Research Article

Antifungal activity of *Zingiber officinale* oil against plant pathogenic fungi isolated from solanaceous vegetable fruits

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Abstract

Objective: The main aim of this research paper is to determine the antifungal activity of zingiber rhizome extract against some isolated fungi from solanaceous vegetables**. Materials and methods:** The ginger oil, extracted by hydrodistillation unit, to inhibit fungal growth isolated from solanaceous vegetables was studied. The oil was used at different concentrations 5%, 10%, 20% against plant pathogenic fungi viz, *Fusarium oxysporum, Alternaria alternata* and *Aspergillus flavus*. Each experiment was done in triplicates so as to get the desired result. **Results and conclusion**: Highest inhibition was seen against *Aspergillus flavus* followed by *Fusarium oxysporum* and *Alternaria alternata*. The major chemical compounds that were extracted through GC-MS analysis were, 1, 8-cineol 27%.Other hydrocarbons were α- seliene α- pinene, ar- curcumene, Camphor α- farnesene, Tricyclene . The main oxygenated compounds were Neral, Elemol, Geranial 2.8, Nerolidol, Zingiberenol and Octanel.

Keywords: Zingiber oil, antifungal activity, solanaceous vegetables

Introduction

Fungal Infectious diseases accounts for high proportion of losses to vegetables. A vegetable, exposed to deterioration by the fungus can have a decreasing in its sensory, nutritive and medical characteristics. *Alternaria alternata* species is an opportunistic pathogen affecting many post-harvest storage vegetables. This fungus attacks vegetables such as eggplant, pepper, potato, tomato and fruits such as citrus, apple, strawberry and peach (Thoma, 2003). They cause huge losses to humans as well as economy in the commercialisation phase. (Janardhana et al., 1999; Marin et al., 1999). Agricultural practices have been great concern by using chemicals as management of plant diseases. These chemicals in addition kill various beneficial organisms and their toxity can persist in the soil (Onuegbu, 2002). The increasing resistance by these microorganisms against these chemicals has been a great concern. In Jabalpur Madhya Pradesh, vegetables produced by the local farmers are not educated and in this regard cannot use the best methods to control the diseases on these vegetable fruits. Among the various alternatives, natural plants products are used having no side effect and are been used by scientists (Amadioha, 2000; Okigbo, 2009). Extracts obtained from these valuable plants have gained attention as scientific interest for having antifungal activity (Lee et al., 2007; Verastegui et al., 2008; Santas et al., 2010). Other research workers (Amadioha and Obi, 1999; Amadioha, 2000; Okigbo, 2009) have given the importance and possible means of these fungal pathogens to control the fungal diseases on vegetables and fruits. This investigation was therefore targeted at the *in vitro* inhibitory effects of *zingiber officinale* oil extracted from rhizome portion as an antifungal agent. *Aspergillus flavus* and *A. alternata* are the predominant fungal species responsible for causing deterioration of these vegetable fruits during storage (Yu et al., 2004). *Aspergillus* species are to known fungal pathogens in decay process (Raper and Fennel, 1965).

The aim of this study was to investigate inhibitory concentrations of ginger oil (*Zingiber officinale* Roscoe, Zingiberaceae against mycotoxin producers *Aspergillus flavus* and *Alternaria alternata* and *Fusarium oxysporum*.

In general, plant-derived essential oils are non phytotoxic and potentially effective against all fungal pathogens (Pandey et al., 1984; Chaung et al., 2007). They can be used as a natural therapy to inhibit the growth of these fungal pathogens. In recent years, several researchers have reported the mono and sesquiterpene hydrocarbons as the major components of plant essential oils with enormous potential to inhibit microbial pathogens.

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Materials and methods

Plant material

Ginger rhizomes were purchased from a local market in Jabalpur (India). Ginger was cleaned with distilled water to remove soil and dust, cleaned ginger was chopped into small pieces.

Extraction of essential oil

The fresh ginger purchased from the market of Jabalpur was hydro-distilled for 5-6 hours in a hydrodistillation unit called Clevenger type apparatus Voucher specimens. The oil was dried using anhydrous sodium sulphate. To separate the oil from the aqueous part, the oil was separated by using ether solvent in a separating funnel. The ether was removed at reduced pressure which resulted in an oily residue that was added to the oil collected earlier. The remaining aqueous portion was separated that was free from smell and other impurities. Thus, the hydrodistilled volatile fraction from the ginger rhizome was separated into two fractions an oil fraction and an aqueous fraction. The oil fraction was used at increasing concentration from 5% to 20% against different fungal pathogens isolated from solanaceous vegetables. The oil was analysed through **GC-MS** analysis.

