CHAPTER VI

SUMMARY AND CONCLUSIONS
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Plants are known to contain various antimicrobial substances (Thapliyal and Nene, 1967). The wide distribution of antibiotic principles has comprehensively been reviewed (Skinner, 1955). It was followed by survey of 174 research papers by Nickell (1960) which covered the distribution of antibiotics in 147 plant families. Various surveys carried out in U.S.A. and many other countries revealed that antibiotics can be obtained from higher plants too. Since then several antibacterial antibiotics have been extracted from higher plants by various workers and several research papers have been published on a large number of antimicrobial screening studies (Cavallito and Bailey, 1944; Heately, 1944; Chen et al., 1945; Bear et al., 1946; Irving et al., 1946; Kurup, 1956; Godbole and Pandse, 1960; Bhakuni et al., 1969; Mitschar et al., 1972; Roia and Smith, 1977; Leven et al., 1979; Pandey et al., 1982 etc.). Surprisingly, the antifungal principles of higher plants have received relatively little attention.

However, due to growing importance of agriculture, scientists, became more and more interested in antifungal antibiotics. Since most of the diseases of plants are of fungal origin. As such many synthetic organic and inorganic fungicides were discovered and put to use during recent years. The extensive application of many of them,
however, has been cautioned due to their phytotoxicity, carcinogenicity, teratogenicity and residual effects. This naturally has induced a prized position of antifungal antibiotics obtained from higher plants, which are presumed to be more systemic and less phytotoxic (Fawcett and Spencer, 1970). There is a pressing need to investigate new compounds for the development of more efficient and harmless antifungal substances. Recent researches on the fungitoxicity of higher plants have indicated their fruitful exploitation as a possible source of antifungal substances. Surprisingly, in our country much not/work has been done in this direction, although we have rich flora of angiosperms.

With this in view, the present study has been undertaken. About 137 plant samples belonging to 77 species of angiospermic plants were tested for their antifungal efficacy. The main aspects of present study were as follows:

1. Collection of plant materials from about 12 localities, their identification, storage and preservation.
2. Processing and extraction of plant materials in different solvents.
3. Antifungal screening of various extracts against certain plant pathogenic fungi viz. Fusarium sonalani
(Martius) Sacc., F. oxysporum f. udum (Butler) Snyder and Hensen, Sclerotium rolfsii Sacc., Phytophthora parasitica var. piperina Dastur, Botryodiplodia theobromae Pat., Alternaria solani (Ellis & Martin), Jones & Grout and Colletotrichum capsici Butler and Bisby and also against eight species of Aspergillus.

4. Selection of most effective antifungal extracts and their preliminary chemical estimations by successive solvent extraction and chromatography.

5. The antifungal efficacy of some purified samples of phytochemical constituents of most effective plant species.

The results obtained from the aforesaid study are summarized as follows:

1. ANTIFUNGAL ACTIVITY OF TEST PLANTS AGAINST FUSARIA

SOLANI (MARTIUS) SACC.

A. Aqueous Extracts

The efficacy of 137 samples of 77 angiospermic plants has been tested against Fusarium solani, a wilt pathogen of Phaseolus mungo. Out of 77 plants, the aqueous extracts of 36 species were found to cause negligible or poor (0-35%) inhibition. Moderate (36-50%) inhibitory effects were evident with 19 species. Rest of the plants showed strong or very strong antifungal effects.
Among the samples causing 51 to 70 percent suppression of fungal growth were those of *Acacia nilotica* (bark), *A. catechu* (bark), *Allium sativum* (bulb), *Butea monosperma* (leaves and bark), *Cassia fistula* (bark), *Callistemon lanceolatus* (bark), *Datura innoxia* (fruit), *Miliusa tomentosa* (bark), *Malvastrum tricuspidatum* (root), *Madhuca indica* (bark), *Ocimum basilicum* (leaves) and *Santalum album* (bark).

