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The Use of Biochemical Responses for Detecting the Impact of Gas Pollutant on *Vigna sinensis* L.

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Abstract

Gaseous air pollutants in the troposphere, which is formed in the air under the influence of sunlight and lightning if the air contains nitrogen dioxide or sulfur dioxide even if at low concentrations. Conducted study the effect of gaseous air pollutants emitted by industrial city in Jeddah to evaluate the response of protein and fatty contents in plant *Vigna sinensis* L. and transplanted at distances (1-5,500,1000,1500,2000 meters) from industrial city, has been planting the seeds of the plant *Vigna sinensis* L. In the uncontaminated region far from industrial city, where we put three pots at each site contains five seeds, and has agriculture in the January 9, 2013, and left until the completion of the initial growth of leaves and then transported to the site of the study. The results showed that the concentrations of polluting gases around industrial city is going up during the study period, reaching 82 ppb for ozone and sulfur dioxide reached 28ppb while the nitrogen dioxide recorded 35ppb.The results also showed that there is a significant effect of these pollutants on protein content and fatty content ranging in plant leaves for protein (4.11 %) at a distance 1-5 meters, and (4.40 %) at a distance of 2000 meters. The fat content in experimented leaves lied between fat (3.13 %) at a distance and 1-5 meters (4.40%) at the distance of 2000 meters.

Keywords: gas pollutants, *Vigna sinensis* L., protein, fats. Industrial city.

1. Introduction

Global mean concentrations of O_3 have increased from a pre-industrial level of 10 ppb to about 50 ppb in 2000, and is predicted to reach up to 80 ppb by 2100 (Prather et al. 2001). Most of this increase was driven by nearly three-fold increase in NOx and CO emissions (Prather et al. 2001). In the last few decades, peak O_3 concentrations have declined in North America and Europe (Ashmore 2005) due to reductions in precursor emissions. However, over the same period, anthropogenic emissions of O_3 precursors across Asia have increased

(Ohara et al. 2007). Tropical regions are more prone to increasing O_3 concentrations due to climatic conditions of these regions which favor O_3 formation (Tiwari et al. 2008). It has been established that O_3 causes a wide range of detrimental effects on the metabolic processes in horticultural species such as The ozone gas is consider as one of the oxidizing pumpkin (Castagna et al. 2001), sugar beet and rape (Kollner and Krause 2003), lettuce (Calatayud et al. 2002), potato (Pleijel et al. 2004), and tobacco (Degl'Innocenti et al. 2002). Plants may experience O_3 damage by physiological dysfunction that occurs before or without the appearance of visible symptoms (Nussbaum et al. 2001; Guidi et al. 2002). Physiological measurements are more reliable to assess intrinsic O_3 damage to plants, especially because they can occur earlier in time and at lower O_3 fluxes than that required for the appearance of visible O_3 injury symptoms (Nussbaum et al. 2001). O_3 is a highly reactive molecule which induces formation of reactive oxygen species (ROS), including hydrogen peroxide (H_2O_2), superoxide (O − 2), and hydroxyl (OH・) radicals and singlet oxygen in plants (Pasqualini et al. 2002).

The apoplastic matrix is the first compartment of mesophyll cells through which the pollutant has to pass before reaching the symplastic components. The apoplastic components react with O_3 and its derived species within the wall space protecting the next level of organization (membranes) from injury. Depletion of antioxidants or a rapid entry of O_3 will lessen any protection and will lead to membrane level injury (Conklin and Barth 2004). Any change in the membrane generally leads to some sort of membrane leakage or shifts in signal transduction proteins within the membrane (Cerena et al. 2006) leading to shift in ion concentrations (Klusener et al. 2002) or triggering of a protein cascade, forming new proteins via transcription factor activation (Evans et al. 2005).

