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Original Research Paper

An Evaluation of the Impact of By-product Gypsum from a Phosphoric Acid Factory on *Scoparia dulcis* L.

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ABSTRACT

The impact of the by-product gypsum on the morphology, phytochemistry and antibacterial activity of *Scoparia dulcis* L. has been studied. The gypsum and control site soils were subjected to analysis and the high incidence of abnormalities noticed in the plant species could be taken as a pointer to define the environmental hazards caused by industrial pollution.

INTRODUCTION

Man is part of the environment and ecosystem, exploiting natural resources for his interest. Disturbance in any component of the environment is likely to have a harmful effect on ecosystems. Any change in the environment, which contributes to its deterioration, is called pollution. Industries of certain kind produce hazardous materials or noxious wastes and much of these poisonous materials cannot be disposed off by any natural biological process. Environment of an urban industrial area may be contaminated with several pollutants to which the vegetation would be exposed. In a polluted environment plants absorb and accumulate pollutants and abnormalities caused are easily noted in their morphology. Plants are differentially sensitive to pollutants; some of them decrease in number and may totally disappear, while others thrive showing abnormal features to adapt themselves to the environment (Salanki 1986). The by-product gypsum, produced from the phosphoric acid plant of FACT, Ambala-medu is considered as a major solid effluent. Existence of surrounding plants has been threatened by addition of gypsum to the soil. Almost a bare land was observed near the gypsum deposition, with exception of a few genera like *Mikania scandens*, *Cynodon dactylon*, *Cyperus rotundus*, *Lippia nodiflora* and *Scoparia dulcis*. These plants, however, showed considerable differences in growth from those growing in unpolluted areas and among these, *Scoparia dulcis* showed a much pronounced growth, and hence selected for the present study.

Scoparia dulcis L. belonging to family Scrophulariaceae is a medicinal herb, distributed throughout tropical and sub-tropical regions. Traditionally, fresh or dried plant is used for treating stomach ailments, hypertension, diabetes, inflammation and bronchitis, and as an analgesic and antipyretic agent. Numerous chemical constituents have been isolated from *S. dulcis*, which include coumarins, phenols, saponins, tannins, amino acids, flavonoids, triterpenoids, glycosides, and alkaloids (Edeoga & Okwu 2005). The triterpenoids are responsible for its medicinal property, saponins impart diuretic and antipyretic effects and cardiac glycosides are a group of natural compounds with cardiac actions. The present study was an attempt made to analyse the effect of gypsum on its growth, phytochemical properties and antibacterial activity.

MATERIALS AND METHODS

The plant *Scoparia dulcis* L. was collected from two different sites, site 1 the remote areas of Kochi and site 2 the gypsum deposited areas of Ambalamedu. Soil analyses of both the sites were carried out to study parameters such as temperature, pH, electrical conductivity, nitrogen, phosphorus and potassium. Gypsum polluted soil was also analysed to detect percentage of gypsum, moisture and fluoride content. Morphological features like, number and size of flowers, floral parts, fruits per plant, pollen sterility, nature and pigmentation of leaves and roots, phytochemical analysis and antibacterial activity of *S. dulcis* growing at both sites were studied. In order to study pollen sterility, pollen grains were collected and stained in 1% acetocarmine. The stained pollen grains were counted as fertile and unstained ones sterile.

Phytochemical studies of aqueous plant extracts and powdered specimens using standard procedures were conducted to identify chemical constituents in the plant as described by Harborne (1973), Trease & Evans (1978) and Sofowara (1993). Different chemicals screened include: tannins, saponins, flavonoids, steroids, triterpenoids, cardiac glycosides and alkaloids. High performance thin layer chromatography (HPTLC) was done with the methanolic extracts of powdered samples of both sites and the plates were viewed under UV 254nm and 366nm, derivetized and observed in visible light. For HPTLC of triterpenoids and cardiac glycosides, a combination of toluene: chloroform: methanol, while for saponins, butanol: water: acetic acid and ethyl acetate: methanol: water: ammonia were used as solvent systems. *E. coli* strains obtained from Trinity Biotech Laboratory, Ernakulam, were used for screening purpose of *S. dulcis* from the two sites by well plate method and diameter of inhibition zone in mm was recorded. Distilled water was used as control and experiment was performed in triplicate and average diameter of inhibition zone was obtained.

