SJIF IMPACT FACTOR: 5.79 CRDEEP Journals
International Journal of Life Sciences Handiso et.al., Vol. 7 No. 1 ISSN: 2277-193x
*International Journal of Life Sciences. Vol. 7 No. 1. 2017. Pp. 9-15*


*Full Length Research Paper*

# A Comparative Study on Aqueous Extracts of Some Indigenous Medicinal Plants and Fungicides against Anthracnose (*Colletotrichum spp*) of Chili (*Capsicum spp*)

**Serawit Handiso[a*] and Tesfaye Alemu[b]**

[a]*Wolaita Sodo University, Department of Plant Sciences, College of Agriculture, Po Box 138, Wolaita Sodo, Ethiopia*

[b]*Addis Ababa University, Department of Microbial, Cellular and Molecular Biology, College of Natural Sciences, Po Box: 1176, Addis Ababa, Ethiopia.*

**Article history**
*Received: 15-10-2017*
*Revised: 25-10-2017*
*Accepted: 01-11-2017*

**Corresponding Author:**
**Serawit Handiso**
*Wolaita Sodo University, Department of Plant Sciences, College of Agriculture, Po Box 138, Wolaita Sodo, Ethiopia.*

***Abstract***
*Chili (capsicum spp), one of the principal vegetable crop, is being affected by several diseases. Among these, anthracnose caused by Colletotrichum spp is the most prevalent one. This research was aimed to manage anthracnose* by using different botanical and fungicide antagonist.*The treatments were laid in CRD and replicated thrice. The results of the study showed that among aqueous extracts of 8 plant species evaluated the best were aqueous matico extracts, which reduced disease severity by 77.4% followed by Garlic (56.4%), Ginger (48.6%), Phytolacca dodecandra (27.28%) and Desmodium dichotomum (24.2%)). Least growth inhibition of Colletotrichum isolates was obtained from Solanum marginatum (9.14%).Among fungicides copper oxy chloride (systemic) was found to be most effective which inhibited the growth of the fungus at all three concentrations (0.05, 0.1 and 0.15 percent), that is 86, 94.9, and 98.4% respectively. Similarly 36.24, 47.29, 52.66, 53.96, and 62.2 percent inhibition was observed in case of Mancozeb (non-systemic) at 0.05, 0.1, 0.15, 0.2 &0.3 percent concentration. Therefore, the utilization of botanicals must be encouraged among small scale poor farmers of Ethiopia.*

**Key words:** *Capsicum spp; Colletotrichum spp; fungicides; Matico extract*

**Introduction**

Chilli (*Capsicum* spp) is infected by different fungal pathogens, among them anthracnose is the most serious fungal disease and is caused by *Colletotrichum gloeosporioides*. (Shivapuri, *et al*., 1997; Than *et al*., 2008; Narasimhan and Shivakumar, 2012).*Colletotrichum gloeosporioides* has also been reported to cause anthracnose in many tropical fruit trees such as mango, papaya (Pandey *et al*., 2011). This disease is very harmful and can cause spoilage and rotting of fruit plants, resulting in low yield and poor quality of the fruits (Peraza-S´anchez*etal*., 2005).

Among the large number of diseases affecting chilli cultivation, anthracnose disease caused by *Colletotrichum* species, infection has been most detrimental to chilli production (Than et al., 2008). Anthracnose disease has been reported to be a major constraint in chilli production in tropical and subtropical countries causing huge losses. An estimated annual loss of about 29.5%, amounting whopping figure of US$ 491.67 million has been reported from India alone (Garg et *al.,*2014). In India, a calculated loss of 10–54% has been reported in yield of the crop due to the anthracnose disease (Lakshmesha *et al.,*2005; Ramachandran and Rathnamma, 2006). Significant losses have been reported from other parts of the world as well, like a significant amount of 20–80% loss has been accounted from Vietnam (Don *et al.,*2007) and about 10% from Korea (Byung, 2007). The loss is high owing to the post and pre harvest involvement of the pathogen causing a loss of 10–80% of the marketable yield of chili fruits (Than et al., 2008). Management of chili anthracnose has been a burning issue for the agriculturists and the farmers as till date, no effective control measures has been proposed. The fall in the chili production and the drop in fruit quality have further intensified the need for developing a sustainable approach for controlling the spread of the disease. No single management technique has been found to efficiently control the disease. Generally, using a combination of the different strategies like chemical control, biological control, physical control and intrinsic resistance has been recommended for managing the disease (Agrios, 2005). Numerous reports on the destructive effects of the use of fungicides on farmers' health, economic status, and toxic contamination of the environment, particularly in developing countries cannot be ignored (Voorrips *et al.,*2004; Garg*et al.,*2014). Different classes of fungicides have specific mode of action along with their duration of effect on disease control. So, wise choice of fungicides by the farmers in a particular area, according to prevailing environmental conditions, should be taken into consideration. Rotation of two or more different classes of fungicides is highly recommended for increasing the chance of better protection against the disease in the fields (Förster*et al.,*2007).Disease control through the use of botanicals extracts of medicinal plants have been explored in recent years for their effective antifungal and antimicrobial properties. Their easy decomposition, non-residual activity and non-phytotoxic properties further popularize their use for controlling phytopathogens. Several studies using crude plant extracts have also been conducted to access the control of *Colletotrichum* spp. on chili (Ngullie *et al.,*2010; Johnny *et al.,*2011).

