INTRODUCTION

Chilli (Capsicum annuum L.) is one of the most important economic food crops grown in various countries for domestic usage and export. It is used as a vegetable (fresh) as well as a spice (dried). India is one of the largest producers of chilli. The chilli suffers from various diseases, and chilli anthracnose is one of the most important among them. It is the most important disease of chilli in tropics and subtropics worldwide. The disease drastically reduces the yield, deteriorates the fruit quality, and hence results in low returns to farmers. In severe cases, the crop loss may exceed 50%. Species of the genus Colletotrichum such as C. capsici, C. gloeosporioides, C. acutatum etc have been identified as pathogens causing chilli anthracnose. Out of these, C. capsici is the major pathogen causing anthracnose disease (Gomathi and Kannabiran, 2000; Kaur et al., 2006; Montri et al., 2009; Susheela, 2012; Chaisemsaeng et al., 2013).

Various fungicides such as mancozeb, captan, bavistin, thiram, copper oxychloride, cosan, benlate and ziram are employed in order to control anthracnose disease. The resistance to these fungicides has been noticed in most fungal pathogens including C. capsici. Moreover, the residues of these fungicides remain in the harvested produce. Hence, search for alternative disease control strategies are of immense interest. Natural products are promising in terms of their low cost, potential efficacy as well as no or negligible side effects. Plants and their derivatives have been extensively studied for the control of phytopathogenic fungi. Several studies have been carried out on inhibitory potential of many botanical extracts against phytopathogenic fungi including species of Colletotrichum (Gomathi and Kannabiran, 2000; Kumaran et al., 2003; Nduagu et al., 2008; Rahman et al., 2011; Mukherjee et al., 2011; Johnny et al., 2011; Bajpai and Kang, 2012; Ajith et al., 2012; Dileep et al., 2013; Jagtap et al., 2013; Sundaramoorthy et al., 2014).

India has a rich floristic diversity which represents about 11% of total flora of the world. Western Ghats of India is one among the global biodiversity hotspots. The mountain ranges of Western Ghats harbor a large number of plant species with high degree of endemism. It is a mountainous range extending from the mouth of the river Tapti in Gujarat to Kanyakumari in Tamil Nadu. The Western Ghats encompass various vegetation types such as wet evergreen forests, moist and dry deciduous forests, montane forests, sholas, scrub and savannas (Richard and Muthukumar, 2012; Sundaramoorthy et al., 2014). Western Ghats of Karnataka, known as Sahyadri, represents a long mountain chain along the west coast of India and encompass districts namely Chikmagalur, Shimavogga, Udipi, Dakshina Kannada, Uttar Kannada, Hassan and Coorg. The present study was carried out to investigate...
the antifungal efficacy of 35 plants (belonging to 23 families) from three different regions viz., Haniya and of P. macrantha (16.13%) respectively. Next to M. indica, leaf extract of P. dioica caused high inhibition of fungus (70.96%). An inhibition of 60-70% was observed in case of leaf extract of F. tetraphylla, F. montana and P. scandens, L. roxburghii and C. odorata and bark extract of F. zeylanica. Inhibition of fungus ranged 50-60% in case of leaf extract of J. arborescens, F. zeylanica, O. dioica, A. lakoocha, A. indica and C. roxburghii, bark extract of D. montana and P. macrantha, root extract of A. curassavica and whole plant extract of H. indicus. All other extracts (except leaf extract of P. macrantha) inhibited the fungus to an extent which ranged between >20 and <50%.

Bark extract of D. montana inhibited the fungus to high extent than leaf extract. Leaf extract of D. buxifolia was more effective than that of leaf extract of D. montana. Leaf extract of T. heyeana inhibited fungus to high extent when compared to flower extract. Leaf extract of C. odorata was more inhibitory to fungus than inflorescence extract. In case of F. zeylanica, bark extract was more effective in inhibiting the fungus when compared to leaf extract. The extract from roots of A. curassavica inhibited the growth of fungus to high extent when compared to leaf and flower extracts which showed similar inhibition. Extracts from all parts of L. speciosa exhibited similar inhibition of the fungus. The bark extracts of P. macrantha and A. occidentale exhibited stronger inhibitory activity when compared to leaf extracts. In case of leaf and bark extract of P. dioica, leaf extract caused higher suppression of fungal growth. Rhizome extract of A. galanga was effective in inhibiting fungus to high extent than leaf “extract. Leaf and flower extracts of P. ferrugineum, D. regia and C. pulcherrima exhibited more or less similar inhibition of C. capsici.