GC-MS analysis method: Gas chromatography and mass spectra analysis was done in Perkin Elmer Autosystem XL Packed mode. Column for the analysis was OV-1, 100% Methyl gum (10 feet). The conditions were as follows; Temperature programming from 4°C-220°C, hold at 75°C for 20 minute. Injection temperature 250°C and detector temperature was 255°C. Carrier gas was N_2 at a flow rate 14 ml/min. The identification of individual compound is based on their retention time's relatives to those of authentic samples and matching spectral peaks availably with NIST mass spectral libraries.

Antifungal activity (Poisoned food Technique) of *Zingiber officinale* oil

The antifungal activity of ginger oil was tested against *Aspergillus flavus, Fusarium oxysporum* and *Alternaria alternata* at increasing concentrations. The fungi-toxicity of the oil was evaluated against the test fungi by the method of **Grover and Moore** (1962). PDA (20ml) was poured into sterilized Petri dishes and measured amount of oil was added to give desired concentrations. In medium **0.05 % Tween-80** was also added for even distribution of the oil in the medium. For control sets, the medium was supplemented with the same amount of distilled water instead of oil and 0.05 % Tween-80. Plates were incubated at 25±1°C. The growth of the test fungi were recorded for seven days and percent inhibition was computed after comparison with the control by the method of **Vincent, 1947.**

% inhibition growth was measured by % inhibition:

$$\% \text{ inhibition} = \frac{R1 - R2}{R1} X100$$

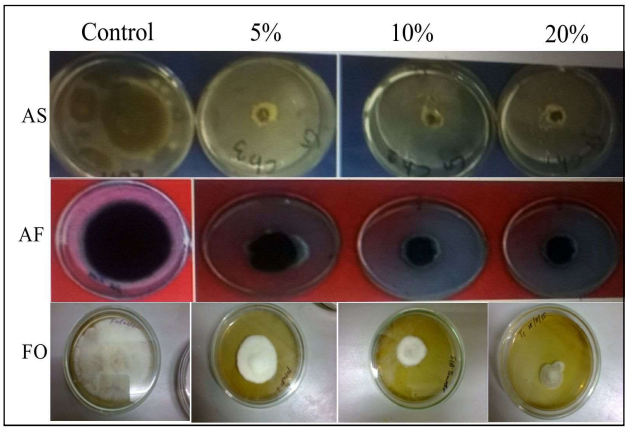

Figure 1. The fungi-toxicity of the oil was evaluated against the test fungi by the method of Grover and Moore (1962).

Table 1. The fungi-toxicity of the oil was evaluated against the test fungi by the method of **Grover and Moore (1962).**

	% growth inhibition control		
Concentration of oil	*Fusarium oxysporum*	*Aspergillus flavus*	*Alternaria solani*
5%	46.15± 1.98	78.12± 1.09	45.83± 1.92
10%	60.25± 2.12	82.81± 1.82	66.66± 2.49
20%	79.48± 1.19	87.5± 0.95	73.61± 2.43

Each value is the mean of three replicates ± SE are given along the mean value

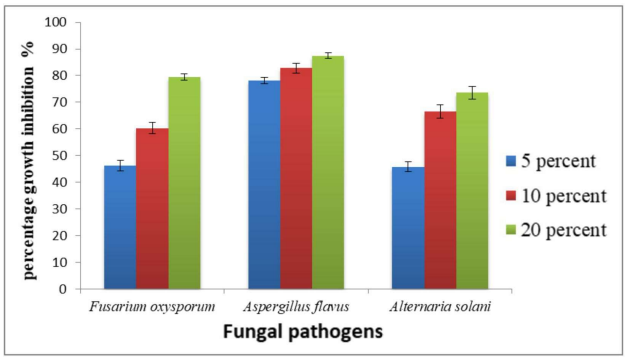

Figure 2. Graph showing fungi toxicity of zingiber oil at different concentrations against different fungi isolated from solanaceous vegetables.