The air pollution problems that affect the environmental aspects and the industry has taken a dangerous trend in the great diversity of industries in the field of complex accompanied by often pollution usually results in deterioration of the biosphere in the ecosystem (Janik 1985). The ozone gas is produced from oxidizing gaseous air pollutants in the troposphere which is formed in the air under the influence of sunlight and lightning if the air contains nitrogen dioxide or sulfur dioxide concentrations were even a few (Sandermann et al. 1998). The impact of air pollution on plants through poisoning specific parts of the plant tissue due to the absorption of the leaves of these toxic substances or as a result of chemical reactions to these substances on the surface of the contaminated plant parts. (Febrile et al. 1999).

Introduces ozone into the plant through the stomata where disintegrates in water cell wall and then interacts directly with the plasma membrane through the decomposition process (Ozonolysis) or turns into a form of oxygen active that interact with the plasma membrane and amino acids target proteins of the cell membrane, in addition to materials metabolic existing in the cell wall. These interactions change cellular components may lead to acceleration of aging or cell death (Logan and Naidu, 2002).

The (Plessl et al. 2007) studied the effect of increasing the concentration of ozone on the fat and protein in the leaves and tubers potato plant *Solanum tuberosum* L. which resulted in the increase of the ozone decrease in the content of protein and fat in the leaves. (Agrawalet al.

2005) found Low protein content (9.8%) at 64-69 ppb ozone, (Brunschon-Harti et al. 1995) also found results in similar plant beans, Phaseolus vulgaris L. According to (Cross et al. 1998) that ozone damage proteins and lipids in the cell membrane. In another interpretation found that cracks or oxygen free radicals generated by the interaction of ozone after entering the cell responsible for stimulating the production of compounds such as ethylene, which works as signals or stimuli pay the nucleus to accelerate the aging of the cell and appears in reducing proteins (Pell et al. 1997). Confirmed (Moldau 1999) that the forms of active oxygen that can break down proteins and fats. The study aims to identify the concentrations of some air pollutants (ozone, sulfur dioxide, and the nitrogen dioxide) emitted from industrial city in Jeddah and estimate their adverse effects on the protein content and fatty plant *Vigna sinensis* L. And transplanted at distances (1-5, 500,1000,1500,2000 meters) from industrial city.

2. Materials and Methods

2.1 Site under Study

Industrial city in Jeddah city was selected for the current study and select five distances in the direction of the wind far from industrial city, according to the following (1-5, 500, 1000, 1500 ,2000 meters)

2.2 Work Steps

Agriculture:

Planted seeds (*Vigna sinensis* L.) outdoors in plastic pots (size 20 cm) in silty sandy soil rate (1:1) sterilized by pesticide for the prevention of fungi, where they were put three pots for each distance (1-5, 500, 1000, 1500 , 2000 meters) each pots have of five seeds, and has agriculture in 9th January 2013, and left until the completion of the initial growth of leaves and then transferred to the study site.

2.3 Measurements

-Samples were taken from leaves plant (*Vigna sinensis* L.) in the late vegetative growth before flowering.

-Measurement of the concentration of air pollutants daily in industrial city for the duration of agriculture, by using the device (AEROQUAL Series Monitor with multy head) and was calculated as the average monthly readings.

2.4 Protein Content Estimation

Total protein was estimated on the basis of what they contain nitrogen from the sample using the method of Microkeldal. By multiplying the total protein content of total nitrogen in 6.25 (Jones 1991).

2.5 Fat Content Estimation

Fat was estimated according to the method contained in the standard Saudi Arabia (1982) No. 547 using a device extraction (Soxhelt).

