away from Indore in north east direction. This was considered as reference area for comparison.

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MATERIAL

Bark is the main material for present work. Bark samples of *Tamarindus indica* L. was collected in triplicate in all three seasons i.e. rainy (August), winter (December) and summer (April) in years 2015 and 2016. About 2 to 5 mm thick chips of bark was removed by sharp knife from all the directions around the tree at a height of 5-6 feet above the ground level and placed in a zipper poly bag. For uniformity trees of same height, canopy and main trunk size were selected at all polluted area. Bark sample of *Tamarindus indica* was also collected from low polluted area which serves as control or reference for comparison. The sample was brought in the laboratory for the further analysis.

METHODS

Quantitative estimation for pollutant deposition

Sulphate estimation

For the estimation of Sulphate - Sulphur, standard method given by Patterson (1958) was adopted **[19]**. The oven dried samples of bark were ground and passed through 72 mesh sieve. 300 mg sieved bark powder and 0.1 ml selenium dioxide (SeO_2) solution was digested using a mixture of 10 ml conc. HNO_3 and 1 ml of conc. HCl. After filtering the digested material, 10 ml of 3% glycerol was added and volume was made upto 100 ml with distilled water. To this solution 5 ml of 2% barium chloride ($BaCl_2$) solution was added to precipitate sulphur as barium sulphate ($BaSO_4$). The optical density was measured at 420 nm on a UV spectrophotometer 1800. The amount of sulphur was determined by freshly prepared standard curve with potassium sulphate solution.

$$SO_4^{2-} \text{ content in sample} = \frac{\text{Conc. obtained from curve}}{\text{Weight}} \times \text{dilution factor}$$

➢ **Calibration curve**

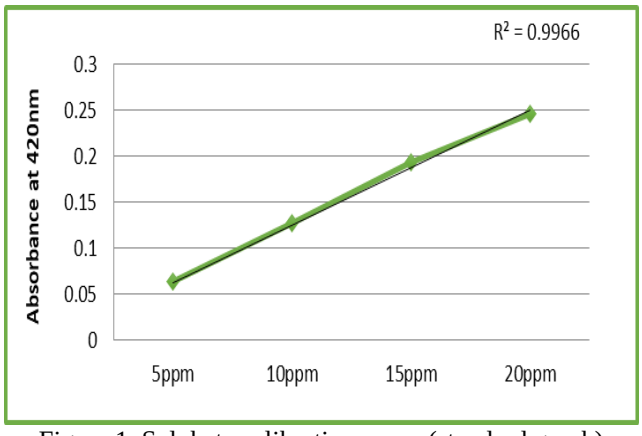

Figure 1. Sulphate calibration curve (standard graph)

Nitrate estimation

The nitrate contents in bark powder was determined by using rapid colorimetric method given by Cataldo et al. (1975) **[20].** To 100mg of dry sieved bark powder in test tube 10 ml of distilled water was added. The suspension was incubated at 45°C for one hour. After incubation, the sample was centrifuged at 5000 rpm for 15 minutes. The residue was discarded and the supernatant was taken for nitrate estimation. In test tubes, 0.2 ml supernatant mixed thoroughly with 0.8 ml of 5% (w/v) salicylic acid (prepared in concentrated H_2SO_4). After 20 minutes at room temperature, 19 ml of 2N NaOH were added slowly to raise the pH above 12. Samples were brought to room temperature and measure the absorbance at 410 nm was determined on a double beam spectrophotometer (UV spectrophotometer 1800). The amount of nitrate was calculated with the help of a standard curve obtained by taking different concentrations of KNO_3.

$$NO_3^{1-} \text{ content in sample} = \frac{\text{Conc. obtained from curve}}{\text{weight}} \times \text{dilution factor}$$

➢ **Calibration curve**

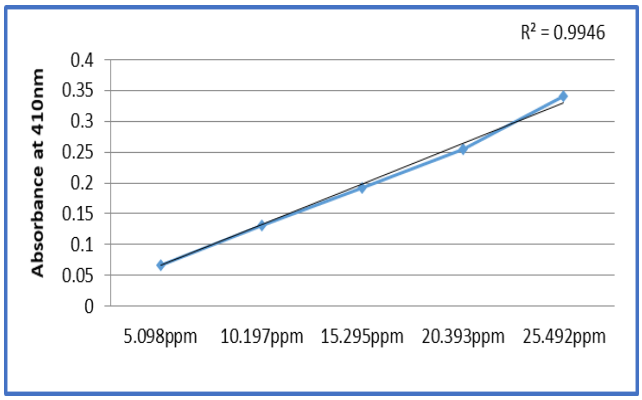

Figure 2. Nitrate calibration curve (standard graph)

IV. RESULTS AND DISCUSSION

Table 1 Sulphate accumulation in bark extract of *Tamarindus indica* growing in different Pollution areas of Indore city in different seasons (mg kg^{-1} dry weight)