In an earlier study, Johnny et al. (2011) showed dose dependent inhibitory activity of leaves of A. galanga and A. mnicata against C. capsici. Extract of A. galanga exhibited stronger inhibition of fungus than extract of A. muricata. However, in our study, leaf extract of A. muricata inhibited C. capsici to higher extent than leaf extract of A. galanga. In an earlier study, Nduagu et al. (2008) found that extract of C. odorata failed to cause reduction in the colony diameter of C. capsici. However, in our study, the leaf and inflorescence extract of C. odorata inhibited mycelial growth of the fungus. Leaf extract was found to be more effective. Kumaran et al. (2003) found low inhibitory potential of L. aspera when compared to R. tetraphylla against C. capsici. In our study also, similar result was observed. The study of Sarathambal et al. (2011) revealed the efficacy of solvent extracts of L. aspera against a panel of fungi which included C. capsici. In a previous study, we reported inhibitory effect of leaf and bark extracts of P. dioica and A. occidentale against Fusarium oxysporum f.sp. zingiberi isolated from soft rot of ginger. Leaf extracts of both the plants were more effective in inhibiting mycelial growth of fungus when compared to bark extracts (Vivek et al., 2013). In the present study, similar result was observed only in case of P. dioica but not in case of A. occidentale as bark extract of A. occidentale inhibited fungus to higher extent than leaf extract.
Table 1: Plants used in this study.

| No. | Name of the plant                      | Family            | Habit   | Part/s used      | Place of collection |
|-----|----------------------------------------|-------------------|---------|------------------|--------------------|
| 1   | Tabernaemontana heyneana Wall.         | Apocynaceae       | Tree    | Leaf, flower     | Haniya             |
| 2   | Rauvolfia tetraphylla L.               | Apocynaceae       | Shrub   | Leaf             | Haniya             |
| 3   | Psychotria nigra (Gaert.) Alston       | Rubiaceae         | Shrub   | Leaf             | Haniya             |
| 4   | Flacourtia montana Graham              | Flacourtiaceae    | Tree    | Leaf             | Haniya             |
| 5   | Jasminum arborescens Roxb.             | Oleaceae          | Shrub   | Leaf             | Haniya             |
| 6   | Rubia cordifolia Linn.                 | Rubiaceae         | Climbing herb | Whole plant   | Haniya             |
| 7   | Aglaia roxburghiana (W. & A) Miq. Var. Beddomei | Euphorbiaceae | Sub-shrub | Leaf, root, flower | Haniya             |
| 8   | Pothis scandens L.                     | Araceae           | Climbing shrub | Leaf | Haniya             |
| 9   | Diospyros montana Roxb.                | Ebenaceae         | Tree    | Leaf, bark       | Haniya             |
| 10  | Leucas aspera (Willd.) Linn.           | Lamiaceae         | Herb    | Leaf             | Haniya             |
| 11  | Trichosanthes asiatica (Thunb.) R. King & H. Robinson | Asteraceae | Perennial shrub | Leaf, inflorescence | Haniya             |
| 12  | Fahrenheitia zeylanica (Thw.) Ainy     | Euphorbiaceae     | Tree    | Leaf, bark       | Hulikal            |
| 13  | Olea dioica Roxb.                      | Oleaceae          | Tree    | Leaf             | Haniya             |
| 14  | Maesa indica (Roxb.) A.DC              | Myrsinaceae       | Small tree | Leaf | Haniya             |
| 15  | Asclepias curassavica L.               | Asclepiaceae      | Sub-shrub | Leaf, root, flower | Haniya             |
| 16  | Elaeagnus kologa Schlecht              | Elaeagnaceae      | Shrub   | Leaf             | Haniya             |
| 17  | Artocarpus lakoocha Roxb.              | Moraceae          | Tree    | Leaf             | Hulikal            |
| 18  | Croton roxburghii Balak.               | Euphorbiaceae     | Tree    | Leaf             | Haniya             |
| 19  | Lagerstroemia speciosa (L.)            | Lythraceae        | Medium sized tree | Leaf, seed, flower | Haniya             |
| 20  | Ligustrum roxburghii C.B. Clarke       | Oleaceae          | Tree    | Leaf             | Haniya             |
| 21  | Annona muricata Linn.                  | Annonaceae        | Tree    | Leaf             | Maragalale         |
| 22  | Persea macrantha (Nees.) Kosterm.      | Lauraceae         | Tree    | Leaf, bark       | Haniya             |
| 23  | Pimenta dioica (Linn.) Merril          | Myrtaceae         | Tree    | Leaf, bark       | Maragalale         |
| 24  | Anacardium occidentale L               | Anacardaceae      | Tree    | Leaf             | Maragalale         |
| 25  | Ziziphus mauritiana Lam.               | Rhamnaceae        | Small tree | Leaf | Maragalale         |
| 26  | Alpinia galanga Willd.                 | Zingiberaceae     | Herb    | Leaf, rhizome    | Maragalale         |
| 27  | Capsicum frutescens Linn.              | Solanaceae        | Sub-shrub | Leaf | Haniya             |
| 28  | Mucuna pruriens Linn.                  | Fabaceae          | Twining herb | Flower | Haniya             |
| 29  | Anisomeles indica Linn.                | Lamiaceae         | Herb    | Leaf             | Haniya             |
| 30  | Hedemusmus indicus R.Br                | Asclepiadaceae    | Semi-erect shrub | Root | Maragalale         |
| 31  | Caesalpinia pulcherrima Linn.          | Fabaceae          | Shrub   | Leaf and flower  | Maragalale         |
| 32  | Delonix regia (Bojer Ex. Hook.)        | Fabaceae          | Tree    | Leaf and flower  | Maragalale         |
| 33  | Peltaphorum ferrugineum                | Fabaceae          | Tree    | Leaf and flower  | Maragalale         |
### Table 2: Antifungal activity of selected plants