GC-MS analysis of oil

The chemical compounds that were isolated through GC-MS analysis of zingiber oil gives fifteen different compounds. The chemical compounds were identified based on their molecular weight, retention time and peak area. From GC-MS analysis a total of thirteen different compounds were isolated. The main compounds were

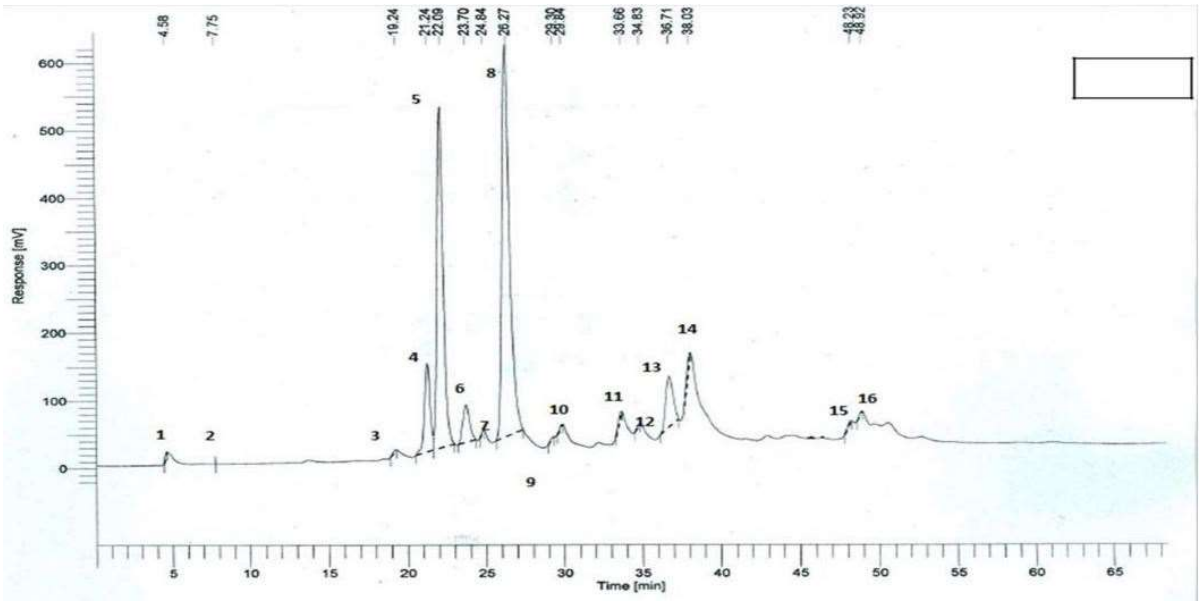

Figure 3. Gas chromatogram of *Zingiber officinale* essential oil

camphene, followed by zingiberene 12.2%, 1-8 cineole was the major compound and was in higher proportion in the oil. Other hydrocarbons were α- farnesene, α piene, , ar- curcumene, Tricyclene, camphor. The main oxygenated compounds were 2.8, Nerolidol, Geranial, Elemol, Neral, Octanel ,Zingiberenol.

Discussions

The antifungal activity of ginger oil observed in our study is contrary to those reported in several studies. Indeed, El-Baroty et al (2012) reported that *Zingiber officinale* rhizomes essential oil possessed high antifungal activity against pathogenic fungi; this oil inhibited the growth of *Fusarium oxysporum, Aspergillus flavus* and *Alternaria alternata*. This same effect was observed by de Silva et al. (2011) who reported that essential oil of ginger possessed antifungal activity against potentially mycotoxigenic *Aspergillus flavus*. Bansod and Rai (2008) showed that oil of zingiber offinale had significant inhibitory activity against pathogenic fungi, *Alternaria alternata* and *Fusarim oxysporum*. A fungicide should be able to retain its activity over a long period of shelf life. Phytotoxicity of ginger oil has been reported by Singh et al (2008) against different fungi *Aspergillus* spp., viz. *Aspergillus flavus*, *Aspergillus oryzae*, *Aspergillus niger* and *Fusarium* spp. The general antifungal activity of plant extract and their extracted oil is well documented (Reuveni et al. 1984; Meepagala et al. 2002). In particular, essential oils were seen to exert good antifungal activities both *in vitro* and *invivo* (Baruah et al. 1996; Tripathi et al. 2004; Sharma and Tripathi, 2008).

Conclusion

The compound that was in highest proportion were camphene, 1,8-cineol and α-pinene. The ginger oil extracts inhibits the growth of fungi isolated from solanaceous vegetables. Highest inhibition was seen in *Aspergillus flavus* followed by *Fusarium oxysporum* and then in *Alternaraia alternata*.

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