Samples which caused 71 to 100 percent inhibition of test fungus were those of *Acacia leucopholea* (bark), *Euphorbia thymifolia* (root), *Grevillea robusta* (leaves), *Lawsonia inermis* (leaves), *Parthenium hysterophorus* (aerial parts and roots), *Putranjiva roxburghii* (bark), *Ruta graveolens* (roots), *Ricinus communis* (roots), *Terminalia tomentosa* (bark) and *Vinca rosea* (leaves).

Different part of a plant species were not equally effective in case of almost of the test plants. For example, *E. thymifolia* roots caused 76.2% inhibition while its aerial parts could produce only 37.5% inhibition. *G. robusta* (leaves) caused complete suppression (100%) of fungal growth while bark suppressed it only upto 60%. Similarly, *P. hysterophorus* aerial parts (100%), *P. roxburghii* bark (100%), *R. communis* roots (72.5%) and *T. tomentosa* bark were more effective than their respective roots (72%), leaves (14.3%), leaves (25%) and leaves 64.3%).
These results are in agreement with those of Abdullaeva (1959), Mishra (1975) and Tripathi (1978) where the fungitoxicity in different parts of a plant has been found to vary. During present study the leaf and bark extracts of A. indica showed no activity. The effect of N. indicum and L. inermis were similar to those observed by Dube and Tripathi (1987).

Acacia nilotica leaf extracts showed poor activity (14.3%) while bark extracts were more effective (56.1%). Similarly, Singh and Dwivedi (1989) have also reported its bark extracts more inhibitory than leaf extracts against the growth of Sclerotium rolfsii. The bark of Acacia leucophloea was more effective (71.4%) than that of A. nilotica against F. solani. In case of A. catechu and A. concinna also the bark samples were more inhibitory than leaves. It is clear from results with these 4 species of the genus Acacia, that the bark constituents were strong antifungal than leaves. In general, Allium sativum was more inhibitory than Allium cepa. Similar findings were those of Singh and Dwivedi (1989) where A. sativum bulb extracts were more effective than A. ceapa against S. rolfsii. Two species of Cassia were tested where C. fistula was more effective than C. tora. Calotropis procera leaves were ineffective while roots could cause 38% inhibition. Among two species of Euphorbia Ethymifolia
was more effective than *F. hirta* where the root extracts of
former produced 76 percent inhibition. Among three
species of *Ficus*, only *F. religiosa* showed moderate
(43-48%) antifungal activity while *F. glomerata* and
*F. beng(h)alensis* showed no activity. *Grevillea robusta*
leaves showed absolute fungitoxicocity, however, its bark
was less effective (60%).

Results with *Aegle marmelos*, *Cordia dichotoma*,
*Dillenia* sp., *Dracaena* sp., *Holepelela integrifolia*,
*Jasminum grandiflorum*, *Moringa oleifera*, *Millingtonia*
hortensia*, *Morus lavigata*, *Momordica charantia*,
*Pathecellobium dulce*, *Pterocarpus marssupium*, *Pongamia*
pinnata, *Pterospermum acerifolium*, *Salmalia malabarica*,
*Tamarindus indica*, *Tagetes erecta*, *Tectona grandis*,
*Xanthium strumarium* and *Ziziphus jujuba* were insignificant.

*Ageratum conyzoides* (aerial part), *Bauhinia*
racemosa* (bark), *Bryophyllum calycinum* (leaf), *Citrus*
medica* (fruit), *Capsium annuum* (fruit), *Ipomea palmata*
(leaves), *Lantana camara* (leaves), *Murraya koenigii*
(bark), *Mangifera indica* (leaves), *Mimospos elengii*
(bark), *Osinum sanctum* (leaf), *Polyalthia longifolia*
(bark), *Raphanus sativus* (leaves), *Sapindus trifoliatum*
(bark) and *Syzygium cuminni* (bark) were found to cause
49, 42.8, 30, 40, 30, 48, 36, 47.1, 32.8, 31.4, 45.2,
31.4, 28.5, 40 and 42.8 percent inhibition of mycelial
growth of **Fusarium solani**.

