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Evaluation of Air Pollution Tolerance Index (APTI) by two species of terrestrial plants in some stations within Babylon Province, Iraq

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Abstract:

This study deals with air pollution tolerance index (APTI) and anatomical variation in leaves of two species of terrestrial plants *Ficus sp.* and *Conocarpus sp.* that have bee commonly the separated along roadsides in many stations within Babylon province. APTI values of both species were less than 10 during study period which represented sensitivity of these plants to air pollution. There are Anatomical responses to pollution in the leaves of both studied species. Main adaptations included increased thickness of parenchyma cell walls with clear dark deposits in sections of *Ficus sp.* from sections of stations 2 and 4 which represent polluted stations. *Conocarpus sp.* main adaptation included stomata increased in density and decreased in size with high tannin cells content in heavy polluted station.

Key words: air pollution, APTI, *Ficus sp.*, *Conocarpus sp.* leaf anatomy

Introduction:

Plants are stationary and continuously exposed to air pollution, thus using them as Bio monitors and bio indicators is an important tool to evaluated the impact of air pollution [1] by studying many physiological changes in response to it. Air pollution is one of major problems that are caused by industrialization, which can effect plants both directly via leaves or indirectly through soil [2]. Many studies theorized the impacts of air pollutants on many physiological parameters like ascorbic acid content, chlorophyll, content pH of leaf extract, and relative water content which all give the value of APTI (air pollution tolerance index) [3]. Others studied the impact on leaves anatomy and described effects include changing in number of stomata and epidermal cells per unit area in leaf [4], or variation in mesophyll thickness, structure of conducting and mechanical tissue and distribution and frequency of stomata ,or dark deposition in assimilatory cells with thick walls of cells [5], or increased thickness of palisade and spongy mesophyll[6].Many researchers studied APTI in terrestrial plants like work of Salman[7] which was on some plants in Babylon Governorate This study aim at evaluation APTI and some anatomical change in leaves of two species of terrestrial plants within Babylon Province.

Material and Methods:

Four sites selected within Babylon Governorate the first was near Tohmasia bridge (N 32 25 955, E 44 19 269), the second was from roadside of Hilla – Baghdad high way near Al-Neel region (N 32 33 198, E 44 26 690),while the third site was in Aufy region N 32 25 955, E 44 19 269) and last site was in Abygkarak region (N 32 31 971, E 44 20 454). Leaves of *Ficussp sp.*. and *Conocarpus sp.* were collected monthly from December 2015 to February 2016 to study APTI and anatomical adaptations to air pollution. The total chlorophyll was estimated by extracted with acetone 80% according to Arnon [8]. A relative leaf water content determined is based on the method that was described by Singh [9]. Leaf extract pH is determined by homogenize 5 gm of fresh leaves with 10 ml of distilled water [3]. Ascorbic acid content estimated with potassium permanganate titration method [10]. Anatomical analysis was studyed by free hand sections that were performed using a razor blade and finally stained with fast green and safranin stains respectively to study by microscope[11].

Results and Discussion:

The biochemical parameter and the APTI values of studied plant species from December 2015 utile February 2016 at four different study sites are shown in tables 1, 2, 3 respectively.

Table 1: APTI values of *Ficussp.* and *Conocarpus sp.*in December 2015, A.A.=ascorbic acid, Tchll= total chlorophyll, RWC= relative water content in leaf.

Plant species	Station	pH	A.A. mg/g	Tchll. mg/g	RWC %	APTI
Ficus sp.	1	7.36	0.0059	0.079	96.75	9.68
	2	6.95	0.0070	0.229	91.83	9.19
	3	6.95	0.0057	0.121	97.10	9.71
	4	7.13	0.0044	0.224	88.45	8.85
Conocarpus sp.	1	7.80	0.0070	0.079	87.79	8.79
	2	6.86	0.0066	0.248	91.41	9.15
	3	6.79	0.0048	0.167	89.03	8.91
	4	6.98	0.0040	0.148	94.45	9.45

Table 2: APTI values of *Ficus sp.* and *Conocarpus sp.*in January 2016, A.A.=ascorbic acid, Tchll= total chlorophyll, RWC= relative water content in leaf.

