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Impact of Air Pollution on Proline and Soluble Sugar Content of Selected Plant Species

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Abstract
This study examined the effect of ambient air population of two biochemical factors of plants; Proline and soluble sugar. Two sets of similar ecological statues of but different exposure to vehicular activities were used. The initiative, known as Experiment Site (ES) and the other, Control Site (CS). Twenty plant species were chosen from these sites. Proline and soluble sugar were determined according to standard methods. The result of this study showed an increase proline content on the experimental site suggestive of its protective mechanism under stress condition. There was a significant difference between the concentration of proline at the experimental and control sites. The percentage change (increase) from control site to experimental sites ranged between 24.90 % in *Citrus sinesis* to 57.22 % in *Carica papaya.* Soluble sugar on the other had reduced at experimental site when compared with those of a control site. There was however no significant difference in the concentration of soluble sugar from experimental and control sites. The percentage change (reduction) ranged between 24.49 % in *Tipu tipuana* and 47.87 % in *Psidium guajava* and *Anacadium occidentale*. This reduction in the concentration of soluble sugar in experimental site, suggest photosynthetic inhibition.
Keywords: Soluble Sugar, Proline, Air Pollution, Biochemical, Nigeria

1. Introduction

Pollution which is the defilement of the environment could be traced back to the beginning of urbanization and industrialization. The various activities of the twin phenomenon of industrialization and urbanization led to the production of waste which could not be accommodated by the natural cycles. These wastes when pumped into the environment led to pollution. There are various types of pollution, among which are air, land, water, sound, radioactive etc. Among these types, air pollution has the highest effect on life (Khedlar and Gadge, 2014). Air pollution is the pollution of the atmosphere such that the atmosphere either has additional constituents or same constituents in higher proportion or both. Once air is polluted, it affects other aspects of the environment since these pollutants would eventually be washed down by rains to the land and water bodies. Air pollution affects both human, plants and materials. The five primary air pollutants are the oxides of carbon, sulphur and nitrogen, as well as Volatile Organic Compounds (VOCs) and suspended particulate matter. These are known as primary pollutants. These primary pollutants could produce secondary pollutants if they undergo some sort of chemical reactions in the atmosphere. The effect of both the primary and secondary pollutant on human and the environment cannot be overemphasized. Since plants are stationary and so continually exposed to environmental variation, the effect of air quality has a huge effect on them. The health condition of plants would therefore reflect air quality of the immediate surroundings. It has been reported that air quality effect plant physiology and health (Priyanka & Dibyendu, 2009). When plants are exposed to stress or air pollution, they developed adaptive mechanism as a survival mechanism which lead to the accumulation of some organic solutes such as sugars, polyols, betains and proline (Yancey *et al*, 1982). Studies have shown an increase in proline content of leaves under stress condition (Hare & Cress, 1997, Mohammadkhani & Heidar, 2008, Seyydnejad & Koochak, 2011). Some workers also observed an increase in the soluble sugar levels under stress conditions (Prado, et al, 2000; Raajasubromanian *et al,* 2011) and others a reduction (Mafakheri et al 2010; Seyydnejad & Koochak, 2011; Seyydnejad & Koochak, 2013). Research has shown that air pollution resistant plants show accumulation of soluble sugar under stress/ air pollution while the less tolerant species has less accumulation of soluble sugar (Kameli & Losel, 1993; Ludlow, 1993). The aim of the present study is to determine the effect of air pollution on proline and soluble sugars in some plant species in Delta State, Nigeria.

2. Materials and methods

The Sites chosen for the study are an urban and a semi urban town. These towns are Asaba and Anwai. Asaba is the capital of Delta State and it is densely populated with both human and heavy vehicular activities while Anwai is the seat of one of the campuses of the Delta State University. It could be classified as a semi-urban community and it is less populated than Asaba both have similar geographical properties. Asaba is designated as the Experimental Site (ES), while Anwai the Control Site (CS).

Mature leaves were collected at random from twenty identified plant species from each site. These were then taken in polyethylene bags to the laboratory for analysis. Samples not immediately used were preserved in a refrigerator in the laboratory. Proline in the various plant species was determined following the method of Bates *et al* 1975. The leaves were dried under shade and powdered. 0.1 g of the powdered leaves was homogenized in 5 ml of 3 % (w/v) aqueous sulphosalicyclic acid and the mixture was filtered through a Whatman filter paper. 2 ml of the extract was then reacted with 2 ml glacial acetic acid and 2 ml of acid ninhyrin reagent in a test-tube. This was then heated over a water-bath until the brick red colour was developed was allowed to cool and 4 ml of toluene was added. This mixture was then thoroughly mixed. The colour separated in the toluene layer. The intensity of the colour was measured at 520 nm with a spectrophotometer against toluene. The concentration of proline was then determined using a calibration curve.