Some of the plants which showed good antifungal effect were **Madhuca indica** (Leaves 45.7 and bark 64.1%), **Myctanthes arboristris** (leaves 47.5 and bark 50%) and **Santalum album** (leaves 47.8 and bark 55.7%). **Tridex procumbans** and **Zingiber officinale** were found to show poor activity on the mycelial growth of **F.solani**. Though in the studies of Dixit and Tripathy (1975), **T.procumbans** extracts showed 100% inhibition of spore germination of **Fusarium nivale** while no inhibition in **Cephalosporium sacchari**. Similar to the present findings the rhizome of **Z.officinale** showed insignificant activity against **Sclerotium rolfsii** (Singh and Dwivedi, 1989). During present study two species of **Ocimum** were tested, among these **O.basilicum** was better over **O.sanctum**.

**Narain and Satapathy (1977)** studied the effect of aqueous extracts of **Vinca rosea** leaves, flower, stem and roots against **Helminthosporium nodulosum**, **Sclerotium rolfsii**, **Pestalotia sp.**, **Fusarium oxysporum**, **Colletotrichum sp.**, and **Aspergillus niger**. They reported strong antifungal activity of all the test parts against most of their test pathogens, however, the leaf extracts were most growth inhibitory. Similar to the above findings, in the present study the leaves of **V.rosea** caused absolute fungitoxicity of **Fusarium solani**. They suggested the use
of *V. rosea* extract for plant disease control.

Although it has been established that when organisms are destroyed or their multiplication inhibited, they are said to be sensitive to that particular extract. The plant extracts which gave poor or negligible effects against test fungi should not be disregarded totally, considering that these are so many factors which affect end results in *in vitro* studies. The solubility of the drug or extract, may affect its rate of diffusion in the agar. Other factors may be, the stage of maturity, time of collection and storage which affect the quality, quantity and potency of antibiotic principles. Similarly, Roia and Sminth (1977) have also concluded that varied results may occur due to different methods of extraction and different parts of a plant. Furthermore, the metabolic activities of plants also vary in a more or less wide range during the various seasons, and antibiotics being substances formed in plants as secondary metabolities, the seasonal variation may have an effect on the formation, accumulation and decomposition of antimicrobial substance(s) in the plant (George and Pandalai, 1949).
Among other most effective plants, *Grevillea robusta*, *Lawsonia inermis*, *Parthenium hysterophorus*, *Putranjiva roxburghii*, *Ruta graveolens*, *Ricinus communis* and *Terminalia tomentosa* are of special mention.

Two species of *Terminalia* were tested and among these *T. tomentosa* was found to be more effective than *T. bellirica*. *Grevillea robusta* leaves and bark caused 100 and 60 percent inhibition, respectively while opposite effects were evident with *Putranjiva roxburghii* were leaves and bark caused 14.3 and 100 percent inhibition, respectively.

It is evident from foregoing results that antifungal property is neither a family character nor a generic one. It varies from family to family, from genus to genus and from species to species. On the basis of comparison of the effects, the bark samples showed more antifungal activity than leaf samples in most of the plant species.

Root extracts of *Ricinus communis* also showed strong antifungal effect (72.5%). Similarly *Ruta graveolens* roots caused 82.1% inhibition while leaves caused 57.1 percent inhibition. The aerial parts of *Parthenium hysterophorus* caused absolute fungitoxicity
against \textit{F. solani}, however, its roots extracts could inhibit the fungal growth upto 72 percent. \textit{Lawsonia inermis} leaf extract was found to suppress \textit{F. solani} to a great extent (85.7\%). There are good records in the literature on the fungitoxic properties of \textit{Lawsonia inermis}. Tripathi (1980) has studied leaf extracts of this plant in details by using \textit{Helminthosporium oryzae} as test pathogen. From the leaves of \textit{Lawsonia inermis} a fungitoxic principle has also been isolated by Tripathi et al. (1978). These workers named it as 'Lawsone' and it was found to exhibit fungicidal activity, wide fungitoxic spectrum and nonphytotoxicity.