3. Results

First measurements of the concentrations of air polluting gases (ozone, sulfur dioxide and nitrogen dioxide) in industrial city:

Results shown in Table (1) that the concentrations of air polluting gases (ozone, sulfur dioxide, and the nitrogen- dioxide) emitted from industrial city on the rise during the study period, where it was noted that the concentrations of ozone and sulfur dioxide and nitrogen dioxide at (2000 meters) less than when it was at the distances (1-5, 500, 1000.1500 meters). Where the ozone concentration at the distance (2000 meters) during the month of April ppb 61, and at distances (1-5, 500, 1000,1500 meters) 82, 74, 69, 65 ppb, respectively, and the concentration of sulfur dioxide at the distance (2000 meters) during the month of April ppb 22, and at distances (1-5, 500, 1000,1500 meters) 28, 27, 25, 25ppb respectively. concentration of nitrogen dioxide at the distance (2000 meters) during the month of April ppb 28, and at distances (1-5, 500, 1000,1500 meters) 35, 34, 32, 29 ppb, respectively. As shown in table (4). The correlation of ozone exposure level with plant fats and protein was significantly correlated reversely which prevail the impacts of ozone oxidizing in reducing the protein and fats content in studied plant especially in the distances near to air pollution source. Sulfur dioxide and nitrogen dioxide didn't represent any correlation with changes in plant biochemical parameters.

Table 1. Monthly changes of polluting gases (ozone, sulfur dioxide and nitrogen dioxide) industrial city (*Vigna sinensis* L.) in the city of Jeddah, Saudi Arabia.

Site	Distance (meter)	Month	polluting gases conc. (ppb)		
			O_3	SO_2	NO_2
Industrial city	1 - 5	January	71	27	34
		February	73	28	35
		March	78	27	34
		April	82	28	35
	500	January	67	25	33
		February	64	26	34
		March	68	27	33
		April	74	27	34
	1000	January	61	24	32
		February	60	25	32
		March	64	26	31
		April	69	25	32
	1500	January	57	22	29
		February	56	24	30
		March	59	25	29
		April	65	25	29
	2000	January	52	21	29
		February	51	23	28
		March	55	24	29
		April	61	22	28
Limit global air pollution (ppb)			25 - 30	30	35

Table 2. The effect of polluting gases emitted from industrial city in Jeddah on the content of the leaves of fats and protein in plant. Implanted at different distances from industrial city.

Site	Distance (meter)	Leaves Fat content (%)	Leaves Protein Content (٪)
Industrial city	Control	3.64	4.67
	5 -1	3.13	4.11
	500	3.16	4.17
	1000	3.23	4.25
	1500	3.25	4.32
	2000	3.35	4.40
L.S.D (0.05)		0.50	0.191

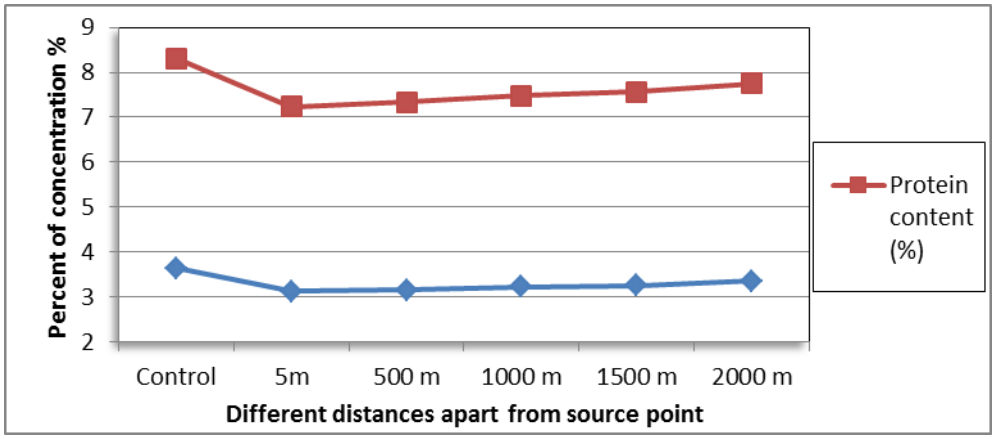

Figure 1. Show the variation in protein and fats content inside the plant (*Vigna sinensis* L.) in industrial city in Jeddah, Saudi Arabia

Table 3. Statistical analysis for some minerals.

