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EFFECT OF PHYTOTOXIC AIR POLLUTION ON THE AMINO ACID CONTENT OF PLANTS GROWING IN KARACHI AREA

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Abstract

The effect of air pollution on the amino acid content of plants growing in Karachi area was studied. High amino acid contents were observed in *Aerva javanica, Alstonia scholaris, Cassia holosericea, Ficus benghalensis, F. religiosa, Guaiacum officinale, Mangifera indica, Murraya paniculata, Nerium oleander, Polyalthia longifolia, Prosopis juliflora, Samanea saman* and *Trachelospermum lucidum* growing at Gurumandir and Cement Factory area as compared to those growing at Karachi University Campus. *Eucalyptus* sp. and *Prosopis glandulosa* showed a minimum difference in amino acid content suggesting some mechanism of resistance against pollution.

Introduction

Air pollution, in addition to killing, inhibit many enzyme systems and metabolic processes of plants (McCune, 1975). Most air pollutants decrease photosynthesis directly or indirectly by causing loss of photosynthetic tissues and by affecting stomatal aperture (Hill *et al.,* 1969; Zahoor & Qadir, 1975). Since the synthesis of amino acid is correlated with carbon and nitrogen metabolism, any change in photosynthesis and respiration may affect amino acid metabolism in plants (Yang & Miller, 1963; Tomlinson & Rich, 1967). Studies were, therefore, carried out to study the effect of air pollution on amino acid content of some plants growing in Karachi area.

Material and Method

Fully mature and healthy leaf samples from about 3 meter height of the plants were collected in late morning hours during middle of December, 1982. Leaf samples of *Nerium oleander* L., *Eucalyptus* sp., *Alstonia scholaris,* R. Br., *Bougainvillea spectabilis* Willd, *Samanea saman* (Jacq.) Merrill, *Murraya paniculata* (L.) Jack, *Guaiacum officinale* L., *Polyalthia longifolia* Bth. & Hook. f., *Mangifera indica* L. and *Trachelospermum lucidum* (D.Don) Schum were collected from Gurumandir whereas *Prosopis juliflora*

DC., *P. glandulosa* Torr, *Cassia holosericea* Fres, *Aerva javanica* Burm. f. *Ficus benghalensis* L. and *F. religiosa* L. were collected from near National Cement Factory, Karachi to examine the effect of phytotoxic air pollutants on the amino acid metabolism. For comparison leaves of the same species of plants and of approximately same physiological age were collected from Karachi University Campus on the same date.

Qualitative Estimation: Amino acids were determined by descending paper chromatography. One gm of fresh material was plunged and homogenized in 10.0 ml of cool 80% ethanol. After 24 hr. extract was centrifuged and evaporated to dryness. Two ml of ethyl acetate: water (1:1 v/v) was added to the dried extract. Ethyl acetate fraction was discarded and water fraction was used for detection of amino acid. About 0.05 ml extract was applied as single spot on chromatographic paper and chromatograms were developed in the solvent system using n-butanol: acetic acid: water (5:1:4 v/v). Chromatographic papers were washed in the same solvent system before the application of samples. Ninhydrin 0.2% in acetone was used as locating agent. R_f values of unknown spots were calculated and they were identified by comparing with the R_f of standard amino acids.

Quantitative Estimation: Areas of the chromatograms corresponding to known standards of amino acids were cut and eluted in 2.0 ml of 50% ethanol as suggested by Shaw & Colotelo (1961), optical density was recorded at 530 nm against 50% ethyl alcohol as reagent blank.

Result and Discussion

The free amino acid content of plants growing in three localities are given in Table 1. Almost all the amino acids present in plants growing in Karachi University Campus were detected in plants growing in the vicinity of National Cement Factory and Gurumandir area. Valine in *M. indica,* arginine in *G. officinale* and lysine in *N. oleander* were, however, detected only from Karachi University Campus. The concentration of amino acids were high in plants growing at Gurumandir area and Cement Factory area with significant increase in concentration of arginine, lysine, tyrosine, ornithine and glutamic acid.

The free amino acid pool in tissues depends on the relative contribution of degradation of storage protein, amino acid synthesis and amino acid utilization for protein synthesis (Tomlinson, 1967). An increase in amino acid composition in plants growing along roadsides thus be attributed to inhibition of protein synthesis or enhanced protein degradation due to the effects of pollutants. Smokes and gases from automobile exhaust are the chief atmospheric pollutants in Karachi city. Automobile emissions principally consists of carbon monoxide, carbondioxide, the oxides of nitrogen and a variety of unburned or partially oxidized hydrocarbons (Hesketch, 1973). These pollutants participate in the formation of secondary pollutants like peroxyacetyl nitrate and ozones