B. Ethanolic Extracts:

On the basis of aforesaid results, to evaluate further the antifungal properties of most active samples, ethanolic extraction of plant parts was made and their extracts were further tested against \textit{F. solani}. The selection of 14 samples was made for further study.

Out of the 14 test samples, 5 were found to cause absolute fungitoxicity (i.e. 100\% inhibition). The aqueous extracts of these samples also caused similar complete inhibition of mycelial growth. These samples were, \textit{Grevillea robusta} (leaves), \textit{Lawsonia inermis} (leaves), \textit{Parthenium hysterophorus} (aerial parts), \textit{Vinca rosea} (leaves), \textit{Putranjiva roxburghii} (bark) and \textit{Terminalia
tomentosa (bark). It is clear from these results that the fungicidal constituents of these plant samples can be extracted in both the solvents, i.e. water and ethanol.

The selection was made from these plants and three samples were selected for further study. These were Grevillea robusta (leaves), Parthenium hysterophorus (aerial parts) and Terminalia tomentosa (bark). Though, the bark of Putranjiva roxburghii was also equally effective, but its very rare occurrence could provide only limited quantity of bark.

2. Broad spectrum activity of P. hysterophorus, T. tomentosa and G. robusta against 15 fungi

A. Aqueous Extracts

The crude extract of P. hysterophorus showed absolute fungitoxicity (100%) against Fusarium solani and Phytophthora parasitica var. piperina. It also showed strong activity against three species of Aspergillus viz. A. fumigatus, A. niger and A. ochraceous. While against all other test fungal species, the extract was found to produce poor or moderate antifungal effects. Interestingly, it showed no effect against Fusarium oxysporum f. udum while on the other hand absolute toxicity against Fusarium solani. While comparing the effects of various extracts with those of Griseofulvin (an antifungal antibiotics) P. hysterophorus aqueous extract showed more or less equal
or more antifungal activity than that of griseofulvin (1.0 mg/ml) against many fungi.

The bark of *T. tomentosa* also showed absolute toxicity against two pathogenic fungi viz. *F. solani* and *P. parasitica* var. *piperina*. Mycelial growth of *F. oxysporum* f. *udum* was inhibited about 40% by this extract. In general, *T. tomentosa* showed poor or moderate antifungal effects against all other test fungi. The antifungal activity of *T. tomentosa* against *P. parasitica* var. *piperina*, *Colletotrichum capsici* and *A. fumigatus* was more or less equal to that shown by griseofulvin (1 mg/ml).

The leaf extract of *G. robusta* produced absolute toxic effects (100%) against *F. solani* and *P. parasitica* var. *piperina*, while some good activity against *Aspergillus niger* (57.1%). This extract produced moderate or poor antifungal effects against all other test fungal organisms.

**B. Ethanolic Extracts:**

The growth of *Fusarium solani* and *P. parasitica* var. *piperina* was completely suppressed by the extracts of all these three plants. The absolute toxicity against *F. solani* and *P. parasitica* var. *piperina* by both the extracts; H$_2$O- and C$_2$H$_5$OH- of *P. hyberophorus*, *T. tomentosa* and *G. robusta* indicates that the antifungal constituents for the concerned fungal pathogens can be extracted out by both the solvents i.e. water and ethanol.
**P. hysterophorus** also acted strongly against *Alternaria solani* (60%) and *Aspergillus niger* (61.2%), while against other fungi it acted moderately or poorly. Effects of *P. hysterophorus* ethanolic extracts against *P. parasitica* var. *piperina*, *B. theobromae* and *A. niger* were almost equal to those caused by 1.0 mg/ml griseofulvin. Similar comparison can also be made for *T. tomentosa* bark against *P. parasitica* var. *piperina*, *C. capsici* and *A. fumigatus*.