The objective of this research work is to study the effect of some plant extracts and fungicides on management of anthracnose disease of chili caused by *Colletotrichum* spp under in vitro condition with an aim to develop a safe and effective product against chili anthracnose.

## Material and methods

### *Pathogen Culture*

*Colletotrichum* spp was cultured for 1weeks on Potato Dextrose Agar (PDA) at 25 °C. The isolate was obtained from infected chili fruit, leave and steam. Spores were harvested by adding 3-4ml of sterile distilled water to the petri dish. The spores were than rubbed with a sterile glass rod to free them the PDA medium and the suspension was passed through two layers of cloth. The suspension was diluted with water to obtain spore concentration of $10^6$ spores/ml was determined with Haemocytometer.

### *Management of Colletotrichum spp isolates*

### *In Vitro* Evaluation of Botanical Plants against Anthracnose of chili

Plant based bio-pesticides which were relatively economical, safe and nonhazardous can be used successfully against the plant pathogenic fungi. The present investigation was aimed to study the antifungal activity of some plant extracts were evaluated against *Colletotrichum* spp of chili. These botanical plants were selected, that are used for traditional medicine for different as antibiotic in Ethiopia.

**Table 1:** Plant extracts used for the control of plant pathogenic fungi

| Sr. No. | Scientific name | Plant part Used | Family | Amharic (Local name) |
|---|---|---|---|---|
| 1 | *Allium sativum* | Bulb | *Liliaceae* | Nech-shenekurt |
| 2 | *Zingiber officinale* | Rhizome | *Zingiberaceae* | Zenegeble |
| 3 | *Phytolacca dodecandra* | Leaf | *phytolaccaceae* | Endod |
| 4 | *Veronia amygdalina* | Leaf | *Asteraceae* | Grawa |
| 5 | Sol*anum marginatum* | Fruit | *Solanaceae* | Embuay |
| 6 | *Desmodium dichotomum* | Leaf | *Fabaceae* | Etsfaris |
| 7 | *Crepis rueppellii* | Leaf | *Asteraceae* | Mucha |
| 8 | *Piper augustifolium* | powder | *Piperaceae* | - |

### *Preparation of Cold Aqueous Extract*

Fresh plant material were collected and washed first in tap water and then in distilled water. Hundred grams of fresh sample was chopped and then crushed in a surface sterilized pestle and mortar by adding 100 ml sterile water. The extract was filtered through two layer of muslin cloth. Finally the filtrate that was obtained during the extraction used as stock solution (Begum and Bhuiyan, 2006).

### *Effect of Botanical Plant Extracts on Mycelial Growth of Colletotrichum Isolates*

To study the antifungal mechanism of plant extract, the poisoned food technique was used (Begum and Bhuiyan, 2006).ten ml of stock solution was mixed with 90 ml of sterilized molten PDA media, so as to get 10 percent concentration. The medium was thoroughly shaken for uniform mixing of extract.