| Sl. No. | Plant name     | Part used | C.D in cm | % inhibition |
|---------|----------------|-----------|-----------|--------------|
| 1       | Control        |           | 3.1±0.1   |              |
| 2       | *T. heyneana*  | Leaf      | 1.9±0.0   | 38.70        |
|         |                | Flower    | 2.0±0.0   | 35.48        |
| 3       | *R. tetraphylla* | Leaf      | 1.0±0.0   | 67.74        |
| 4       | *P. nigra*     | Leaf      | 2.1±0.1   | 32.26        |
| 5       | *F. montana*   | Leaf      | 1.2±0.1   | 61.29        |
| 6       | *J. arborescens* | Leaf      | 1.5±0.0   | 51.61        |
| 7       | *R. cordifolia* | Leaf      | 2.0±0.1   | 35.48        |
| 8       | *A. roxburghiana* | Leaf      | 2.0±0.0   | 35.48        |
| 9       | *C. dicoccum*  | Leaf      | 2.4±0.2   | 22.58        |
| 10      | *P. scandens*  | Leaf      | 1.1±0.0   | 64.52        |
| 11      | *D. montana*   | Leaf      | 1.5±0.0   | 51.61        |
|         |                | Bark      | 1.5±0.2   | 51.61        |
| 12      | *L. aspera*    | Leaf      | 2.2±0.2   | 29.03        |
| 13      | *C. odorata*   | Inflorescence | 2.2±0.1 | 29.03        |
|         |                | Leaf      | 1.1±0.0   | 64.52        |
| 14      | *F. zeylanica* | Leaf      | 1.4±0.0   | 54.83        |
|         |                | Bark      | 1.2±0.0   | 61.29        |
| 15      | *O. dioica*    | Leaf      | 1.5±0.0   | 51.61        |
| 16      | *M. indica*    | Leaf      | 0.8±0.1   | 74.19        |
|         |                | Leaf      | 1.7±0.1   | 45.16        |
| 17      | *A. currasavica* | Root      | 1.5±0.0   | 51.61        |
|         |                | Flower    | 1.7±0.2   | 45.16        |
| 18      | *E. kologa*    | Leaf      | 1.6±0.1   | 48.39        |
| 19      | *A. lakoocha*  | Leaf      | 1.5±0.0   | 51.61        |
| 20      | *C. roxburghii* | Leaf      | 1.5±0.0   | 51.61        |
|         |                | Leaf      | 2.2±0.2   | 29.03        |
| 21      | *L. speciosa*  | Seed      | 2.2±0.2   | 29.03        |
|         |                | Flower    | 2.2±0.1   | 29.03        |
| 22      | *L. roxburghii* | Leaf      | 1.2±0.0   | 61.29        |
| 23      | *A. muricata*  | Leaf      | 1.6±0.1   | 48.39        |
| 24      | *P. macarantha* | Leaf      | 2.6±0.1   | 16.13        |
| 25      | *P. dioica*    | Leaf      | 0.9±0.1   | 70.96        |
|         |                | Bark      | 1.9±0.0   | 38.70        |
| 26      | *A. occidentale* | Leaf      | 2.4±0.1   | 22.58        |
|         |                | Bark      | 1.7±0.1   | 45.16        |
| 27      | *Z. mauritiana* | Leaf      | 1.9±0.1   | 38.70        |
| 28      | *A. galanga*   | Leaf      | 2.0±0.0   | 35.48        |
| 29      | *C. frutescens* | Leaf      | 2.2±0.0   | 29.03        |
| 30      | *D. buxifolia* | Leaf      | 1.6±0.1   | 48.39        |
| 31      | *M. pruriens*  | Flower    | 2.3±0.1   | 25.80        |
| 32      | *A. indica*    | Leaf      | 1.5±0.0   | 51.61        |
| 33      | *H. indicus*   | Whole plant | 1.4±0.0 | 54.83        |
| 34      | *P. ferrugineum* | Leaf      | 2.0±0.0   | 35.48        |
| 35      | *D. regia*     | Flower    | 2.1±0.0   | 32.25        |
| 36      | *C. pulcherrima* | Leaf      | 2.0±0.0   | 35.48        |