On the basis of overall results it is evident that varied responses were shown by most of the test fungal species. Even two species of a genus were not similar in their responses against the same extract. This suggests that perhaps, these species may require even larger quantities of material for complete or strong inhibition.

3. Dosage-Growth Responses of *P. hysterophorus*, *T. tomentosa* and *G. robusta* against *F. solani*

During these investigations, a range of 0.02 to 40.0 mg/ml concentration of crude aqueous extracts and a range of 0.05 to 70 mg/ml concentration of ethanolic crude extracts were tested. The aqueous extract of *P. hysterophorus* was found to be strongly effective from 2.5 to 10 mg/ml concentration. Lower to this (< 2.5) caused gradually poor effects while higher concentration (> 10 mg/ml) caused absolute (100%) fungitoxic effects.
In case of *T. tomentosa* the absolute toxicity was evident above 20 mg/ml and the strong toxic effects could be obtained at the concentrations higher than 7.5 mg/ml. Comparatively stronger effects (> 40%) were evident beyond 2.5 mg/ml concentration in case of *G. robusta*. *G. robusta* showed absolute toxicity at the concentration higher than 7.5 mg/ml.

The ethanolic extracts of all the three test plant species showed moderate to poor antifungal effects at or below 7.5 mg/ml. Very strong (> 90%) antifungal activity was evident at and above 10 mg/ml in cases of *P. hysterophorus* and *G. robusta* while at and above 15 mg/ml concentration in case of *T. tomentosa*. From overall results it can be observed that the antifungal efficacy of aqueous as well as that of ethanolic extracts was increased gradually with the increase of concentration. In general the aqueous extracts were more effective than ethanolic extracts.

**Detailed study of Parthenium hysterophorus Linn.**

Among the very strong antifungal plant materials, three species showed although promising effects. These are *Grevillea robusta* A.Cunn. (leaves), *Parthenium hysterophorus* Linn. (aerial parts) and *Terminalia tomentosa* W. & A. (bark). A selection for further detailed study has been made from among these three species. *Grevillea*
robusta and *Terminalia tomentosa* are tree species and are sparse in their occurrence, therefore their material (leaves or bark) seems difficult to collect in sufficient quantities for their large scale agricultural use against plant pathogens. However, these plants may be explored against fungal pathogens involved in human and other animal diseases or against some other suitable fungi. On the other hand, *P. hysterophorus*, a herbaceous weed, can provide plenty of material for any type of large scale use. Moreover, its delicate aerial parts are easier to process for chemical extraction and to search for antifungal drugs in appreciable quantities. With all this in view, this herbacious weed was selected for detailed study.

This weed has also been known to show insecticidal and herbicidal properties. Sesquiterpene lactones of *P. hysterophorus* are effective physiological and behavioural inhibitors against insects (Jones et al. 1979; Pickman et al., 1981) suggesting that these compounds may play an important role in plant defence against herbivory by insects (Mabry and Gill, 1979; Isman and Rodriguez, 1983). Antifungal properties of *P. hysterophorus*, have not yet been explored. Due to its strong antifungal action it seems worthwhile to have a look on its active constituents responsible for fungitoxic properties. The present work has been made on preliminary isolation of some chemical
constituents from aerial parts of *P. hysterophorus* and their effect on fungal growth. Certain factors in relation to the fungitoxic properties of the plant have also been studied.

1. **Factors effecting fungitoxic properties of *P. hysterophorus* L.**

   The result indicates that drying of material apparently had no adverse effect on its antifungal activity. It is also evident that the dried material stored at room temperature retained its activity for 120 days, the maximum period taken in to consideration in the present study. The autoclaved material showed 100 percent inhibition of mycelial growth indicating that antifungal factor in the aerial parts is not affected at all by autoclaving.