Plant species	Station	pH	A.A. mg/g	Tchll. mg/g	RWC %	APTI
Ficus sp.	1	7.67	0.0154	0.245	94.52	9.46
	2	6.62	0.0053	0.124	89.52	8.96
	3	7.48	0.0022	0.071	66.26	6.64
	4	8.31	0.0066	0.219	92.68	9.27
Conocarpus sp.	1	6.92	0.0066	0.181	88.53	8.86
	2	6.69	0.011	0.161	77.97	7.80
	3	6.90	0.007	0.253	75.64	7.57
	4	7.72	0.0127	0.333	92.80	9.29

Table 3: APTI values of *Ficus sp.* and *Conocarpus sp. sp.*in February 2016, A.A.=ascorbic acid, Tchll= total chlorophyll, RWC= relative water content in leaf.

Plant species	Station	pH	A.A. mg/g	Tchll. mg/g	RWC %	APTI
Ficus sp.	1	8.34	0.0273	0.194	89.48	8.97
	2	7.42	0.0264	0.270	96.04	9.63
	3	7.88	0.0167	0.209	5.994	6.01
	4	8.39	0.0229	0.155	85.56	8.58
Conocarpus sp.	1	6.93	0.0119	0.169	74.14	7.42
	2	6.74	0.0158	0.232	83.46	8.36
	3	6.48	0.0255	0.251	22.05	2.22
	4	6.68	0.0145	0.141	86.95	8.71

The photosynthetic efficiency of plants species and it is strongly depending upon the leaf pH [12].Pollutants have been reported to reduce chlorophyll content [13], which agree with recorded values in this study

that recorded ranges were 0.0711 – 0.270 and 0.079 – 0.334 mg/g in *Ficus sp. and Conocarpus sp* .respectively.

Determination of water relative content (WRC) was studied to explain water status of plants. The WRC values varied from site to site and from month to month even in same species, but the smallest once was in the site 3 in February in *Conocarpus sp.* which may be related to long age of these plants in this region that older plants of this species decline in growth in this month. The WRC was higher than that recorded in other studies in same Governorates in *Conocarpus sp.*and other species [7].

The leaf extract pH values ranged between (6.48 – 7.8) for *Conocarpus sp.* which is acidity to slight alkaline, while in *Ficus sp.* range was 6.62- 8.39 and these variations may be due to the nature of leaves that *Ficus sp.* with more smooth leaves than *Conocarpus sp.* Matter allow to later to keep more parts of dust, which may be rich in acid materials [14].

Ascorbic acid is a more important substance in plants to avoid air pollution that it acts as an antioxidant. It can found in growing parts of plants [15].In this study its concentrations were very small ranged from 0.0044 – 0.0273 mg/g in *Ficus sp.* and 0.004 – 0015 mg/g in *Conocarpus sp.* Some plants used it as defense mechanism to enhance pollution tolerance [15]. Plants fall in three categories according to their sensitivity to pollutants in the meaning of APTI values, which are sensitive when APTI equal or less than 10, while above 10 refers to tolerant plants, and are capable of withstanding air pollution load of significant value [16].. According to this classification both studied species are sensitive to air pollution. The statical analysis ($p<0.05$) showed significant differences in APTI values among sites and months. The upper value of *Ficus sp.* was 9.71 in station 2 in December 2015, while the lower was in site 3 in January 2016,but for *Conocarpus sp.* was 9.45 in site 4 in December and 2.22 in site 3 in February 2016 respectively. The deference in APTI of both ornamental studied plants may be related to variations of their ability to tolerant air pollution depending on the capacity of each species to the effect of pollutants without showing any external damage [17].

Structure of the leaves has an important role in the determining of response of plants to air pollution. Plate 1 explain the leaves anatomical response of *Ficus sp.* in the different studied sites.

Main effects were increased thickness of parenchyma cell walls with clear dark deposits in both sections of Station 2and Station 4 where heavy pollutants were release by heavy vehicular emissions. This results agrees with same response of *Plantago lanceolata* leaves [5]. The pavement cells vary in their size and the smallest were in station 3. The peltate glands vary in their density and the highest was in the station 2 while the lower density was in the site 3as response to tolerant pollutant. Stomata cannot identified in studied upper surface of leaves which may be due to pollutants high concentration as it is known from some studies that pollutant decreases stomata number[18].