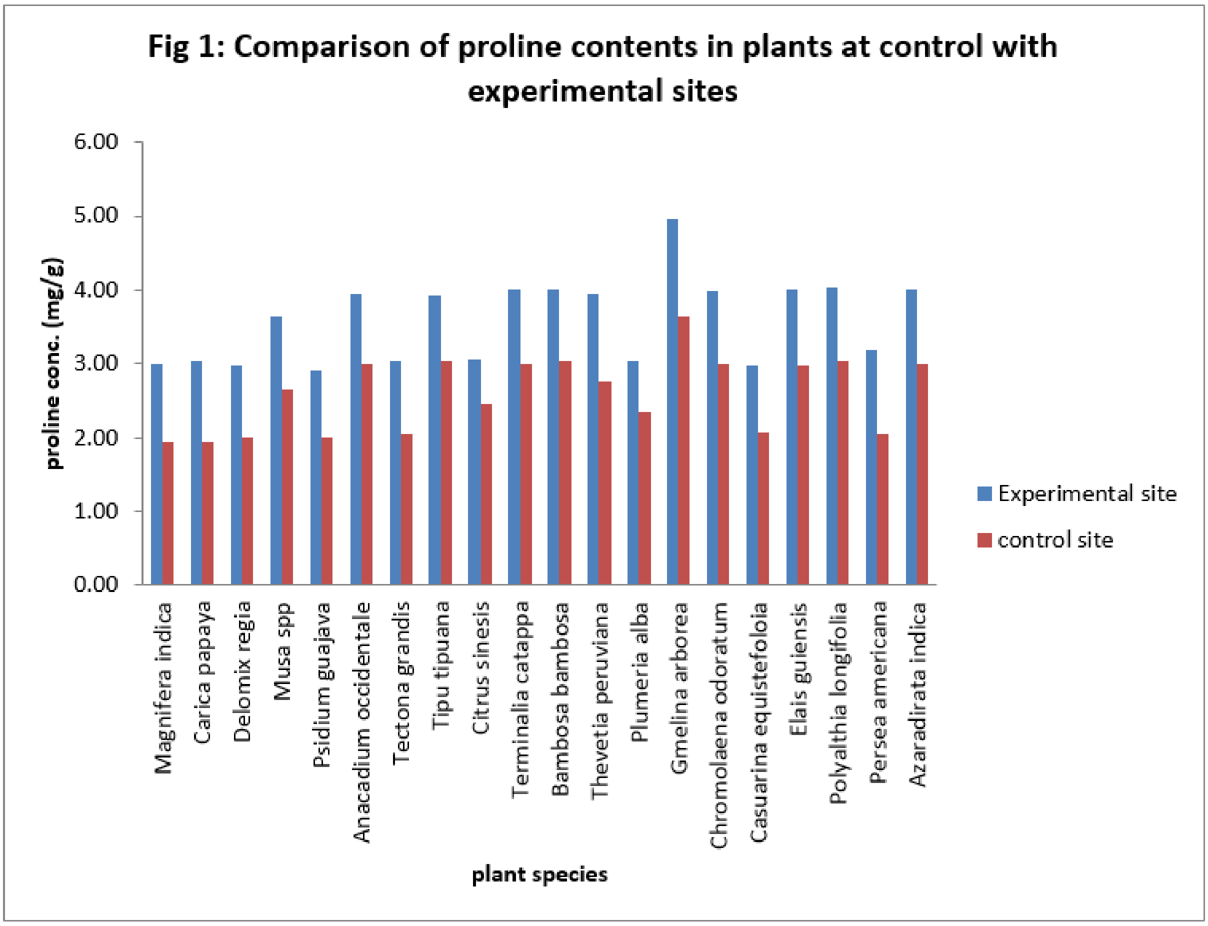
The determination of soluble sugar was done according to the method of Bubois, 1956, 0.5 g of the fresh leaf was homogenized with de-ionized water. The homogenate was filtered and the extract treated with 5 % phenol and 98 % sulphuric acid. This mixture was allowed to stand for 1 hour and the absorbance measured at 485 nm spectrophotometrically.