RESULTS AND DISCUSSION

Soil collected from both sites showed normal temperature, neutral pH and electrical conductivity, but amount of nitrogen, potassium and phosphorus was high in site 2 when compared to site 1. Potassium regulates the opening and closing of stomata and thereby reduces water loss from leaves and increases drought tolerance. This may account to increased tolerance of plants found in site 2. Soil samples from site 2 had about 78% of gypsum and 20% moisture, but fluoride was low at 0.0029% (Table 1). Site -2 soil showed total absence of humus due to lack of earthworms which indirectly affect plant productivity. Plants growing under unfavourable conditions develop some characteristics which are absent in those growing under optimum conditions (Salanki 1986). This can account for decreased productivity and other similar changes observed in *S. dulcis.* Increased concentration of by-product gypsum in soil improves soil composition, decreases bulging clays, corrects soil acidity, promotes deeper and healthier root development and water penetration. Up to 2% gypsum in soil favours plant growth, 2-25% has little or no adverse effect if in powdery form, but more than 25% can cause substantial reduction in yield (Sarvesh 2005). In the present study, gypsum in site 2 was found to be 72% which accounts for decreased productivity.

Morphological differences in plants collected from two sites include change in size of floral parts and nature and colour of leaves and roots. Floral parts were comparatively larger in plants collected from control site. Leaves showed reduction in their size and pigmentation while roots exhibited vigorous growth. Pollen sterility was fairly greater for plants from site 2 and this decreased relative number of their seeds.

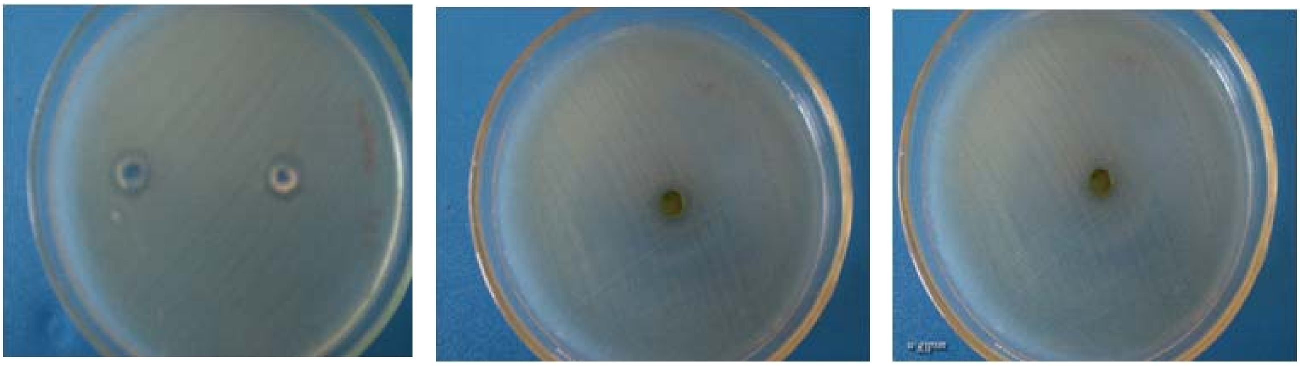
Table 1: Physical and chemical analysis of soil