   Six lots each of 250 g material were taken and placed in incubators separately at different temperatures viz. 50, 75, 100, 125, 150 and 175 for one hour. After keeping at room temperature for one hour these samples were extracted separately with ethanol and tested for their activity against *F. solani*. The material retained activity upto 75°C after which the activity decreased gradually with the further increase in temperature. After 150°C the activity was completely lost.
2. Preliminary chemical analysis and the antifungal activity of phytochemical constituents

A. Effect of various fractions of successive extraction

The plant extract of \textit{P. hysterophorus}, obtained after the extraction of aerial parts in Petroleum ether, Benzene and Solvent ether, were found to remain ineffective. Their antifungal efficacy was nil against \textit{F. solani}.

Acetone extracts caused mycelial inhibition upto only 37.2% and this extract remained poor (30 to 37% inhibition) in almost all the test dilutions (viz. 1:100, 2:100 and 3:100).

Strong antifungal activity was evident with Chloroform, Ethanol, Chloroform : water, and Methanol extracts as they caused 78, 59, 87 and 52 percent inhibition of fungal growth, respectively at their dilution of 1:100 (v/v) in CDA. Higher concentration (≥ 2:100) of all these 4 extracts were still more fungitoxic and at 3:100 concentration they caused absolute fungitoxicity (100%) against \textit{F. solani}. These results indicated that \textit{P. hysterophorus} (aerial parts) probably contains a good number of antifungal constituents (may be of varied chemical nature), and these can be extracted out separately according to their solubility in water, chloroform, methanol, chloroform-water and ethanol.
The results on the effect of Chloroform, Ethanol and Methanol fractions (2:100 dilution) against *F.solani* and other six plant pathogenic fungi viz. *F.oxysporum f.udum*, *Sclerotium rolfsii*, *Phytophthora parasitica* var. *piperina*, *Botryodiplodia theobromae*, *Alternaria solani* and *Colletotrichum capsici*. All the test fractions caused absolute toxicity (100%) not only against *F.solani* but also against *P.parasitica* var. *piperina* (a very destructive pathogen, causes leaf and foot rot of a cash crop Pan - *Piper betle*).

Other pathogenic fungi were suppressed only moderately or slight strongly by the used concentration (2:100) of all the three test fractions. Among these, methanol extract was strongly active (62%) against *F.oxysporum f.udum* and chloroform extract (60%) against *B.theobromae*; which is known to be a very aggressive pathogen and causes very severe rots of mostly fruits of about 140 plant species (Bilgrami et al., 1979).

**B. Effect of extracted phytochemical constituents**

During this study, the Sterols, Glycosides, Alkaloids and Aglycones were extracted separately. These chemical constituents from aerial parts of *P.hysterphorus* were obtained in crude form and were tested for their antifungal efficacy against the mycelial growth of *F.solani* and against six other plant pathogenic fungi.
Two phytochemical groups viz. Glycosides and Alkaloids were found to cause strong antifungal effects against *F. solani*. These constituents were found to cause 100 and 94 percent fungal inhibition respectively at 3:100 concentration. Lower concentrations (1:100 and 2:100) were, however, less effective, though, the glycosides extractive was absolute fungitoxic (100%) at 2:100 concentration also.

Sterol extractives produced no activity at all the three test dilutions. Aglycone extractives were however produced antifungal effect upto certain good extent (50%) at 3:100 dilution, lower concentrations were less effective.

The Glycosides and Alkaloids of *P. hysterophorus* are strong enough to check the fungal growth, however, at dilutions more than 3:100, and the degree of growth inhibition was more or less directly correlated to the relatives quantities of constituents. For the purpose of further evaluations, Glycoside and Alkaloid extractives were also tested against other pathogenic fungi viz. *F. oxysporum f. udum*, *S. rolfsii*, *P. parasitica* var. *piperina*, *B. theobromae*, *Alternaria solani* and *C. capsici*.

