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A Study of the Relative Amount and Composition of the Phenolic Acids Extracted from the Soils Undersome Tree Plantation

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Abstract: ***Allelopathy is shown by the plants through the secretion of secondary metabolites which are mostly phenolic acids or alkaloids. These phenolic acids and resins get released into the environment through leachation or upon decomposition. In the present experiment the relative amount and composition of phenolic acids released in the soils by Eucalyptus tereticornis, Leucaena leucocephala (both exotics), Dalbergia sissoo and Acacia nilotica (both indigenous) to India, is observed. In the present set of observations, it is found that the various exotic and indigenous tree species release certain phenolic acids in the extractable amount which may result in their allelopathic potential. The relative phytotoxicity depends upon the type and amount of phenolic acids present in their organic compounds. The E. tereticornis soils were found to have the maximum number of phenolic acids i.e. seven types. The D. sissoo, as held relatively least number of phenolic acids that too benzoic acid derivatives, has the least phytotoxic influence on under-grown vegetation as compared to other plantations.***

Keywords: Phenolic acids, Allelopathy, *Eucalyptus tereticornis, Leucaena leucocephala, Dalbergia sissoo, Acacia nilotica*.

1. Introduction

Allelopathy is exercised by the plants through secretion of secondary metabolites (Kaminsky and Muller, 1977; Vishwakarma& Mittal, 2014) which are mostly phenolic acids, alkaloids and resins along with terpenes. These phenolic acids and resins get released into the environment through leachation or upon decomposition and terpenes are released through evaporation. Out of the various secondary metabolites, phenolic acids and alkaloids are credited with the allelopathic properties. The phenolic acids in soil are further divided into leachable, non-leachable and bound soluble parts (Singh, 1991). Keeping in mind the volume of data only the soluble or free form phenolic acids are taken, in the present experiment.

2. Observation Parameter

The different types of phenolic acids and their relative amounts present in the soil on the floor of monoculture plantations of *Eucalyptus tereticornis, Leucaena leucocephala* (both exotics) *Dalbergia sissoo* and *Acacia nilotica* (both indigenous) trees were evaluated.

3. Methodology

a) Collection of soil and extraction of soil chemicals

The soil the floor of monoculture plantations of exotic and indigenous trees mentioned above, was collected. The soil samples were taken from different distances of 1.0, 3.0 and 5.0 m. from the tree trunk. The organic chemicals from these samples were extracted using the formula of Kaminsky and Muller (1977). The various samples of organic chemicals extracted from the soil, collected from one plantation type were pooled for further analysis.

b) Separation and identification of phenolic acids

Each of the samples, dissolved in methanol was subjected to thin layer chromatography (TLC) on plates coated with silica gel, pre- activated at 120^0C. Benzene and ethyl acetate (8:2v/v) formed the mobile phase. The phenolic acids were visualized on plates as bright spots against iodine. The spots from the chromatograms were eluted collectively in methanol and subjected to further identification through High Pressure Liquid Chromatography (HPLC).Pure Phenolic acids of " Sigma" make served as standards.

4. Results

In the soils of monoculture plantations of *E. tereticornis, L. leucocephala, D. sissoo* and *A. nilotica*, the number of phenolic acids which could be identified (or remained unidentified but counted) were found to differ. From the list of 13 which could be counted from all these four plantations, only syringic acid and gentisic acid were the ones which could be identified from the plantation floor of each of the tree species (Table 1.1).

From the 13 phenolic acids only seven could be identified and for the rest six, due to non-availability of standards identification could not be made. Therefore, these has been referred to as Unidentified I-VI. From among the seven identified phenolic acids four happen to be derivatives of benzoic acid while rest three that of cinnamic acid (Table 1.2). The identified phenolic acids include gentisic acid, syringic acid, vanillic acid, salicylic acid, cinnamic acid and ferulic acid.

Table 1.1: average amount of phenolic acids (relative percent) present in organic chemicals extracted from soils from the floor of various exotic and indigenous tree species (arranged as per their Retention time).

