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Use *Citrus aurantium* plant as bio-indicator of air pollution in Baghdad city

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Abstract

The current study was conducted to demonstrate the effects of air pollution on different biochemical parameters in *Citrus aurantium* plant and calculation the Air Pollution Tolerance Index (APTI). Five sites were selected to collect plant leaves, four of them within the city of Baghdad, namely Al-Jadriya, Al-Andlous, Al-Doura and close to the private generators to represent the urban areas and Abu Ghraib site to represent the rural area. Seasonal samples were collected for the period from October 2016 to June 2017. Eleven biochemical parameters total chlorophyll, ascorbic acid, leaf extract pH, relative water content, total nitrogen, total protein content, total sugar content, proline, electrical conductivity, cadmium and lead. The results of *Citrus* plant showed high chlorophyll concentration and ascorbic acid content in private generator site reached to (10.620 mg/g and 0.403 mg/g) respectively. While relative water content recorded high concentration (57.563 %) at Al-Jadriya site. pH recorded high value (6.358) at Al-Doura site. In addition, values of APTI of the *Citrus* plant were calculated to determine the sensitivity of the plant to air pollution. Highest value of APTI (6.23) was recorded at Al-Jadriya site, while lowest value of APTI (5.03) was recorded at Al-Andlous site. The results of present study revealed that *Citrus aurantium* is sensitive to air pollution and can be used as bio-indicator under pollution stress.

Keywords: Air pollution, Biochemical parameters, Urban, Tolerance index, sensitivity.

استخدام اشجار *Citrus aurantium* كدليل حيوي لتلوث الهواء في مدينة بغداد

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الخلاصة

أجريت الدراسة الحالية لتحديد آثار تلوث الهواء على مختلف العوامل البايوكيميائية في نبات النارنج *Citrus aurantium*. تم جمع أوراق نبات النارنج لهذه الدراسة من خمسة مواقع أربع منها داخل مدينة بغداد وهي كل من الجادرية والاندلس والدورة وقريب من المولدات الاهلية لتمثيل المناطق الحضرية وموقع ابو غريب لتمثيل المنطقة الريفية. وتم أخذ الأوراق على اساس موسمي للفترة من أكتوبر ٢٠١٦ ألى يونيو ٢٠١٧. تم في هذه الدراسة قياس احد عشر من العوامل البايوكيميائية وهي كل من المحتوى الكلي للكلوروفيل و حامض الاسكوربك و ودرجة الاس الهيدروجيني ومحتوى الماء النسبي والمحتوى الكلي للنتروجين والمحتوى الكلي للبروتين والمحتوى الكلي للسكريات والبرولين والتوصيلية الكهربائية وعنصري الكادميوم والرصاص. أظهرت نتائج نبات النارنج بأن أعلى تركيز للكلوروفيل قد سجل في موقع المولدات و بلغ ١٠.٦٢٠ ملغم/غرام. سجل محتوى حامض الأسكوربيك اعلى تركيز (٠.٤٠٣ ملغم/غرام) في موقع المولدات. في حين سجل محتوى الماء النسبي اعلى نسبة تركيز (٥٧.٥٦٣ %) في موقع الجادرية. بينما سجل الأس

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الهيدروجيني اعلى قيمة (٦.٣٥٨) في موقع الدورة. بالإضافة إلى حساب قيم مؤشر تحمل تلوث الهواء (APTI) لنبات النارنج وذلك من أجل معرفة مدى حساسية هذه النبات لتلوث الهواء. تم تسجيل أعلى قيمة لـ APTI (٦.٢٣) في موقع الجادرية ، بينما تم تسجيل أدنى قيمة لـ APTI (٥.٠٣) وكانت في موقع الأندلس.