Pollution areas	Year	Rainy	Winter	Summer
LPA	2015	25.2	14.8	12.0
	2016	26.3	19.0	11.3
	AV±SD	**25.7±0.8**	**16.9±3.0**	**11.7±0.5**
MPA	2015	33.6	21.4	18.9
	2016	34.3	25.3	16.3
	AV±SD	**34.0±0.5**	**23.4±2.8**	**17.6±1.8**
VPA	2015	33.5	25.4	12.4
	2016	37.3	27	20.1
	AV±SD	**35.4±2.7**	**26.2±1.1**	**16.3±5.4**
IPA	2015	39.4	27.5	23.7
	2016	34.3	29.3	20.3
	AV±SD	**36.9±3.6**	**28.4±1.3**	**22.0±2.4**

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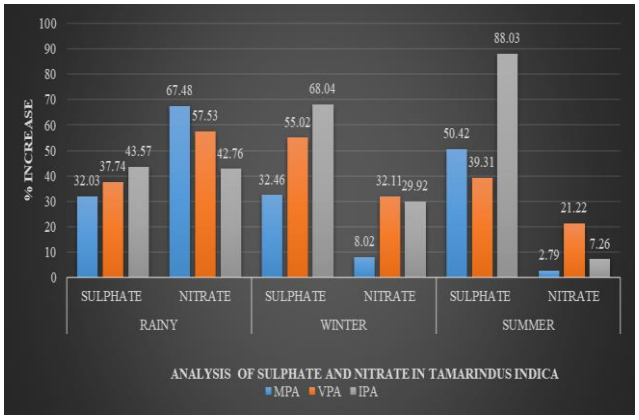
Table 2 Nitrate accumulation in Bark extract extract of *Tamarindus indica* growing in different Pollution areas of Indore city in different seasons (mg kg^{-1} dry weight)

Pollution areas	Year	Rainy	Winter	Summer
LPA	2015	14	11.8	16.9
	2016	18.5	15.5	18.9
	AV±SD	**16.25±3.2**	**13.7±2.6**	**17.9±1.4**
MPA	2015	29.2	15.1	17.3
	2016	25.3	14.5	19.5
	AV±SD	**27.3±2.8**	**14.8±0.4**	**18.4±1.6**
VPA	2015	24.9	19.7	18.9
	2016	26.3	16.5	24.5
	AV±SD	**25.6±1.0**	**18.1±2.3**	**21.7±4.0**
IPA	2015	19.3	19	20.4
	2016	27	16.5	18
	AV±SD	**23.2±5.4**	**17.8±1.8**	**19.2±1.7**



GRAPH 1

Discussion

Plants being constantly exposed to environment absorb and integrate air pollutants on their foliar and bark surfaces. This causes changes in their physico – chemical characters. In case of bark sulphate and nitrate content has been found to be changed. From above table 1 and 2 sulphate and nitrate was found to be higher at all pollution areas in comparison to reference area. Among three polluted area sulphate and nitrate accumulation was more in rains in comparison to winter and summer. The results of present study shows sulphate and nitrate accumulation more in rainy season at all pollution areas while maximum sulphate accumulation was found at IPA i.e. 36.9 mg kg^{-1} whereas it was 27.3 mg kg^{-1} at MPA for nitrate in rainy season respectively. As shown in graph 1 maximum % increase for sulphate was found at IPA in summer season i.e. 88.03 % while for nitrate it was 67.48 % at MPA in rainy season. The minimum sulphate was 16 mg kg^{-1} at VPA in summer season while it was 14.8 mg kg^{-1} for nitrate at MPA in winter season. It is concluded from above data that increasing trend in sulphate accumulation as observed at all the three pollution areas over LPA in all the experimental trees might be due to presence of SO_2 at pollution areas emitted by industrialization, urbanization and increase traffic density (Wolterbeek, H.Th et.al.,) **[21].** He also studied relations between sulphate, ammonia, nitrate, pH(SO_2) and 20 trace element concentrations in tree bark of the *Populus spp., Quercus spp. and Ulmus spp.* in the Netherlands and suggested the suitability of bark as a biomonitor for air pollution. With similar studies, Schulz, H et.al., **[22]** worked on Scots pine (*Pinus sylvestris*) bark in Germany, at two different sites for 28 organic & inorganic substances including (SO_4^{2-}, NO_3^-, Pb) and found the accumulation of sulphate, and nitrate on bark. In polluted areas the plants are reported to have higher sulphate content *(Reddy and Dubey, 2002),* Though in leaves but it is in conformation with our findings.

In contrast to control area (Ralamandal sanctuary) which is situated 20km away from the city. The area is not frequently affected by the vehicles and industries. The study reveals that the values of the sulphate and nitrare accumulation of bark samples of plant specie is not very high in comparison to different polluted areas at Indore city.

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