S. No	Phenolic acid	Retention time (RT)	*E. tereticornis*	*L. leucocephala*	*D. sissoo*	*A. nilotica*
1	Gentisic acid	3.40	4.56%	0.70%	1.08%	11.30%

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2	Unidentified I	3.90+0.1	3.95%	-	-	
3	Syringic acid	4.31+0.21	35.18%	63.29%	50.59%	60.80%
4	Unidentified II	4.67+0.01	24.03%	_	21.26%	_
5	Vanilic acid	4.93	13.84%	-		
6	Caffeic acid	7.80+0.03	5.74%	_	-	_
7	Unidentified III	13.81	_	0.98%	_	
8	Unidentified IV	14.57	_	0.98%	_	_
9	Salicylic acid	18.01+0.2	_	_	27.05%	13.17%
10	Cinnamic acid	18.81 0.13	1.05%	1.92%	-	1.12%
11	Ferulic acid	19.21 0.51	11.61%	-	-	-
12	Unidentified V	21.78	-	-	-	8.95%
13	Unidentified VI	23.12	-	25.3%	-	-

Table 1.2: Chemical nature and name of different identified phenolic acids

Phenolic aicd	Chemical nature	Chemical name
1. Gentisic acid	Benzoic acid derivative	2,5- Dihydroxy benzoic acid
2. Syringic acid	Benzoic acid derivative	4- hydroxy 3,5- dimethoxy benzoic acid
3. Vanillic acid	Benzoic acid derivative	4-Hydroxy –3 methoxy benzoic acid
4. Caffiec acid	Cinnamic acid derivative	3D (3,4-Dihydroxy phenyl)-2 propanoic acid
5. Salicylic acid	Benzoic acid derivative	2-hydroxy benzoic acid
6. Cinnamic acid	Cinnamic acid derivative	3- Phenyl 2- propanoic acid
7.Ferulic acid	Cinnamic acid derivative	3- (4-Hydroxy –3methoxy phenyl)194.2 –2 propanoic acid

From among the four plantation soil maximum (eight) types ofphenolic acid could be found from the soils of *E. tereticornis* and the least (four types) from *D. sissoo*. From the soils of *L. leucocephala* and *A. nilotica* six types of phenolic acids found in each, with Gentisic acid, syringic and cinnamic acid are common in the both (Table 1.1).

Table 1.3: Percentage of identified phenolic acids with reference to their respective molecular weight (arranged as per molecular weight)

Phenolic acid	Mol.Wt.	*E. tereticornis*	*L.leucocephala*	*D. sissoo*	*A. nilotica*
Salicylic acid	138	-	-	27.05	13.17
Cinnamic acid	148	1.05	1.92	-	-
Gentisic acid	154	4.56	0.706	1.08	-
Vanillic acid	168	13.84	-	-	-
Caffeic acid	180	5.74	-	-	4.63
Ferulic acid	194	11.61	-	-	-
Syringic acid	198	35.18	63.18	50.59	60.80

In the soil of *E. tereticornis* except for salicylic acid all the other six which are identified are present. In addition, two unidentified marked as Unidentified I and Unidentified II with retention times (RT) 3.90+ 0.1 and 4.67+ 0.01 and relative amount of 3.95% and 24.03% respectively are also noticed (Table 1.1). With respect to RT value no apparent relationship as regards the amount in respective phenolic acids could be seen. However, it was noticed that with increasing molecular weights of identified phenolic acids, the relative amounts were seen to increase (Table 1.3). Thus, in comparison to the amounts of 1.05% of cinnamic acid with molecular weight of 148, the syringic acid contents of molecular weight of 198 are seen to be maximum (38.15%) in terms of relative percentage. Exception is, however, in case of vanillic acid in this regard (Table 1.3).

The soils of *L. leucocephala*contain syringic acid (63.29%),Cinnamic acid (1.92%) and gentisic acid (0.706%). In addition to these, three unidentified marked as unidentified III, and VI with RT values of 13.81, 14.57 and 23.12 respectively are also observed. Among the unidentified samples, the contents of the samples increased with increasing retention time (Table 1.1).

There are only four types of phenolic acids observed in the soils of *D. sissoo*, of which one marked as unidentified II with RT value of 4.67 (Table 1.1). Syringic acid with relative value of 50.59% followed by salicylic acid with relative value of 27.05% and gentisic acid having relative value of 1.08% could also be noticed (Table 1.1) Each of the identified phenolic acids belong to the group of benzoic acid derivatives (Table 1.2).

Five identified and one unidentified phenolic acid is recorded from the soil collected under the plantation of *A. nilotica*. Like in other, maximum relative content (60.80%) was that of syringic acid, while the minimum in case of cinnamic acid (1.12%) (Table 1.1).

Gentisic acid was found to be present under each of the plantation studied (Table 1.1).Unidentified V was present only in *A. nilotica* while Unidentified III, IV and VI could be found only in the soils of *L. leucocephala* (Table 1.1).

5. Discussion

Phenolic acids and their derivatives form a major part of phytotoxins released by plants which show allelopathic properties (Blum *et al*., 1984). The phytotoxic potential of the organic chemicals released by the plants depend upon the composition and relative amount various phenolic acids (Haider and Martin, 1975; Lehmann *et al*., 1987).