Twenty ml of poisoned medium was poured into each of the 90 mm sterile Petri plates. Each plate was seeded with mycelium of five mm size discs form periphery of actively growing culture were cut out by cork borer and one such disc was placed at the centre of each agar plate. Controls were also maintained by growing the pathogen on PDA plates. Then such plates were incubated at 25ºC temperature for four days and radial growth was taken when maximum growth was occurred in the control plates. Matico that has been taken from Bako agricultural research center used currently as antifungal activity at the concentration of 0.25 %( 2500 ppm). 2.5gm of matico powder diluted with 1 gm of sterilized distilled water and mixed with required amount of PDA. After four days of incubation radial growth was taken when maximum growth was occurred in the control plates.The efficacy of plant extract products was expressed as percent of radial growth over the control which was calculated by using the formula as stated by Sundar *et al.* (1995). Calculating Percent inhibition of mycelial growth over control:

$$\% \text{ Inhibition} = \frac{X-Y}{X} \times 100$$

*Where,*
*X= Growth of control plate*
*Y= Growth of fungicide treated plate*

**In vitro Evaluation of Matico Powder**

Matico was taken from Bako agricultural research center which is currently used. The present investigation was aimed to study the antifungal activity of matico at concentration of 0.25%.

**In vitro evaluation of fungicides**

The efficacy of one systemic fungicide and one non-systemic fungicide were assayed at the concentration of 0.05, 0.1, 0.15, 0.2 and 0.3 percent. The fungicides used are given below in table 2.

**Table 2:** Evaluation and testing of systemic and non-systemic fungicide against *Colletotrichum* spp

| Sl. No. | Common Name | Chemical Name | Trade Name |
|---|---|---|---|
| 1 | Mancozeb (non-systemic) | Manganese ethylene bis-dithiocarbonate plus zinc | Indofil M-45 75% WP |
| 2 | Copper oxychloride (systemic) | Copper oxychloride | Fytolon 50% WP |

Required quantity of individual fungicide was added separately into molten and cool potato dextrose agar in order to get the desired concentration of fungicide. Later 20 ml of the poisoned medium was poured into sterile Petri plates. Mycelial discs of 5 mm size from actively growing culture of the fungus were cut by sterile cork borer and one such disc was placed at the centre of each agar plate. Control was maintained without adding any fungicide to the medium. Each treatment was replicated thrice. Then such plates were incubated at25$^{0}$C for four days and radial colony growth was measured. The efficacy of a fungicide was expressed as percent inhibition of mycelial growth over control that was calculated by using the formula suggested by Sundar*et al.* (1995).

$$\% \text{ Inhibition} = \frac{X-Y}{X} \times 100$$

*Where,*
*X= Growth of control plate*
*Y= Growth of fungicide treated plate*

**Results**

***Management Studies***

***In Vitro* evaluation of botanical plants against *Colletotrichum* isolates**

The antifungal activity of eight plant extracts, such as, Matico- powder, *Phytolacca dodecandra* friut, *Desmodium dichotomum* leaf, *Crepis rueppellii* leaf, *Veronia amygdalina* leaf, garlic bulbs, Ginger Rhizome and *Solanum marginatum* fruits were tested against *Colletotrichum* isolates have observed the present inhibition of mycilial growth of the fungal isolates in table 2and 3.The results in table 3 indicated that considerable inhibition of plant extracts on the mycilial growth of the test fungus was significant. Matico(77.4%) was found effective on inhibiting mycelial growth inhibition which was significantly superior over all other plant extracts evaluated and tested. Garlic (56.4%), Ginger (48.6%),*Phytolacca dodecandra* (27.28%) and *Desmodium dichotomum* (24.2%) were the next best followed by*Crepis rueppellii* (20.01%) and *Veronia amygdalina* (17.2%). Least growth inhibition of *Colletotrichum* isolates was obtained from *Solanum marginatum* (9.14%) (Table 3).

Besides, from the extracts of these seven different botanicals, two plants were thoroughly evaluated invitro against mycelial growth of *Colletotrichum* isolates at 10% of concentration.The results in table 3 indicated that, considerable inhibition of plant extracts on the mycilial growth of the test fungus was significant for garlic and ginger. Both Garlic *(Allinum satilum)* and Ginger (*Zingiberofficinale*) were found not only highest in inhibiting mycelial growth but also showed extreme difference from other botanicals in percent mycelial growth of *Colletotrichum* isolates inhibition. *Phytolacca dodecandra* (27.28%) and *Desmodium dichotomum* (24.2%) were the next highest mycelial growth inhibition of *Colletotrichum* isolates at 10% of concentration. The second lowest growth inhibition of *Colletotrichum* isolates was obtained from *Phytolaccadodecandra* (17.9%) which is relatively similar to the mycelia growth of *Colletotrichum* isolates treated with *Crepisrueppellii* (20.01%) and *Veronia amygdalina* (17.2%) Matico powder had the peak percent inhibition of mycelial growth of *Colletotrichum*isolates (77.4%) (Table 4).