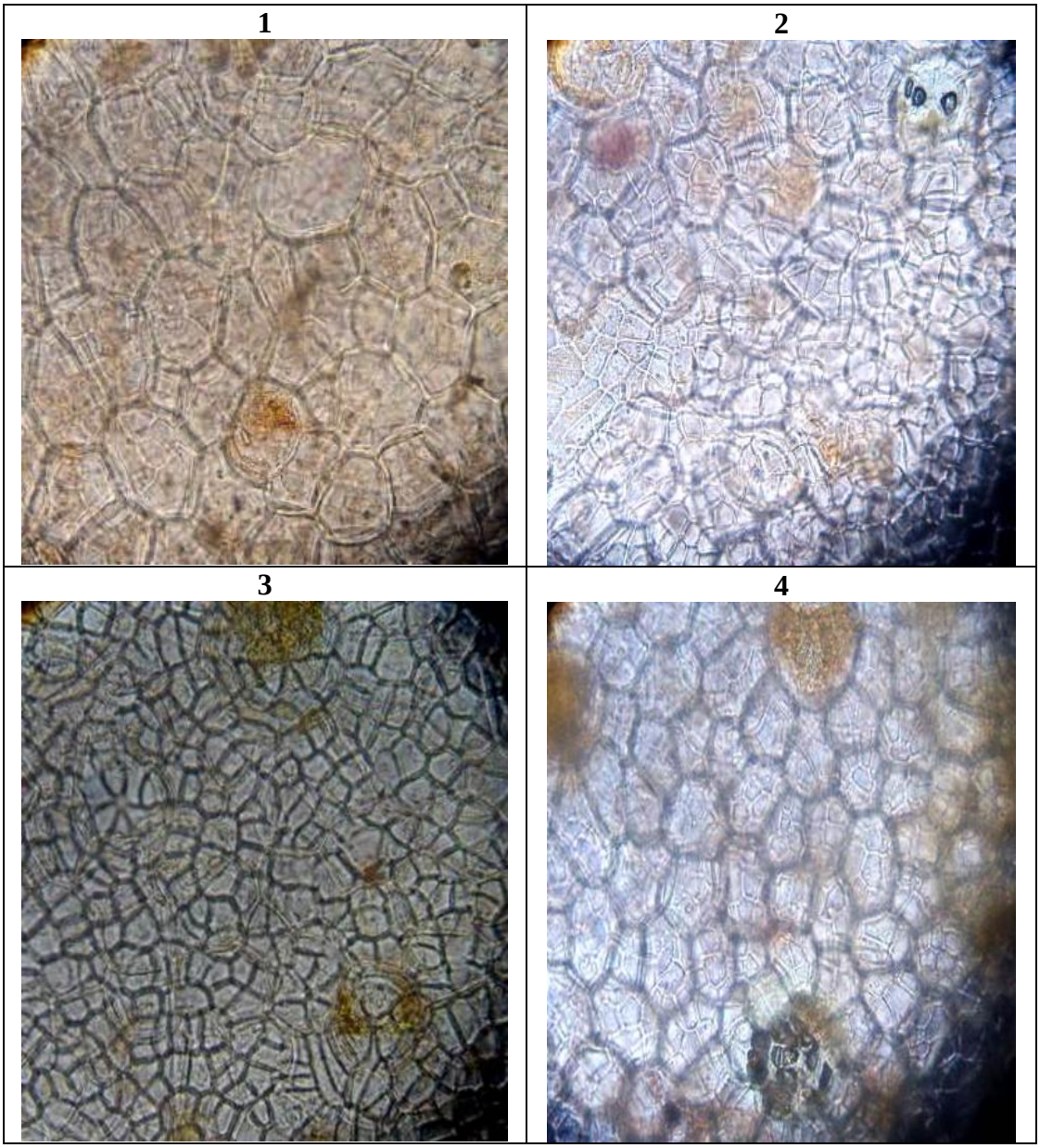

Plate (1) leaves anatomical response of *Ficus sp.* in the different studied sites x40), each 1cm =3.58A°.

In contrast the anatomical study of *Conocarpus sp.* leaves explained dark deposits can see in the station 2 as showing in plate 2 as response to heavy vehicular emissions and its near from bricks factory.

Station 4 showed an increase in stomata number and decrease in their size with high tannin cells content if contrasted with other stations , while Station 3 was the less in them may be due to the nature of this site which in rural region and less than other in pollution. These results agree with work of Gostin on *Fabaceae*s pecies [19].