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It is explicit from the results that phenolic acids either in their benzoic acid or cinnamic acid derivative form occur in the soil. Syringic acid, a form of benzoic acid is found to be present on the floor of each of the plantations studied. Except for syringic acid most of the phenolic acids like Caffeic acid, cinnamic acid, gentisic acid and vanillic acid are polar in nature. During thestudies on phytotoxins present on the floor of *E. tereticornis*, Singh (1991) also found that most of phenolic acids present in these phytotoxins were polar in nature.

The phenolic may be released as such or during microbial decomposition of lignin polymers. Vanillic acid, P-hydroxydenzoic acid, protocatechuic acid, syringic acid were released upon bacterial decomposition (Cheng *et al*.,1982). Various workers (Rice, 1984; Singh, 1991; Santos *et al*. 2013) had also identified the presence of phenolic acid in different soil systems. Cinnamic acid derivatives compared to the benzoic acid derivatives were more reactive in soil ecosystems (Lehmann *et al*., 1987; Haider and Martin, 1975) and toxic to plants (Blum *et al.*; 1984; Tian*et al*. 2012). A highly toxic nature of cinnamic acid and its derivatives as compared to benzoic acid derivatives may be the possible reason of relatively less amount of cinnamic acid and its derivatives in the soil chemics, as is found in the present experiment.

From the present set of observations, it can be concluded that the various exotic and indigenous tree species release certain chemicals including phenolic acids in the extractable amount which may result in their allelopathic potential. In other words tree like *E. tereticornis, L.leucocephala, A. nilotica, D.sissoo* exerts their allelopathic influence by releasing compounds including phenolic acids. The relative phytotoxicity depends upon the type and amount of phenolic acids present in their organic compounds. The *D. sissoo*, as held relatively least number of phenolic acids that too benzoic acid derivatives, has the least phytotoxic influence on under-grown vegetation as compared to other plantations.Somewhat similar observations were made by Cheenprachaet *al.* (2009) in another species of *Dalbergia* as they found only six different phenolic acids in*D. candenatensis.*

References

[1] Blum U., Dalton B.R. and Rawlings J.R. (1984).Effects of ferulic acid and some of its microbial metabolic products on radicle growth of cucumber. J. Chem. Ecol. 10: 1169-1191.
[2] Cheenpracha S., Karalai C., Ponglimanont C. and Opas A.K. (2009).Candenatenins A-F, phenolic compounds from the heartwood of *Dalbergia candenatensis*. J. Nat. Prod. 72(8): 1395-1398.
[3] Cheng C.L., Cheng H.M. and Krik T.K. (1982). Aromatic acids produced during degradation of lignin in spruce wood by *Phanoerochaetechrysosporium*. Holzforschung 36: 3-9.
[4] HaiderK.and Martin J.P. (1975). Decomposition of specifically carbon-14 labeled benzoic and cinnamic acid derivatives in soil. Soil Sci. Soc. Am. Proc. 39: 657-662.
[5] Kaminsky R. and Muller W.H. (1977).The extraction of soil phytotoxins using a natural EDTA solution. Soil Sci. 124(4): 205-209.
[6] Lehman, R.G., Cheng H.H. and Hasrh J.B. (1987).Oxidation of phenolic acids by soil iron and manganese oxides. Soil Sci. Soc. Am. J. 51: 352-356.
[7] Rice E.L. (1984). Allelopathy. Academic Press, New York.
[8] Santos S.A.O., Urlela C., Freire C.S.R., Neto C.P. and Silvestre A.J.D. (2013). Ultra-high performance liquid chromatography couple to mass spectrometry applied to the identification of valuable phenolic compounds from *Eucalyptus* wood. J. Chromatography B. 938: 65-74.
[9] Singh D. (1991).Phytotoxic properties of *Eucalyptus* with special reference to the role of its volatile components. Ph.D. thesis submitted to Panjab University, Chandigarh.
[10] Tian L.W., Xu M., Li. Y., Li X.Y., Wang D., Zhu H.T., Tang C.R. and Zhang Y.J. (2012). Phenolic compounds from the branches of *Eucalyptus maiden*. Chem. Biodivers. 9(1): 123-130.
[11] Vishwakarma G.S. and Mittal S. (2014).Bioherbicidal potential of essential oil from leaves of *Eucalyptus tereticornis* against *Echinochloa crus-galli* L. J. Biopest 7(Supp.): 47-53.

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