**Table 3:** *In Vitro* evaluation of different plant extracts against mycelial growth of *Colletotrichum*isolates at 10% of concentration

| No | Plant extracts at Concentration of 10% | | | | Percent inhibition of mycelial growth |
|---|---|---|---|---|---|
| | Amharic name | part used | Scientific name | Family name | |
| 1 | Endode | Leave | *Phytolacca dodecandra* | *Phytolaccaceae* | 17.9 |
| | Endode | Fruit | *Phytolacca dodecandra* | *Phytolaccaceae* | 27.28 |
| 2 | Mucha | Leave | *Crepis rueppellii* | *Astraceae* | 20.01 |
| 3 | Grawa | Leave | *Veronia amygdalina* | *Astraceae* | 17.2 |
| 4 | Embuoy | Fruit | *Solanum marginatum* | *Solanaceae* | 9.14 |
| 5 | Zenegeble | Rhizome | *Zingiber officinale* | *Zingiberaceae* | 48.6 |
| 6 | Nech-shenekurt | Bulb | *Allinum satilum* | *Liliaceae* | 56.4 |
| 7 | Etsefaris | Leave | *Desmodium dichotomum* | *Fabaceae* | 24.2 |
| 8 | Matico | | *Piper augustifolium* | *Piperaceae* | 77.4 |

**Table 4:***In vitro* evaluation of Matico (*Piper augustifolium) (*Family: *Piperaceae)* leaves powder (0.25%) powder against mycelial growth of *Colletotrichum* isolates

| Colletotrichum isolates | Control | Dual culture | Percent inhibition of Mycelia Growth |
|---|---|---|---|
| **AU -PEP -1** | 45 | 10 | 77.8 |
| **AU PEP -2** | 75 | 15 | 80 |
| **AU PEP -6** | 90 | 28 | 68.9 |
| **AU PEP -7** | 85 | 25 | 70.6 |
| **AU PEP -8** | 60 | 12 | 80 |
| **AU PEP -9** | 40 | 3 | 92.5 |
| **AU PEP-10** | 90 | 25 | 72.2 |
| **Mean** | 69.3 | 16.9 | 77.4 |

## In Vitro Evaluation of Fungicides

Comparative evaluation of fungicides, namely mancozeb at different concentrations was carried out (Table 5). It was revealed from the finding that the effect of different fungicides on mycelial growth of *Colletotrichum* isolateswas significant. Among fungicides copper oxy chloride (systemic) was found to be most effective which inhibited the growth of the fungus at all three concentrations (0.05, 0.1 and 0.15 percent), that is 86, 94.9, and 98.4% respectively. Similarly 36.24, 47.29, 52.66, 53.96, and 62.2 percent inhibition was observed in case of Mancozeb (non-systemic) at 0.05, 0.1, 0.15, 0.2 &0.3 percent concentration.

**Table-5:** In Vitro Evaluation of Mancozeb Fungicide against Mycelial Growth of Colletotrichum Isolates.

| *Colletotrichum* isolates | Fungicides | Mycelial growth Inhibition at different Concentrations (% in ppm) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Control | 500ppm | 1000ppm | 1500ppm | 2000ppm | 3000ppm |
| **AUPEP -1** | Mancozeb | 45 | 55.5 | 60 | 62.22 | 64.44 | 66.67 |
| **AUPEP -2** | Mancozeb | 75 | 50 | 50 | 51.25 | 52.5 | 62.5 |
| **AUPEP -6** | Mancozeb | 90 | 20 | 33 | 33.33 | 33.33 | 40 |
| **AUPEP -7** | Mancozeb | 85 | 50 | 52.5 | 55 | 56.25 | 56.25 |
| **AUPEP -8** | Mancozeb | 60 | 60 | 60 | 60 | 60 | 60 |
| **AUPEP -9** | Mancozeb | 40 | 16.67 | 73.33 | 100 | 100 | 100 |
| **AUPEP -10** | Mancozeb | 90 | 0 | 2.22 | 5.55 | 11.11 | 50 |
| **Mean** | Mancozeb | 62.28 | 36.02 | 47.29 | 52.48 | 53.95 | 62.2 |