Note: C.D = concentration of the sample in cm
Figure 1: Colonies of *C. capsici* on control and poisoned plates [1-16] (1-Control; 2-A.curassavica leaf; 3-A.curassavica flower; 4-A.curassavica root; 5-F.zeylanica leaf; 6-F.zeylanica bark; 7-P.macrantha leaf; 8-P.macrantha bark; 9-L.roxburghii; 10-P.dioica bark; 11-P.dioica leaf; 12-A.muricata; 13-D.buxfolia; 14-D.montana leaf; 15-D.montana bark; 16-R.tetraphylla; 17-T.heyneana leaf; 18-T.heyneana flower; 19-C.odorata leaf; 20-C.odorata inflorescence; 21-A.roxburghiana; 22-O.dioica; 23-J.arborescens; 24-M.indica)
Figure 2: Colonies of C. capsici on control and poisoned plates [25-44] (25-P.nigra; 26-F.montana; 27-E.kologa; 28-C.dicoccum; 29-C.roxburghii; 30-R.cordifolia; 31-P.scandens;32-A.lakoocha; 33-H.indicus; 34-M.pruriens; 35-A.indica; 36-D.regia leaf; 37-Z.mauritiana; 38-C.frutescens; 39-A.galanga leaf; 40-A.galanga rhizome; 41-P.ferrugineum flower; 42-P.ferrugineum leaf; 43-C.pulcherrima flower; 44-C.pulcherrima leaf)
CONCLUSION

The use of fungicides of plant origin has been shown an effective alternative to synthetic chemicals in order to counter the potential hazardous effect on the environment as well as consumer. In the present study, the extracts of all 29 plants collected at different regions of Western Ghats of Shivamogga district, Karnataka displayed inhibitory activity against chilli anthracnose causing fungus in terms of inhibition of mycelial growth. These plants can be exploited as natural fungicides for the control of chilli anthracnose. The study made here is an \textit{in vitro} study and further experiments fields is required to ascertain the possible application of these botanicals for the management of disease.

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