ENZYMES INVOLVED IN PHENOL METABOLISM OF GALL AND NORMAL TISSUES OF INSECT INDUCED LEAF GALLS ON SOME ECONOMICALLY IMPORTANT PLANTS IN RAJASTHAN INDIA

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ABSTRACT

Phenolic (Total phenols and orthodihydroxy phenols) contents of leaves galls on *Dalbergia sissoo, Tectona grandis*, *Salvadora oleoides* and *Salvadora persica* induced by *Eriophyes* sp, unknown itonididae, unknown gall midge and *Thomasiniana salvadorae* respectively, gall and normal tissues as also changes in the activities of enzymes peroxides and polyphenol oxidase were analysed. Total phenolic contents were higher in the gall compared to normal tissues except *Tectona grandis*. Hyperphenolicity in gall tissues is correlated to high activities of peroxidase and polyphenol oxidase. Activities of enzymes provide a clear pointer alteration that the metabolites of insect origin and their interactions with the metabolites of the host plants. Those of normal existence and those of induced as a response of gall inducer invasion that mediate and regulate gall incitant host relationships during cecidogenesis.

Keywords: phenolics gall incitant enzymes, metabolites, leaf galls, and cecidogenesis.

INTRODUCTION

Four types of leaf galls occurs on *Dalbergia sissoo* Roxb caused by *Eriophyes* sp. (Acarina), *Tectona grandis* L. caused by unknown gall midge (Diptera), *Salvadora oleoides* Dine caused by unknown itonididae (Diptera) and *Salvadora persica* L. caused by *Thomasiniana salvadorae* Roa (Diptera) have been studied here. Ramani and Kant (1989) have studied the phenolics and enzymes in *prosopis cineraria* (linn). Druce rachis galls *in vitro* and *in vivo* conditions. Gupta (1997) have analysed the biochemical investigation of leaf galls of *Tectona grandis*. Purohit *et al.* (1979) also studied phenolics, peroxidase and polyphenolase in insect induced plants galls of some arid zone plants. The present observation is to understand the changes in phenolic levels and activities of enzymes involved in phenol metabolism which lead to the development of these neoplastic growths in some economically important plants of Rajasthan. *Dalbergia sissoo* ''*Sheesam*'' and *Tectona grandis* "*Teak*" are known for best quality of wood but *Salvadora oleoides* and *Salvadora persica* ''piloo'' known for indicators as well as oils used for soaping industry. Hence this investigations lead to find out host parasitic relationship in that four plant species.

MATERIALS AND METHODS

Normal and gall tissues of *Dalbergia sissoo, Tectona grandis, Salvadora oleoides* and *Salvadora persica* were collected form jaipur and sitamata forest in various seasons. The methods followed were as follows: Total phenols (Bray and Thorpe 1954), ortho dihydroxy phenols (Johnson and Schall 1952), peroxidase (EC1.11.1.7, Worthington Enzymes Manual 1972) and polyphenol oxidase (Shinshi and Moguchi's 1975). Adequate controls were also run.

RESULTS AND DISCUSSION

Phenolic (Total phenol and orthodihydroxy phenols) contents were higher in the gall tissues compared to the normal counterpart, except *Tectona grandis* (figs. 1 and 2). Maximum phenolic contents were recorded in *Dalbergia sissoo* gall tissues followed by *Tectona grandis, Salvadora oleoides* and *Salvadora persica*. Normal tissues of *Tectona grandis* contain highest total phenolics followed by *Dalbergia sissoo, Salvadora oleoides* and *Salvadora persica*. Gall tissues of all the plants examined showed increased peroxidase activity as compared to thier normal counterparts except in *Tectona grandis*. Maximum difference in the activity of this enzyme between gall and normal tissues was recorded in *Salvadora persica* and minimum in *Tectona grandis* (fig.3). Higher polyphenol oxidase activity was recorded in normal tissues as compared to that of gall tissues of *S. oleoides*, *S. persica* and *Dalbergia sissoo* where normal tissues of *Tectona grandis* showed lesser polyphenol oxidase activity (fig.4).

Phenolic compounds occur in a variety of simple and complex forms. During the present investigation phenolic (Total phenols and ortho dihydroxy phenols) in gall tissues of *Dalbergia sissoo, S. oleoides* and *S. persica* were higher as compared to their normal counterparts. similer finding were recorded in leaf gall of *Cordia myxa* (Ramawat *et al. 1979*), leaf gall of *Zizyphus mauritianr, Achyranthes aspera* and *Ficus mysorensis* (Purohit *et al* 1980a). A higher level of phenol affected adversely the IAA oxidase activity in plant tissue resulting in a higher level of IAA (Andreae 1952, Tomaszeniski and Thimann 1966, Parthsarathi et al. 1970, Ramani and Kant 1989, Sisodia and Patni 2006), thus leading to hyperauxinity and gall formation.