In depth analyses on the performance of the *Colletotrichum* isolates*at* different concentrations of mancozeb gave a different but substantial insight from the management perspective. As indicated in Table 5, it was shown from the finding that the effect of different fungicides on mycelial growth of *Colletotrichum* isolateswas significant. Among the different concentrations of mancozeb, the control is found to inferior in terms of inhibition than the rest of the treatments applied. The most resistant isolatesagainst mancozeb were AAUEP-10, and AAUEP-6 followed by AAUEP-2. However, in isolates AAUEP-10, the trend seemed to be capricious and anomalous. Thus, the trend could not be predicted on the basis of concentration. The overall observation has implied that mycelia growth inhibition capacity increases with increase in mancozeb concentrations. On another experiment that was undertaken to evaluate the mycelial inhibition potential of Copper oxychloride at different concentrations also showed that inhibition efficacy increased with concentration. As exposed in Table 6, it was indicated from the finding that the effect of different concentration of Copper oxychloride fungicides on mycelial growth of *Colletotrichum* isolates was significant. In all three concentration regimes (0.05, 0.1 and 0.15 percent), the magnitudes of mean mycelial growth inhibitions were found to be 86, 94.9, and 98.4% respectively. Similarly 36.24, 47.29, 52.66, 53.96, and 62.2 percent inhibition was observed in case of Copper oxychlorideat 0.05, 0.1, 0.15, 0.2 and 0.3 percent concentration.Comparing the efficacy of the two fungicides, copper oxychloride was found to be most effective which inhibited the growth of the fungus at all three concentrations (0.05, 0.1 and 0.15 percent).

**Table 6:** *In Vitro* Evaluation of Copper Oxychloride Fungicide against Mycelial Growth of *Colletotrichum* isolates

| ***Colletotrichum* isolates** | **Concentrations of Copper oxy chloride(in ppm)** | | |
|---|---|---|---|
| | **500ppm** | **100ppm** | **1500ppm** |
| **AUPEP-1** | 72.22 | 95.55 | 97.78 |
| **AUPEP-2** | 84.37 | 90.06 | 96.87 |
| **AUPEP-6** | 93.33 | 98.67 | 100 |
| **AUPEP-7** | 93.75 | 96.25 | 99.4 |
| **AUPEP-8** | 100 | 100 | 100 |
| **AUPEP-9** | 75 | 95 | 95.8 |
| **AUPEP-10** | 83.33 | 88.9 | 98.89 |
| **Mean** | 86 | 94.9 | 98.4 |

**Discussion**

The results on antifungal effect of the aqueous and dry (powder) extracts of seven botanical plants were evaluated against *Colletotrichum* spp under *in vitro* conditions. The botanicals were *Allium sativum*, *Zingiber officinale*, *Phytolacca dodecandra, Veroni*a *amygdalina,* Sol*anum marginatum*, *Desmodium dichotomum, Crepis rueppellii*, and *Piper augustifolium* . Besides, the efficacy of different concentration of Mancozeb (non-systemic) (Manganese ethylene bis- dithiocarbonate plus zinc and Copper oxychloride (systemic) (Fytolon 50% WP) were evaluated. The findings showed that the effect of plant extracts on *Colletotrichum* spp radial growth and disease development vary depending on the type of plant species used, method of extraction, time of application, the type of formulation and part of the plant extracts applied. *Garlic* and *C. procera* were found to be the most effective plant extracts in inhibiting the radial growth of the pathogen in vitro condition. However, Garlic is the most effective plant extract in reducing the radial growth of *Colletotrichum* spp *invitro* in both aqueous and dry extracts. The result of this study corresponds with the report by Serawit and Tesfaye, (2014); and Deepka and Padma, (2011) that sprays made from aqueous *Cassia spp* extracts have an antibiotic and antifungal activities/properties. During the last two decades, the development of drug resistance as well as the appearance of undesirable side effects of certain antibiotics (Zampini, *et al.,* 2009) has lead to the search of new antimicrobial agents mainly among plant extracts with the goal to discover new chemical structures, which overcome the above disadvantages (Kemo, *et al* ., 2003). Current research on natural molecule and products primarily focuses on plants since they can be sourced more easily and be selected based on their ethno-medicinal uses (Roopashre, *et al.,* 2008). Arora and Kaur (2007) have studied *Garlic*, exhaustively. However, the use of plant materials to prevent and treat infectious diseases successfully over the years has continued to attract the attention of scientists worldwide (Roopashre, *et al.,* 2008; Kunle and Egharevba, 2009; Ettu, *et al.,* 2012). It is an ayurvedic plant with huge medicinal importance. *Garlic* leaf extracts demonstrated antimicrobial activity against both the test bacteria and fungi with water extract (Jaya, 2008).