Introduction:

Air pollution from various sources is a serious problem in today's world and exposure to ambient air pollution has been linked to a number of different health effects [1]. Rapid industrialization and vehicular traffic emission especially in the urban areas lead to the deterioration of air quality by adding toxic gases and other substances to the atmosphere [2]. Vegetation can directly affect by pollutants through leaves or indirectly through soil. If they are constantly exposed to airborne pollutants, most plants develop physiological changes showing foliar visible symptoms [3]. Recent researches such as [4,5] demonstrated that urban vegetation plays a significant role in ameliorating environment of the cities. The plant responses to pollutants may provide a simple method of monitoring air pollutants as well as providing the pollution abatement measures. Cultivation of tolerant tree species may have a marked effect on varied aspects of the quality of the urban environment and the cleanliness of life in a city [6]. Thus, the need for monitoring the responses of plants to air pollution has been increased more than ever, especially in urban areas. This may allow for the direct explanation of the effect that air pollution exerts on the environment. Air pollution tolerance index (APTI) value is calculated by using four biochemical parameters chlorophyll content, leaf extract pH, ascorbic acid content and relative water content in leaf samples [7,8]. APTI values in the present study of growing plants in Baghdad city have been investigated.

Materials and Methods:

This study was carried out on *Citrus* plant along polluted and non-polluted sites during 2016-2017. Five sites were selected located inside Baghdad city in Al-Rusafa and Al-Karkh district. Those sites are Al-Jadriya as roadsides, Al-Andlous as commercial site, Al-Doura as industrial site, Abu-Ghraib as control and private generator to investigate the effect of air pollution. Seasonally samples were collected for measuring the levels of air pollutants. Mature green leaves were selected for sampling and were kept in clean plastic bags. Then plant samples will be transported to the laboratory for testing. The fresh leaf samples collected were analyzed for total chlorophyll content [9]; ascorbic acid content [10]; proline determination [11]; pH was determined by pH meter after calibrating with buffer solution [12]. The other parameters like relative water content of leaf samples [13]; Electrical conductivity [14]; total nitrogen content and protein content were estimated by Antial *et al.* [15]; sugar content [16]; determination of elements like cadmium, lead were measured by x-ray fluorescence device (made in Germany) [17]. Values of APTI was calculated by method of Singh and Rao [7] by calculating four biochemical parameters where $= A(T + P) + R/10$.

Statistical analysis In order to evaluate the parameters for *Citrus* plant, different tests such as analysis of variance, F-test and t-test were used in this study. The data were expressed as (mean ± SEM). The differences between means were explained by using least significant differences (LSD) at p ≤0.05. SPSS program 2010 and excel application were used to find the result and draw the figures with some effects [18, 19].

Results and Discussion:

Table 1-Biochemical parameters of *Citrus aurantium* in different sites at Baghdad city.

Parameters / Locations	Total protein content %	Total nitrogen content %	Total sugar content %	Proline content µ mole/g	EC µS/cm	Cadmium ppm	Lead ppm
Al-Jadriya	16.433 ± 0.356 a	2.470 ± 0.210 b	19.585 ± 1.346 a	11.595 ± 0.509 ab	1493.750 ± 68.474 a	2.000 ± 0.000 a	1.150 ± 0.240 ab
Al-Andlous	16.855 ± 0.258 a	2.538 ± 0.228 b	20.835 ± 1.574 a	12.838 ± 0.262 a	1535.000 ± 67.629 ab	1.375 ± 0.405 ab	2.250 ± 0.587 a
Al-Doura	16.638 ± 0.397 a	2.503 ± 0.180 b	19.940 ± 0.575 a	11.185 ± 0.491 b	1537.250 ± 81.751 ab	1.475 ± 0.225 ab	1.650 ± 0.132 b
Abu-Ghraib	16.215 ± 0.577 a	2.025 ± 0.191 b	14.390 ± 0.265 b	11.405 ± 0.201 b	1361.750 ± 77.759 b	0.600 ± 0.082 c	1.050 ± 0.065 c
Private generator	14.215 ± 0.762 b	3.275 ± 0.165 a	19.148 ± 1.027 a	12.793 ± 0.544 a	1710.500 ± 45.304 a	1.500 ± 0.187 b	2.200 ± 0.242 a

Small letters indicate to comparison in column, similar letters are non-significantly differences between means at ($p \leq 0.05$), Using (LSD test).