Low level of phenol and orthodihydroxy phenols in *Tectona grandis* galls than that of normal. This decrease in phenolic contents have been attributed to their utilization by ''insect'' (Bernays *et al* 1983). Phenolics also act as substrates for some enzymes such as peroxidase. *Gopinathan* and Ananthakrishnan (1985) have reported increased polyphenol oxidase and peroxidase activities in galls of *Mimusopsd elengi* and *Calycopteris floribundus*.

Increase in severity of gall disease with increased peroxidase activity has been recorded (Ramani 1987). Hence; in the present study increased activity of peroxidase indicates that the cecidozoan has the capacity of detoxifying the effect of oxidized phenols.

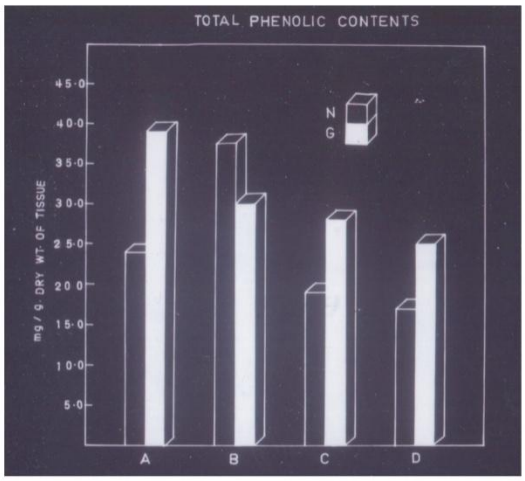

Fig. 1

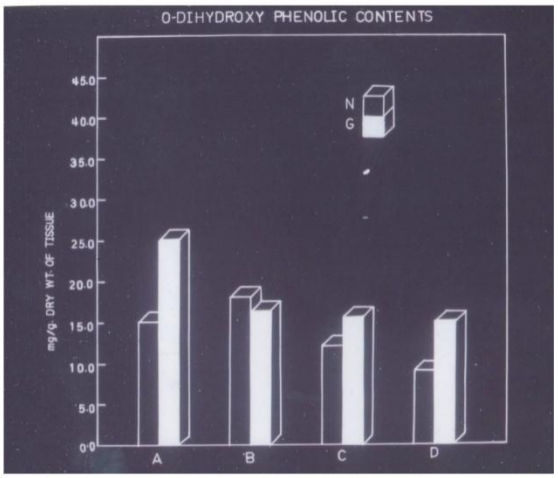

Fig. 2

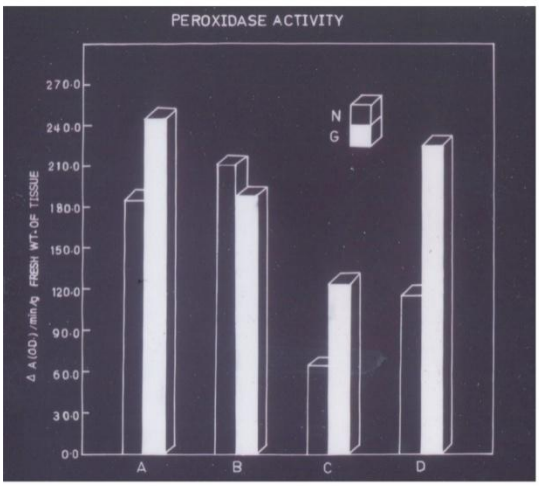

Fig. 3

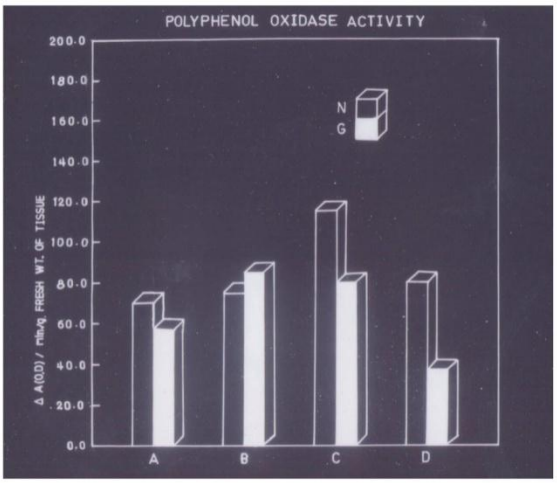

Fig. 4

FIG. 1: Total phenolic contents of normal and gall tissues of plants A-D.

A- Dalbergia sissoo *C- Salvadora oleoides*

B- Tectona grandis D- *Salvadora persica*

FIG. 2: Ortho-diphydroxyphenolic contents of normal and gall tissuse of plants A-D.

A- Dalbergia sissoo *C- Salvadora oleoides*

B- Tectona grandis D- *Salvadora persica*

FIG. 3: peroxidase activity of normal and gall tissuse of plants A-D.

A- Dalbergia sissoo *C- Salvadora oleoides*

B- Tectona grandis D- *Salvadora persica*

FIG. 4: Polyphenol oxidase activity of normal and gall tissuse of plants A-D.