Component	Control site		Gypsum site	
	Value	Rating	Value	Rating
Temperature (°C)	30.5	Normal	31.5	Normal
pH	7.1	Neutral	8.4	Basic
EC (mohms/cm)	0.1	Neutral	0.1	Neutral
Nitrogen (%)	0.15	Low	1.65	High
Phosphorus (kg/ha)	80	High	18	Medium
Potassium (kg/ha)	90	High	80	High
Gypsum (%)	-	-	72	-
Moisture (%)	-	-	20	-
Fluoride (%)	-	-	0.0029	-

Qualitative screening of phytochemicals revealed presence of alkaloids, tannins, saponins, triterpenoids, flavonoids and cardiac glycosides, but steroids were absent in both. They were known to exhibit medicinal as well as physiological activities (Sofowara 1993). Absence of steroids in *S. dulcis* in the present study is in contrast with the opinion of Edeoga & Okwu (2005). However, the presence of triterpenoids in this plant has been earlier reported by Hayashi et al. (1997).

Further, quantitative screening of saponins, triterpenoids and cardiac glycosides by HPTLC showed comparatively greater concentration of triterpenoids in plants collected from site 2. Generally, triterpenoids are stress compounds produced by plants in response to environmental stress and ecological interactions (Kokate 1997). Thus, increased content of triterpenoids in plants collected from site 2 indicates their importance to overcome adverse environmental effects. It was noticed that bands were more clearly visible under 366 nm than 254 nm. The saponin content of *S. dulcis* collected from site 1 was rather more and its separation was clearly observed under UV 254 nm compared to UV 366 nm in ethyl acetate: methanol: water: ammonia, while in butanol: water: acetic acid, the bands were not much clear. Not much quantitative difference was observed in cardiac glycoside concentration between two sites. The spots made in HPTLC plates of cardiac glycosides were scattered to some distance from spotting point and this was due to their increased polarity. The derivertized plate of cardiac glycosides viewed under visible light was not much clear compared to that of saponins and triterpenoids.

S. dulcis screened for antibacterial activity against *E. coli* by well plate method revealed appreciable zone of activity against the pathogen. Among the two solvent extracts, chlo-



a b c

Fig. 1: a-chloroform extract (sites 1 and 2), b-water extract (site 1), c-water extract (site 2).

roform extract showed remarkable antimicrobial activity compared to water extract. Moreover, *S. dulcis*, collected from site 1, showed considerable antibacterial activity than those collected from site 2. Inhibition zone was measured about 1.5 mm and 1.2 mm for site 1 and 1.4 mm and 1.1 mm for site 2 each in chloroform and water extracts respectively (Fig. 1 a,b,c). Least inhibitory action was found in plants collected from site 2 and this reduction in antimicrobial property is due to low saponin content. Antimicrobial activity is mainly due to presence of alkaloids, terpenoids, saponins and other natural polyphenolic compounds in plants (Frazier 1995).

CONCLUSION

Soil analyses showed differences in ratings of physical and chemical components in both sites. Morphological variations exhibited by plants include difference in size of floral parts, nature and pigmentation of leaves and roots, and pollen sterility percentage. Changes observed in plants collected from site 2 were a clear reference to indicate the effect of gypsum in altering morphological characters. Phytochemical screening of plants collected from two sites revealed that aqueous extracts showed presence of alkaloids, tannins, saponins, triterpenoids and flavonoids. HPTLC studies done with methanolic extracts of plants revealed a quantitative difference in amount of saponins, triterpenoids and cardiac glycosides. Decrease in saponin and cardiac glycoside contents in plants collected from site 2 will lower its medicinal property. But evaluation of triterpenoids showed that the content was appreciably more in sample collected from site 2. Successive extracts of *S. dulcis* collected from sites 1 and 2 showed antibacterial properties when tested with *E. coli*, owing to the presence of saponins. From the results obtained it can be emphatically stated that the by-product gypsum interferes with normal growth and development of flora. The strikingly high incidence of various types of abnormalities noticed in the present plant species could be taken as a pointer to define the environmental hazards caused by industrial pollution.

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