The results of current study referred that total nitrogen found in high percentage in *Citrus* plant at all sites, while the results showed reduction in total protein content. In the polluted plant, the probable reason behind the reduction of protein content might be the enhanced rate of protein denaturation and also the breakdown of existing protein to amino acid and this consistent with the results of [20,21] revealed that in the polluted plant. The results as seen in Table-1, soluble sugar accumulates under salinity stress at Al-Jadriya, Al-Andlous, Al-Doura and private generator sites [22]. Table-1 shown that proline level of polluted leaves under air pollution conditions has significantly increased ($P < 0.05$). The study of [23] reported that proline acts as a free radical scavenger to protect plants away from damage by oxidative stress. The results of the current study showed that cadmium concentrations in all sites were above the permissible limits (0.02 ppm) according to WHO [24]. From the results of current study, it can be concluded that high amount of cadmium were detected in leaves of plants collected from polluted sites. This might be due to the polluted air from the surrounding area. This result is in agreement with the study of [25]. The high lead concentrations in leaves of plants from polluted areas is due to the lead coming from the emission of vehicles as well as its presence in the soils polluted with wastes from different operations [26,27].

Table 2-Air Pollution Tolerance Index (APTI) of *Citrus aurantium* in different sites at Baghdad city. Results of *Citrus* samples (mean ± SE).

Parameters / Locations	Ascorbic acid mg/g	Total chlorophyll content mg/g	pH	Relative water content %	APTI
Al-Jadriya	0.360 ± 0.021 abc	7.088 ± 0.846 b	6.263 ± 0.034 a	57.563 ± 2.070 a	6.240
Al-Andlous	0.343 ± 0.014 bc	6.453 ± 1.082 b	6.333 ± 0.078 a	45.968 ± 2.247 c	5.030
Al-Doura	0.323 ± 0.010 c	6.600 ± 0.924 b	6.358 ± 0.046 a	49.798 ± 0.596 bc	5.393
Abu-Ghraib	0.383 ± 0.018 ab	6.233 ± 0.736 b	6.078 ± 0.055 b	51.508 ± 2.371 b	5.617
Private generator	0.403 ± 0.019 a	10.620 ± 0.215 a	6.240 ± 0.054 ab	49.820 ± 0.927 bc	5.656

Small letters indicate to comparison in column, similar letters are non-significantly differences between means at ($p \leq 0.05$), Using (LSD test).

The results as shown on Table-2. alterations in biochemical parameters such as total chlorophyll content, relative water content, pH of leaf extract and ascorbic acid content were used in determining the tolerance degree to air pollution by the plant species. Hence, chlorophyll is an index of productivity of plant [12]. Whereas certain pollutants decrease the total chlorophyll content [28], while other increase it. In this study, the results showed high chlorophyll concentration in private generator site and low concentration in Abu-Ghraib site, and this results supported by the study of [29]. They found that total chlorophyll content from *Eucalyptus camaldulensis* and *Prosopis juliflora* leaves in polluted site increased when exposed to concentrations of pollutants as comparing with the control. Under air pollution, several researches have been reported an increase in chlorophyll content, such as [30] referred that leaves of *Mangifera indica* subjected to air pollution showed an increase in chlorophyll content. The results of [12] in a study have established that concentration of chlorophyll in plants from polluted site is higher when compared with those from the control site. Under experimental condition, ascorbic acid concentration from the urban sites gave highest levels than the control site. Previous investigations mentioned that ascorbic acid is an antisorbic vitamin and it activates many physiological and defense mechanism. The study of [31] mentioned that depending on its concentration, ascorbic acid has a reducing power and it affects numerous physiological mechanisms such as cell wall synthesis, cell division and photosynthetic carbon fixation. Its reducing activity is pH dependent being more at higher pH and lesser at lower pH . Under environmental stress condition, the relative water content helps the plant to maintain its physiological balance when exposed to air pollution [32]. This is the reason for plant samples from the urban sites were quite higher compared to those of the control site.

From the results mentioned above, computed APTI levels revealed that all plants samples in all sites had APTI level < 10 (i.e. APTI sensitive category). This is in agreement with the report of [33, 34]. They reported that APTI levels of plants increased at the urban site when compared with those at the control site. This may be due to constant exposure of these plants to particulate matter and gaseous emissions from industries operating where they were collected, as well as vehicle exhaust emissions.

Conclusions

In conclusion, determination of APTI offers a reliable method for selecting large number of plants with respect to their susceptibility to air pollutants. The results of present study revealed that *Citrus aurantium* is sensitive to air pollution and can be used as bio-indicator under pollution stress.

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