Prior investigations showed that *Garlic* leaf extracts have antibacterial (Khan and Aslam, 2008). However, not many reports are available on the exploitation of antifungal of antibacterial property of plant products for developing commercial formulations for applications in crop protection. Similar reports made by Tapwal, *et al*., (2011) on the antifungal properties of some medicinal plants indicating that plant extracts are promisingly vital for the management of *Colletotrichum spp.* In general a voluminous number of literatures reported the effectiveness of *Garlic* against most pathogenic microorganisms. A crude extracts of *Garlic*, however showed the highest inhibitory effect (<10%) at 10% concentrations. The effect of the antifungal compounds may be on spore germination leading to its inhibition of may be due to the effect of these compounds on the cell wall altering the permeability of (Jaya, 2008). The antifungal compounds may also suppress the early stages of mycelia growth leading to inhibition of the fungus. Next to garlic extract of ginger had shown 48.00% growth inhibition against *Colletotrichum spp*, followed by *Desmodium dichotomum*. Similar findings on antifungal nature of ginger were documented by Serawit and Tesfaye (2017); Bajwa, *et al.,* (2004); and Sharma and Trivedi (2002). Hence, by utilizing this weed in the plant disease management, one could protect the land from its invasion as well as get some economic gains by disease control. A number of antifungal compounds of diverse skeletal patterns have been found in the plants. These compounds belong mainly to six broad chemical groups, such as phenolics and phenolic acids, coumarins and pyrones, flavonoids, isoflavonoids, steroids and steroidal alkaloids, and other miscellaneous compounds (Mitra, *et al.,* 1984). However, only a few commercial products from the plant are being used in practical plant protection. The fungitoxic effects of the phyto-extracts indicate the potential of selected plant species as a source of natural fungicidal material. Antifungal activity was confirmed by all of the selected plant species and the results revealed that different plant extracts varied in their efficacy for inhibiting the mycelial growth of tested pathogens. Although the selected concentration of tested plant species was unable to completely inhibit the pathogens but they could be used in combination with the fungicides as IPM strategy to minimize the use of fungicides. The finding of the present investigation could be an important step towards the possibilities of using botanical plant products as pesticides in the plant disease control.

## Conclusion
The findings of this study substantiated that aqueous and dry extracts of *Garlic* have potential to be applied as a control measure against coffee berry disease (*Colletotrichum spp)*. The application of aqueous extract of *Garlic* seems promising as it is simple, efficient and inexpensive alternative means of *Colletotrichum spp* management for the farmers, which may replace the synthetic fungicides, particularly to those who cannot afford synthetic chemicals. Likewise, the risk associated with synthetic chemicals as well as consumers' resistance, towards its application in agriculture make the product more attractive natural product for organic agriculture. The findings also provide new scientific information on antifungal activity of *Garlic* against *Colletotrichum* spp.

## Recommendations
Based on the finding of this research, the regional bureau of agriculture is recommended to encourage paper producing application of dry and aqueous extract of *Garlic against chili anthracnose.* For large scale, efficient and cheaper alternative means of *Colletotrichum* spp management for the small scale poor farmers. Government should devise mechanisms to replace the synthetic fungicides for the benefit of those who cannot afford synthetic chemicals. Moreover, awareness must be raised towards the risk associated with synthetic chemicals as well as consumers' toxicity at different levels of food chain. Training must be provided for the farmers regarding pesticide residue, botanical preparation and application against anthracnose. Further, phyto-chemical and antifungal characteristics of botanicals, such as Garlic, Ginger and Matico, against *Colletotrichum* spp. must be strengthened.