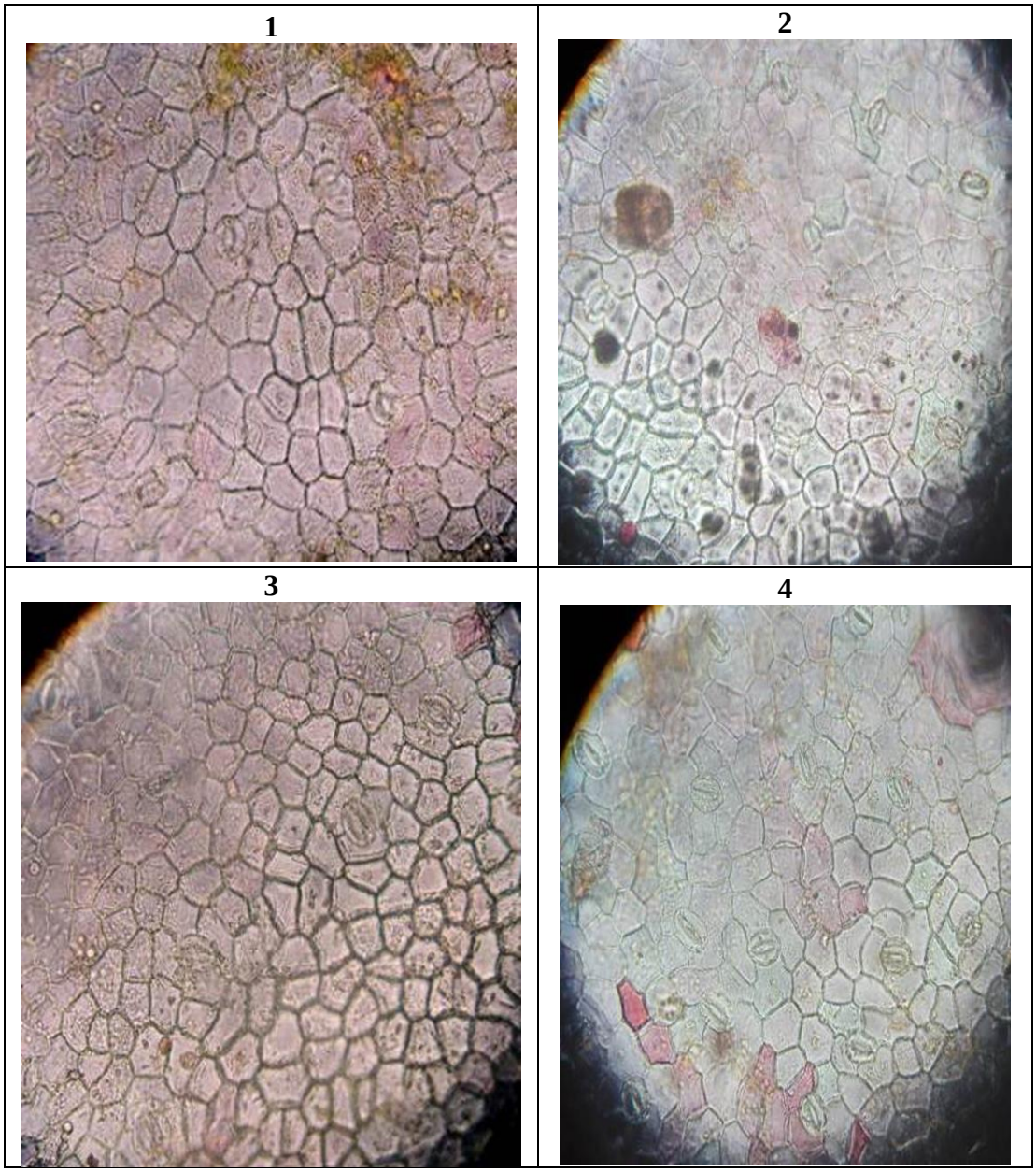

Plate (2) leaves anatomical response of *Conocarpus sp.* leaves in the different studied sites (x40), each 1cm =3.58A°.

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تقدير دليل تلوث الهواء بواسطة نباتين بريين في بعض المحطات ضمن محافظة بابل، العراق

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الخلاصة:
تضمنت الدراسة تحديد مؤشر دليل تلوث الهواء والتغايرات التشريحية لاوراق نوعين من النباتات البرية وهما الفكس والكونوكاربس في عدة محطات ضمن محافظة بابل. كانت قيم مؤشر دليل تلوث الهواء لكلا النوعين اقل من 10 مما يعني حساسيتهما لتلوث الهواء و سجلت استجابة تشريحية لاوراق النوعين واهمها كانت زيادة سمك جدران الخلايا البرنكيمية مع وجود بقع سوداء واضحة في مقاطع اوراق نبات الفكس بالنسبة لعينات المحطتين 2 و 4 مما يعكس شدة التلوث في تلك المنطقتين. اما اهم التكيفات في اوراق نبات الكونوكاربس فقد تضمنت زيادة كثافة الثغور و صغر حجمها مع زيادة محتوى الخلايا من المادة الدباغية في الموقع الاكثر تلوثاً.

الكلمات المفتاحية: تلوث الهواء، دليل تحمل تلوث الهواء، تشريح الورقة نبات الكونوكاربس و الفكس.