Statistical parameters	*Fat content(%)*	*protein content(%)*	*O_3 ppb*	*SO_2 ppb*	*NO_2 ppb*
Mean	1.057	4.320	58.625	25.875	32.083
Standard Error	0.067	0.082	6.463	1.087	1.116
Median	1.020	4.285	61.375	25.625	32.625
Standard Deviation	0.165	0.200	15.831	2.663	2.733
Minimum	0.880	4.110	30.000	22.500	28.500
Maximum	1.340	4.670	76.000	30.000	35.000
Sum	6.340	25.920	351.750	155.250	192.500

Table 4. Correlation coefficient for plant fats and protein with gaseous pollutants

	Fat content	*protein content*	*O_3*	*SO_2*	*NO_2*
Fat content	1				
protein content	0.998111	1			
O_3	-0.99044	-0.99468	1		
SO_2	0.285149	0.314133	-0.3728	1	
NO_2	-0.01033	0.01371	-0.08033	0.939498	1

4. Discussion

In this research study the effect of gaseous air pollutants (ozone, sulfur dioxide and nitrogen dioxide) emitted from (Table 4) Correlation coefficient for plant fats and protein with gaseous pollutants on the plant *Vigna sinensis* L. And determine the five distances (1-5, 500, 1000, 1500 and 2000 meters) and the reason for conducting this study is to identify concentrations of gaseous air pollutants emitted from industrial city in Jeddah and estimate its harmful effects on protein content and fatty, where results indicate that the concentration of ozone gas exceeded the allowable limit of global air pollution in this gas a 25-30 ppb, while the concentration of sulfur dioxide did not exceed the allowable limit of global air pollution which is 30 ppb, as well as the gas concentration of nitrogen dioxide did not exceed the allowable limit global air pollution in this gas, which ppb 35 (Castnet 2004). The results showed no difference in the content of the leaves of protein and fat between distances under study, where the differences were statistically significant and may be the low protein content and fatty plant *Vigna sinensis* L. at distances (1-5, 500, 1000, 1500 meters) compared with the proportion of protein content and fatty at the distance (2000 meters) due to the high concentration of polluting gases in the closer to the source of contamination. This result is consistent with the (Matousel et al. 2005) in his study on *Vignara diata* L. In order to evaluate the effect of high ozone found where low protein content of 9.8%, also found (Brunschon-Harti et al. 1995) the same result in the bean *Phaseolus vulgaris* L. It also agrees with what referred to (Cross et al. 1998) that ozone damage proteins and lipids in the cell membrane. As a result of this study supports findings of (Plessl et al. 2007) and (Vorne et al. 2002) in the leaves of potato *Solanum tuberosum* L. That increasing the concentration of ozone led to a reduction in the content of protein and fat. This result is consistent with findings of (BouJoude et al. 2008) in his study on soybean Glycine max L. It was found that the high ozone led to a decline in the proportion of protein and fat. As mentioned researchers (Devlin and Wiseham, 1998) found that, the difference in metabolic products to members of the communities affected by plant environmental factors and different geographical locations. Exposure to ozone immediately creates an oxidizing environment in plant tissues and triggers an array of cellular responses, including the accumulation of antioxidants, elicitation of pathogenesis-related proteins, deposition of phenols, induction of ethylene synthesis, suppression of primary metabolic activities such as photosynthesis, and eventually cell death (Darrall, 1989; Schraudner et al. 1992; Conklin and Last, 1995; Sharma and Davis, 1997; Tuomainen et al. 1997).

5. Conclusion

Exposure to ground level ozone has significant effect on plant biochemical factors especially protein and fats, ground level ozone can change the protein and fats contents in plant while low concentrations of sulfur dioxide and nitrogen dioxide have not any significant impacts on plant metabolism. The proteins and fats plant contents improved as go far from industrial city in Jeddah -Saudi Arabia

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