## Acknowledgements
The Authors are thankful to the Addis Ababa University, Department of MCM Biology, mycology laboratory, for providing the entire materials needed for this research.

## References
Agrios G. N. (2005) Plant Pathology. St. Louis, MO: Academic Press.

Anand T., Chandrasekaran A., Raguchander T., Prakasam T., Samiyappan R. (2009). Chemical and biological treatments for enhancing resistance in chili against *Collectotrichum capsici* and *Leveillula taurica*. Arch. Phytopathol. PFL 1, 1–19

Arora, D.S. and G.J. Kaur. "Antibacterial activity of some Indian medicinal plants". *Journal of Natural Medicine*, 2007, **61**:313-317.

Bajwa, R. S. Shafique, T. Anjum, and S. Shafique. "Antifungal activity of allelopathic plant extracts IV: Growth response of *Drechslera hawaiiensis, Alternaria alternata* and *Fusarium moniliforme* to aqueous extract of *Parthenium hysterophorus". Int. J. Agri. Biol.* , 2004, **6**: 511-516.

Byung S. K. (2007). Country report of Anthracnose research in Korea, in First International Symposium on Chili Anthracnose, Hoam Faculty House, Seoul National University (Seoul: ), 24.

Deepika, S. and S. Padma. "Antifungal Potential of Two Common Weeds against Plant Pathogenic Fungi-*Alternaria Spp". Asian J. exp. biol. sci* . 2011, **2**(3): 525-528

Don L. D., Van T. T., Phuong Vy T. T., Kieu P. T. M. (2007). *Colletotrichum* spp. attacking on chili pepper growing in Vietnam, Country Report, in Abstracts of the First International Symposium on Chilli Anthracnose, eds Oh D. G., Kim K. T., editors. (Seoul: Seoul National University ;), 24.

Ettu, A. O., C. T. Senjobi, and O. A. F. Ilusanya. "Antimicrobial Activity of Leaf Extracts of *Senna occidentalis* (L)". *Journal of Agri. and Bio. Sciences* Vol. **2**(1), 2012, pp. 026-030, http://www.globalresearchjournals. com/ journal/id=JABS/homeid=JABS

Förster H., Driever G. F., Thompson D. C., Adaskaveg J. E. (2007). Postharvest decay management for stone fruit crops in California using the "reduced-risk" fungicides fludioxonil and fenhexamid. Plant Dis. 91, 209–215. 10.1094/PDIS-91-2-0209.

Garg R., Loganathan M., Saha S., Roy B. K. (2014). Chilli Anthracnose: a review of causal organism, resistance source and mapping of gene, in Microbial Diversity and Biotechnology in Food Security, eds, Kharwar R. N., Upadhyay R., Dubey N., Raguwanshi R., editors. (Springer; ), 589–610.

Garg R., Loganathan M., Saha S., Roy B. K. (2014). Chilli Anthracnose: a review of causal organism, resistance source and mapping of gene, in Microbial Diversity and Biotechnology in Food Security, eds Kharwar R. N., Upadhyay R., Dubey N., Raguwanshi R., editors. (Springer ;), 589–610.

Jaya, J. "Studies on Paradoxial nature of Indian herb: *Azadirachta indica"*. International Journal of Chemical Sciences, 2008, 6 (3): 1571-1575.

Johnny L., Yusuf U. K., Nulit R. (2011). Antifungal activity of selected plant leaves crude extracts against a pepper anthracnose fungus, *Colletotrichum capsici* (Sydow) Butler and Bisby (Ascomycota: Phyllachorales). Afr. J. Biotechnol. 10, 4157–4165.

Kemo, P.O. H.P. Bais, and J..M. Vivanco. "*In vitro* activities of *Maesa lanceolata* extracts against fungal plant pathogens". *Fitoterapia,* 2003*,* **74**: 312-316.

Khan, S. A. and J. Aslam. "Study on the Effect of Neem (*Azadirachta indica*) Leaves Smoke in Controlling Airborne Bacteria in Residential Premises". *Current Research in Bacteriology*, 2008, 1 (2): 64-66.

Kunle, O.F. and H.O. Egharevba. "Preliminary studies on *Vernonia ambigua*: Phyto-chemistry and Antimicrobial screening of the whole plant". *Ethnobotanical Leaflets*, 2009. **13**: 1216-21.