A- Dalbergia sissoo *C- Salvadora oleoides*

B- Tectona grandis *D- Salvadora persica*

Peroxidases are responsible for oxidation of phenolics (Kosuge 1969). Lower polyphenol oxidase activity in the gall tissue might be another factor for hyperphenolic level. Therefore, the phenolic compounds are regulated by polyphenol oxidase (Stonier *et al*. 1970). The higher level of orthodihydroxyphenols in the diseased tissues is responsible for lower polyphenol oxidase activity (Webb 1966). Increase in peroxidase activity is due to increased phenol concentration, which plays an important role in oxidating enzymes (*Kant et al*. 1992, Arora and Patni 2001). However, in *Tectona grandis* a decrease in phenolics and peroxidase with increased polyphenol oxidase activity was not drastic and did not bring complete oxidation of phenolics. More, so since phenolics are inhibitors, of IAA oxidase, low peroxidase activity was recorded. Increased peroxidase and polyphenol oxidase converts phenolics into quinones (Farkas and Kiraly 1962). Increase activity of these oxidative enzymes indicates a state of high catabolism induced during pathogenesis.

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LITERATURE CITED

Andreae WA. 1952. Effect of scopoletin in Indole acetic acid metabolism. *Nature*. **170**:83-84

Arora DK and V Patni. 2001. localization of metabolites and enzymes in insect induced rachis gall and normal tissues of *prosopis cineraria* (linn.) Druce. *J. phytol Res.***14** (2):179-181.

Bernays EA, Chamberlain DI and Woodhead S.1983. Phenols as nutrients for phytophagous insect, *Anacridium melonarhodon J.insect Phytol* .**29**:535-539.

Bray HC and Thorpe WV. 1954. Analysis of phenolic compounds of interest metabolism. Meth. *Biochem. Analysis*.**1**:27-52.

Farkas GL and Kiraly I. 1962. Role of phenolic compounds in the physiology of plant disease and disease resistance. *Phytopathology.* **44**:105-150.

Gopinathan K and Ananthakrishnan TN. 1985. Morphogenesis and histochemistry of some thrips (Thysanoptera: Insecta) induced galls. *Proc. Indian Natn. Sci. Acad.* **B51**:413-456.

Gupta JP.1997. Histochemical investigations of leaf gall of Tectona *grandis* L. incited by an unknown midge from sitamata forest Rajasthan. *J. phytol. Res.* **10(1-2):**43-46.

Johnson G and Schall LA. 1952. Reletion of chlorogenic and scab resistance in potatoes. *Science.* **115**:627-629.

Kant U, Qureshi MA and Jain P. 1992. *in vitro* studies of nematode induced gall of economically important plants, In: *Vistas of seed Biology Eds: singh, T. and P.C. Trevedi.* 91-97.

Kosuge T. 1969. The role of phenolics in host response to infection. *Ann. Rev. phytopath*. **7**:195-222.

Parthasarathi KD, RC Babu and PS Rao. 1970. Studies on sandal spike, VIII, polyphenolase activity and metabolism of sandal (*Santalum album* L.). *Proc Indian Acad. Sci*.**72B**: 277-284.

Purohit SD, Ramawat KG and Arya HC. 1979. phenolics, peroxidase and phenolase as related to gall formation in some arid zone plants. *Curr. Sci*. **48**: 714-716.

Ramani V. 1987. *In vitro* and *in-vivo* studies on the leaf rachis gall of *Prosopis cineraria* (L.) Druce induced by *Lobopteromyia prosopidis* mani.Ph. D. Thesis, university of Rajasthan, Jaipur.

Ramani V and Kant U. 1989. Phenolics and enzymes involved in phenol metabolism of gall and normal tissues of *prosopis cineraria* (Linn.) Druce *in vitro* and *invivo*. *Proc. Indian Natn. Acad.* **B55 (5 and 6).** 417-420.

Ranawat G and SD Purohit and HC Arya. 1979. Altered state of oxidising enzymes in *cordia* gall. *Trans. Isdis, ucds*. **4(1):** 38-41.

Sinshi H and M Moguch. 1975. Reletionship between peroxidase, IAA-oxidase and polyphenol oxidase. *Phytochem.* **14**: 1255-1258.

Sisodia R and Panti V. 2006. Histochemical localization of metabolites and enzymes in the leaf gall and normal leaf of *Diospyros melanoxylon* Roxb. *J.Indian Bot. Soc.* **85**:37-42.

Stonier TRW Singer and H Yang. 1970. Studies on auxin protectors IX. Inactivation of certian protectors by polyphenol oxidase. *Plant Physiol*. **46**: 454-457.

Tomaszenisui M and KV Thimann. 1966. Interactions of phenolic acid, metalic ions and chelating agents of auxin induced growth. *Plant Physiol*. **41**:1443-1454.

Webb JL. 1966. In: Quinones, Enzymes and metabolic inhibitors **3**: 421-494, *Newyork Academic press*.

Worthington Enzymes Manual. 1972. Enzymes, Enzyme reagents Related Biochemicals (*New Jesey: Worthington Corporation*) 216pp.