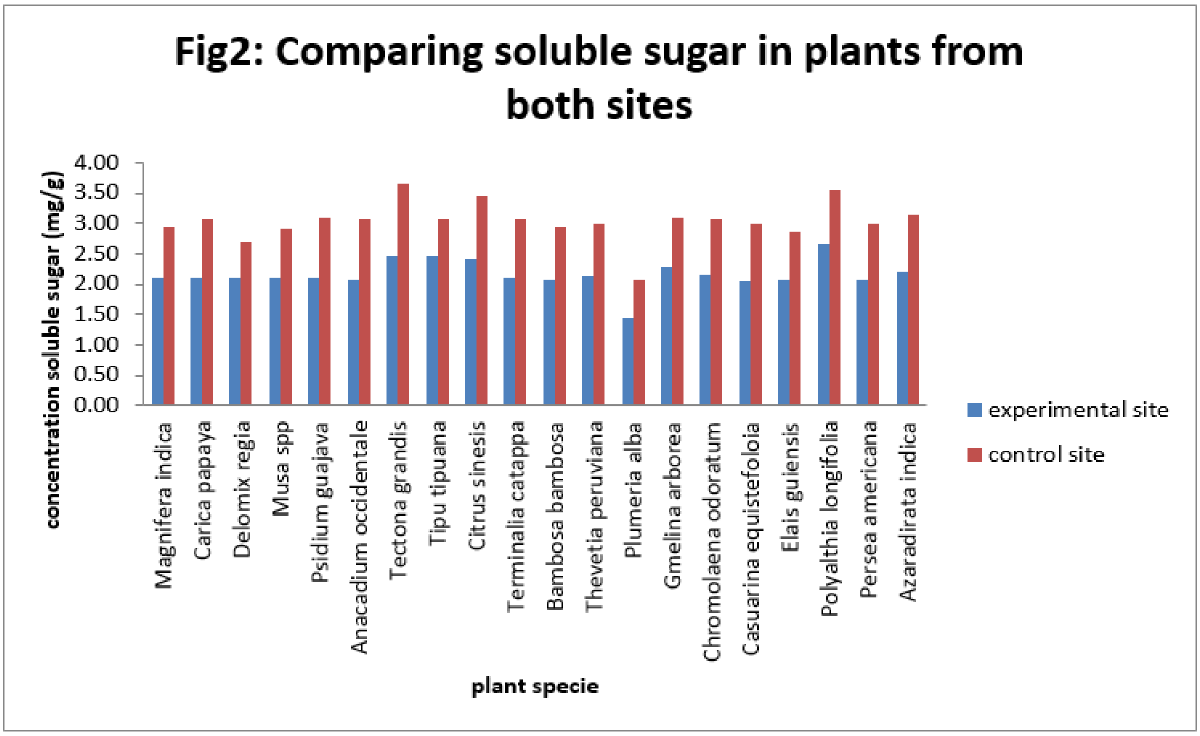
3. Results

The results are as presented in table 1

Table 1: The Effect of Air Pollution on Free Proline and Soluble Sugars

S/n	Plant Species	Sites	Proline	% Change	Soluble Sugar	% Change
1.	*Magnifera indica*	ES	3.00		2.09	
		CS	1.95	53.85	2.95	41.15
2.	*Carica papaya*	ES	3.05		2.09	
		CS	1.94	57.22	3.08	47.37
3.	*Delomix regia*	ES	2.97		2.09	
		CS	2.00	48.50	2.68	28.23
4.	*Musa spp*	ES	3.64		2.09	
		CS	2.65	37.36	2.92	39.71
5.	*Psidium guajava*	ES	2.92		2.09	
		CS	2.00	46.00	3.09	47.85
6.	*Anacadium occidentale*	ES	3.94		2.08	
		CS	3.00	31.33	3.08	47.85
7.	*Tectona grandis*	ES	3.05		2.45	
		CS	2.04	49.51	3.65	48.98
8.	*Tipu tipuana*	ES	3.93		2.45	
		CS	3.04	29.28	3.06	24.49
9.	*Citrus sinesis*	ES	3.06		2.42	
		CS	2.45	24.90	3.44	42.15
10	*Terminalia catappa*	ES	4.02		2.09	
		CS	3.00	34.00	3.08	47.37
11	*Bambosa bambosa*	ES	4.00		2.08	
		CS	3.05	31.15	2.95	41.82
12	*Thevetia peruviana*	ES	3.95		2.14	
		CS	2.76	43.12	3.00	40.19
13	*Plumeria alba*	ES	3.03		1.45	
		CS	2.35	28.94	2.08	43.45
14	*Gmelina arborea*	ES	4.96		2.29	
		CS	3.65	35.89	3.09	34.93
15	*Chromolaena odoratum*	ES	3.98		2.15	
		CS	3.00	32.67	3.08	43.26
16	*Casuarina equistefoloia*	ES	2.97		2.06	
		CS	2.08	42.79	2.99	45.15
17	*Elais guiensis*	ES	4.00		2.08	
		CS	2.97	34.68	2.86	37.50
18	*Polyalthia longifolia*	ES	4.04		2.65	
		CS	3.03	33.33	3.56	34.34
19	*Persea americana*	ES	3.19		2.08	
		CS	2.05	55.61	3.00	44.23
20	*Azaradirata indica*	ES	4.02		2.20	
		CS	2.99	34.45	3.15	43.18