Lakshmesha K., Lakshmidevi K., Aradhya N., Mallikarjuna S. (2005). Changes in pectinase and cellulase activity of *Colletotrichum capsici* mutants and their effect on anthracnose disease on *Capsicum* fruit. Arch. Phytopathol. Plant Prot. 38, 267–279.

Mitra,, S. R. A. Choudhuri, and N. Adityachaudhury. "Production of antifungal compounds by higher plants-a review of recent researches". *Plant Physiol. Biochem*. , 1984, **11**: 53-77.

Ngullie M., Daiho L., Upadhyay D. N. (2010). Biological management of fruit rot in the world's ho Begum F. and Bhuiyan, M.K.A. ( 2006). Integrated control of seedling mortality of lentil caused by *Sclerotium rolfsii*. *Bangladesh J. Plant Path*. **23**: 60-65.

Pandey, K. K. (2003). Survey and surveillance of vegetable growing areas for prevalence of major diseases. *Vegetable Sci*. **30** (2)**:** 128–134.

Peraza-Sanchez, S. Poot-Kantun, L.W. Torres-Tapia, F. May-at, P. Sima-Polanco, R. ( 2005). Screening of native plants from Yucatan for anti-*Giardia lamblia* activity Pharm. Biol., 43 (2005), pp. 594-598

Ramachandran N., Rathnamma K. (2006). *Colletotrichum acutatum* - a new addition to the species of chilli anthracnose pathogen in India, in Paper presented at the Annual Meeting and Symposium of Indian Phytopathological Society, Central Plantation Crops Research Institute (Kasarago: ). T-test of chilli (*Capsicum chinense* jacq.). J. Plant Prot. Res. 50, 269–273.

Roopashre, T.S. and D. Raman, R.R.H. Shobha and C. Narendra. "Antibacterial activity of anti-psorriatic herbs: Cassia tora, *Momordica charantia* and *Calendula officialis". International Journal of Research in National Products,* 2008, **3:** 20-28.

Sanathkumar, V. B. (2012). *Studies on Anthracnose of Chilli Caused by Colletotrichum capsici (Sydow) Butler and Bisby with Special Reference to Epidemiology and Management.* M. Sc. (Agri.) Thesis, Univ. Agric. Sci., Bangalore, Karnataka, India

Serawit Handiso and Tesfaye Alemu (2014). Evaluation of some noxious plants against *Colletotrichum kahawae*. IJSBAR. Vol. 16

Serawit Handiso and Tesfaye Alemu (2017). Integrated management of Chili Anthracnose (*Colletotrichum* spp ) by using plant extracts and antagonists. IJSBAR. Vol. 31

Sharma, N. and P. C. Trivedi, "Screening of leaf extracts of some plants for their nematicidal and fungicidal properties against *Meloidogyne incognita* and *Fusarium oxysporum". Asian J. Exp. Sci.,*2002. 16: 2128.

Shivapuri, A., Sharma, O.P. and Jamaria, S.L. (1997). Fungitoxic properties of plant extracts against pathogenic fungi. *Journal of Mycology and Plant Pathology* **27**: 29-31.

Tapwal, A. N. G.Shipra, G. Nandini, and K. Rajesh. "*In vitro* Antifungal Potency of Plant Extracts Against Five Phytopathogens". *International Journal of pl. pathol.* , 2011, **54** (6): 1093-1098

Than, P. P., Jeewon, R., Hyde, K. D., Pongsupasamit, S., Mongkolporn, O. and Taylor, P. W. J. (2008). Characterization and pathogenicity of *Colletotrichum* species associated with anthracnose disease on chili (*Capsicum spp*.) in Thailand. *Plant Pathology* **57:** 562-572

Vos J. G. M., Uhan T. S., Sutatya R. (1995). Integrated crop management of hot pepper *(Capsicum* spp.) under tropical lowland conditions: effects of rice straw and plastic mulches on crop health. Crop Prot. 14, 445–452.

Zampini, I.C. S. Cuello, M.R. Alberto, R.M. Ordonez, R.D. Almeida, E. Solorzano, and M.I. Isla. "Antimicrobial activity of selected plant species from the Argentine puna against sensitive and multi- resistant bacteria". *Journal of Ethno-pharmacology*, 2009, **124**: 499-505.