Interestingly, the glycosides (crude extractive) of *P. hysterophorus* caused absolute fungitoxicity (100%) against almost all the test pathogens at 2:100 and at higher concentration.
Alkaloids (crude extractives) were, however, less effective against *F. oxysporum* f. *udum*, *S. rolfsii*, *B. theobromae*, *A. solani* and *C. capsici* at 3:100 concentration. Low concentrations (i.e. 1:100, 2:100) were even more poorly acted. However, inhibitory activity was increased with the increase of concentration. Against *F. solani* and *P. parasitica* var. *piperina* the alkaloidal extractive was found to show strong (72 to 100%) antifungal effects.

From these findings it is clear that, a good number of antifungal natural compounds resides in *P. hysterophorus* aerial parts most probably in glycosidic and in alkaloidal forms. Detailed chemical purification studies are needed for isolation and structural elucidation of various glycoside(s) and alkaloid(s) of this plant. Moreover, these natural chemical constituents can also be studied with other aspects such as their phytotoxic, cytogenetic effect etc. During further investigation, the glycosidal and alkaloidal groups of *P. hysterophorus* were further purified and their antifungal effects were observed.

(c) **Antifungal activity of purified phytochemicals**

During this study isolation, preliminary chemical characterization and purification of alkaloids and glycosides of *P. hysterophorus* were made.
Total 8 solvent systems were used to determine the hRf-values of alkaloids of ethanolic plant extract. The extract was then processed through column chromatography and hRf-values of purified fractions were further determined. During these observations the spot of only one alkaloid was appeared on TLC plates. This probably indicates the presence of atleast one prominent alkaloid in sufficient quantities in aerial parts of *P. hysterophorus*. Romo de Vivar et al. (1970). Yashioka et al. (1970) and Wickman et al. (1980) have shown the presence of various phytochemicals including certain alkaloids in some other species of *Parthenium*. The presence of other alkaloid(s) in test species, may be in trace(s) or which are not appeared in the solvent systems of present study may only be confirmed by more detailed chemical investigations with many more solvent systems and advanced technology. However, it is evident from the present study that atleast one alkaloid of this plant may be isolated by simpler methods.

Chromatographic observation has revealed the presence of atleast two prominent glycosidic compounds in the aerial parts of the test plant. The two compounds showed well differentiable hRf-values in almost all the solvent systems. Shen et al. (1976) have reported the presence of three phenolic glycosides in *P. hysterophorus*. However, only further spectral and elemental analysis (UV,
IR etc.), HPLC and other determination may elucidate the exact chemical structure, diversification etc. of the present isolated glycoside fractions.

These purified samples were then tested for their antifungal efficacy against *Fusarium solani*. The two fractions i.e. alkaloid CD 52 and glycoside MCAA 80 were found to produce absolute toxicity against *F. solani*. Another glycoside fraction i.e. MCAA 58, however, showed lesser activity (77%). There is no report on the antifungal efficacy of these phytochemical constituents as well as on that of aqueous, ethanolic and others extracts of *P. hysterophorus* in the available literature. It is clear from the foregoing results that the alkaloidal and/or glycosidal principles of this plant may further be investigated for large scale extraction, chemical characterization, antimicrobial and phytotoxic evaluation and for many other implications in view of their applied use.

The elimination of Parthenin and Ambrosin, the sesquiterpenes and some other chemicals which are considered to be allergic factors in this plant (Savangikar and Joshi, 1978; Lonkar et al., 1974; Tower et al., 1977) must also be considered in details before raw use of this plant. Inspite of these backlashes of the
plant, it is evident from over all study that its phytochemical constituents show very strong fungitoxic activity and this valuable property may be utilized for the cure of widespread fungal diseases of varied nature.