4. Discussion

4.1 Proline

Proline, an amino acid has been reported to accumulate in response to environmental stress (Ozturk and Demir, 2002; Kavi *et al.,* 2005; Khedhar and Gadge, 2014). Accumulation of proline under stress situation is believed to be an adaptive phenomenon (Verbruggen and Hermos, 2008). It has been reported that the accumulation of proline under stress condition could be used to select stress tolerant species since proline concentration has been reported to be higher in stress-tolerant species (Yancy *et al.*, 1982, Ashraf and Foolad 2007; Jaleel *et al*., 2007). It has been suggested that the accumulation of proline under stress condition is as a result of reciprocal regulation of two pathways; an increased expression of proline synthetic enzymes and the repressed activity of proline degradation (Delvaney and Vernma 1993; Peng, Lu and Vermal, 1996). Proline accumulation has been reported to vary from species to species and also among the different organs in the plant (Verbruggen *et al*, 1993; Nathalie and Christian, 2008). It was observed from this study that proline concentration was higher around the experimental sites for all plant species studied. The percentage increase of proline concentration ranged from 24.90 % in *Citrus sinesis* and 57.22 % in *Carica papaya.* Carica papaya could be considered is the least tolerant of the studied species under the air condition that prevailed. Using the students' t-test, there was a significant difference ($p< 0.05$) in the proline concentrations on both sites. This result is in agreement with those of other workers (Seyyednejad *et al*, 2009; Mafakheri *et al*., 2010; Seyyednedjad and Koochak, 2011, Seyydnedjad and Koochak, 2013 & Khedlar and Gadge (2014).

4.2 Soluble sugar

Soluble sugar is an important component of all living things and also an important source of energy for living things. It is produced by plants during photosynthesis and it is broken down during respiration (Tripathi & Gautam, 2007). The concentration of soluble sugar is an indication of physiological activity of plants and it is considered to show the sensitivity of plants to air pollution (Seyyednejad and Koochak, 2013). A reduction in the concentration of soluble sugar under polluted condition can be due to increase respiration and decreased CO_2 fixation. It has been reported that the presence of pollutants such as SO_2, NO_2, and H_2S could result in a reduction of soluble sugars in the leaves of plants. Tripathi and Gautam also reported that the reaction of suphite with ketones and aldehydes of carbohydrates can cause a reduction in carbohydrate content. The result of this study showed a decrease of soluble sugar level at an experimental site. This result was decreased could be attributed to the damage leaves which corresponds with photosynthetic inhibition or increased respiration. There was however no significant difference between the concentration of soluble sugar in the experimental site and control site ($p<0.05$). The percentage change (reduction) ranged from 24.49 % in *Tipu tipuana* and 47.85 % in *Psidium guajava* and *Anacadium occidentale*. Air pollution could reduce growth by adversely effecting photosynthetic actively (Tiwari et al, 2006). The result from this study agrees with other workers (Seyydenjad and Koochak, 2011, Mafakheri *et al* 2010, Irerhievwie *et al,* 2014. The results of this work is however not in agreement those of Seyydnejad et al ., 2009. They reported an accumulation of soluble sugar under polluted environment. It is worthy of note that there would be accumulation or reduction of soluble sugar. The result is dependent on the sensitivity of plant species to air pollution. Research has shown that more resistant plant species show accumulation of soluble sugar while less stress resistant plant show less accumulation solution sugar (Kameli and Losel, 1993; Ludlow, 1993). These plant species could therefore be classified as stress – sensitive species.

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