Table 1. Effect of air pollution on amino acid content of plants.*

Name of the plant	Amino acid	μg amino acid/mg fresh weight			Percentage increase or decrease in amino acid content over the plant growing in University Campus
		Karachi University Campus	Gurumandir	National Cement Factory	
Aerva javanica	Alanine	0.012	–	0.018	+ 50
	Aspartic acid	0.006	–	0.012	+ 100
	Glutamic acid	0.006	–	0.012	+ 100
Alstonia scholaris	Arpartic acid	0.024	0.024	–	0
	Glutamic acid	0.012	0.012	–	0
	Proline	0.006	0.012	–	+ 100
	Tyrosine	0.012	0.012	–	0
Bougainvillea spectabilis	Alanine	0.012	0.024	–	+ 100
	Aspartic acid	0.012	0.018	–	+ 50
	Glutamic acid	0.012	0.012	–	0
	Tyrosine	0.018	0.006	–	– 66.7
Cassia holosericea	Alanine	0.006	–	0.012	+ 100
	Aspartic acid	0.012	–	0.018	+ 50
	Glutamic acid	0.006	–	0.03	+ 400
	Tyrosine	–	–	0.006	Tr
Eucalyptus sp.	Aspartic acid	–	0.006	–	Tr
	Cysteine	0.012	0.006	–	– 50
	Ornithine	0.012	0.012	–	0
	Threonine	–	0.006	–	Tr
Ficus benghalensis	Alanine	0.006	–	0.006	0
	Aspartic acid	0.006	–	0.012	+ 100
	Glutamic acid	0.006	–	0.018	+ 200
	Tyrosine	0.012	–	0.012	0
Ficus religiosa	Glutamic acid	0.006	–	0.024	+ 300
	Glycine	0.006	–	0.012	+ 100
	Tyrosine	–	–	0.006	Tr
Guaiacum officinale	Arginine	0.07	–	–	N.D
	Aspartic acid	0.08	0.092	–	+ 15
	Glutamic acid	0.07	0.07	–	0
	Leucine	0.012	0.018	–	+ 50
	Lysine	0.012	0.084		+ 600
	Proline	0.06	0.06	–	0
	Threonine	0.036	0.048	–	+ 33.3
Mangifera indica	Cysteine	0.006	0.018	–	+ 200
	Ornithine	–	0.006	–	Tr
	Threonine	–	0.006	–	Tr
	Valine	0.006	–	–	N.D
Murraya paniculata	Alanine	0.018	0.024	–	+ 33.3
	Aspartic acid	0.024	0.048	–	+ 100
	Glutamic acid	0.018	0.024	–	+ 33.3
	Proline	0.024	0.024	–	0
	Tyrosine	0.012	0.018	–	+ 50
Nerium oleander	Aspartic acid	0.018	0.018	–	0
	Lysine	0.012	–	–	N.D
	Ornithine	0.012	0.072	–	+ 500
	Threonine	0.006	0.012	–	+ 100

Table 1 (Contd.)

Name of the plant	Amino acid	µg amino acid/mg fresh weight			Percentage increase or decrease in amino acid content over the plant growing in University Campus
		Karachi University Campus	Gurumandir	National Cement Factory	
Polyalthia longifolia	Aspartic acid	0.018	0.018		0
	Glutamic acid	0.012	0.012	–	0
	Proline	0.024	0.04	–	+ 66.6
	Tyrosine	0.012	0.024	–	+ 100
Prosopis glandulosa	Alanine	0.024	–	0.036	+ 50
	Arginine	0.006	–	0.006	0
	Aspartic acid	0.036	–	0.04	+ 11.11
	Leucine	–	–	0.006	Tr
	Tryptophan	–	–	0.006	Tr
	Tyrosine	0.012	–	0.012	0
Prosopis juliflora	Alanine	0.016	–	0.016	0
	Aspartic acid	0.048	–	0.048	0
	Glutamic acid	0.04	–	0.04	0
	Leucine	0.006	–	0.018	+ 200
	Proline	0.006	–	0.012	+ 100
	Tyrosine	0.018	–	0.024	+ 33.33
Samanea saman	Arginine	0.004	0.12	–	+2900
	Aspartic acid	0.006	0.006	–	0
	Lysine	0.006	0.024	–	+ 300
	Ornithine	–	0.006	–	Tr
	Proline	–	0.006	–	Tr
	Threonine	0.012	0.06	–	+ 400
	Tyrosine	0.006	0.024	–	+ 300
Trachelospermum lucidum	Aspartic acid	0.058	0.064	–	+ 10.34
	Glutamic acid	0.04	0.04	–	0
	Proline	0.012	0.018	–	+ 50
	Tryptophan	0.006	0.006	–	0
	Tyrosine	0.03	0.09	–	+ 200

* The result is the average of three determinations.
N.D Not detected in polluted plant.
Tr Traces of amino acid in polluted plant, absent in control plants.

which have been reported to be more dangerous than the original emission (Darley *et al.*, 1963). Ozone affects protein metabolism either by enhancing protein hydrolysis resulting in an increase of free amino acids or by interfering with protein synthesis (Pestka, 1971). Ozone has also been shown to modify amino acids such as cysteine, methionine, tryptophan, tyrosine, histidine and phenyl alanine, proteins, unsaturated fatty acids and sulfhydral residues (Heath, *et al.*, 1974).

The increase in amino acid composition of plants like *A. javanica, C. holosericea, F. benghalensis, F. religiosa* and *P. juliflora* growing near Cement Factory would be due to reduction of photosynthesis presumably due to coating of leaf surface by particulate matters (Darley, 1966; Lerman, 1972). Clogging of stomata was found greater in hairy or rough leaves (Zahoor *et al.*, 1975).

Plants growing in Gurumandir area showed a decrease in concentration of cysteine (50%) in *Eucalyptus* sp. and tyrosine (55.7%) in *B. spectabilis* as compared to those growing at Karachi University Campus. The decrease may be a result of new protein synthesis (Tingey *et al.*, 1976; Craker *et al.*, 1972). Since *Eucalyptus* sp. at Gurumandir area and *P. glandulosa* growing near Cement Factory showed a minimum difference in amino acid content as compared to those growing at Karachi University Campus, it would suggest that these plants possess some mechanism of resistance against pollution. Similarly the carbohydrate metabolism and chlorophyll content of *Eucalyptus* sp. is not disturbed by atmospheric or industrial pollution (unpublished data). *Eucalyptus* sp. could thus be recommended for plantation in polluted areas.

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