Evaluation of *Chenopodium ambrosioides* oil as a potential source of antifungal, antiaflatoxigenic and antioxidant activity

Rajesh Kumar a, Ajay Kumar Mishra a, N.K. Dubey a,⁎, Y.B. Tripathi b

a Centre of Advanced Study in Botany, Faculty of Science, Banaras Hindu University, Varanasi-221005, India
b Department of Medicinal Chemistry, Institute of Medical Sciences, Banaras Hindu University, Varanasi-221005, India

Received 10 May 2006; received in revised form 11 October 2006; accepted 12 October 2006

Abstract

Essential oil extracted from the leaves of *Chenopodium ambrosioides* Linn. (Chenopodiaceae) was tested against the aflatoxigenic strain of test fungus *Aspergillus flavus* Link. The oil completely inhibited the mycelial growth at 100 μg/ml. The oil exhibited broad fungitoxic spectrum against *Aspergillus niger*, *Aspergillus fumigatus*, *Botryodiplodia theobromae*, *Fusarium oxysporum*, *Sclerotium rolfsii*, *Macrophomina phaseolina*, *Cladosporium cladosporioides*, *Helminthosporium oryzae* and *Pythium debaryanum* at 100 μg/ml. The oil showed significant efficacy in inhibiting the aflatoxin B1 production by the aflatoxigenic strain of *A. flavus*. During in vivo investigation it protected stored wheat from different storage fungi for one year. *Chenopodium* oil also exhibited potent antioxidant activity when tested by ABTS method. All these observations suggest the possible exploitation of the *Chenopodium* oil as potential botanical fungitoxicant in ecofriendly control of post harvest biodeterioration of food commodities from storage fungi.

© 2006 Elsevier B.V. All rights reserved.

Keywords: ABTS; *A. flavus*; Aflatoxin; Antioxidant; Antifungal; *C. ambrosioides*; Shelf life

1. Introduction

Fungi are significant destroyers of foodstuffs during storage, rendering them unfit for human consumption by retarding their nutritive value and sometimes by producing mycotoxins. Approximately 25–40% of cereals worldwide are contaminated with mycotoxins produced by different storage fungi (Pittet, 1998). Aflatoxins are the most dangerous mycotoxins produced by *Aspergillus flavus*. About 4.5 billion people in developing countries are chronically exposed to the uncontrolled amounts of aflatoxin (Williams et al., 2004). Lipid peroxidation is also one of the major causes of deterioration of food products during processing and storage (Donnelly and Robinson, 1995). Products of lipid peroxidation influence other food constituents, alter taste and aroma and cause undesirable effects on the human health (Benzie, 1996). The use of synthetic chemicals as antimicrobials has greatly contributed to management of such losses, but indiscriminate application of chemicals has led to a number of ecological and medical problems due to residual toxicity, carcinogenicity, teratogenicity, hormonal imbalance, spermatotoxicity, etc. (Bajaj and Ghosh, 1975; Omura et al., 1995; Pandey, 2003). Synthetic antioxidants, such as, butylated hydroxyanisole (BHA) and tert-butylhydroquinone (TBHQ), have also restricted use in foods due to carcinogenicity (Madhavi and Salunkhe, 1995). The recent reports on large scale use of different higher plant products viz. azadiractin from *Azadirachta indica* (Devkumar and Sukhdev, 1993), carvone from *Carum carvi* (Hartmans et al., 1995) and allyl isothiocynate from mustard and horseradish oil (Ward et al., 1998) have attracted the attention of microbiologists to search some newer plant chemicals for their exploitation as antimicrobials. Such products of higher plants would be biodegradable, renewable in nature and safe to human health (Varma and Dubey, 1999). Different crude extracts of spices, herbs and other plant materials rich in polyphenolics are becoming increasingly important in food industries because of their antifungal, antiaflatoxigenic and antioxidant activity. Hence,
such plant chemicals can improve shelf life, quality and nutritional value of stored food commodities (Mishra and Dubey, 1994; Tripathi and Upadhyay, 2002; Gonçalez et al., 2003; Tripathi and Dubey, 2004).

*Chenopodium ambrosioides* Linn. (Chenopodiaceae) is widely distributed throughout India. It is an erect much branched aromatic herb with a camphoraceous odour. Leaves are oblong, lanceolate, sinuate dentate with obscure petiolar. Flowers are greenish, some turning purplish in small clusters, simple or panicle spikes, utricle membranous. Leaves are useful in the cure of influenza, pneumonia, typhoid and also as vermicide (Cheryl et al., 2006; Mishra, 2002). *Chenopodium* oil is a mixture ascaridole (55.3 8%), p-cymene (16.2%), alpha-terpinene (9.7%), isoascaridole (4.3%) and limonene (3.8%) (Cavalli et al., 2004). The main objective of the present study was to find out the efficacy of *Chenopodium* oil as a botanical fungitoxicant and an antioxidant for protecting stored wheat from fungal deterioration and enhancing their shelf life. In the present investigation, antifungal activity of the essential oil of *C. ambrosioides* against the aflatoxigenic strains of the dominant storage fungus *A. flavus* Link. has been evaluated. Moreover, the potential of the oil in checking aflatoxin B1 production and also its antioxidant activity have been assessed.

2. Materials and methods

Fresh parts of 18 aromatic plants were collected at flowering stage from the campus of Banaras Hindu University. 250 g of fresh parts of each plant species was cut separately into small pieces and thoroughly washed with sterilized water. The volatile fractions (essential oils) were isolated through hydrodistillation by Clevanger apparatus. The isolated fractions of plant parts exhibited two distinct layers—an upper oily layer and the lower aqueous layer. Both the layers were separated and the essential oils were stored in clean glass vials after removing water traces with the help of capillary tubes and anhydrous sodium sulphate (Tripathi et al., 2004).

2.1. Antifungal analysis

The fungitoxic activity of the essential oils against the two aflatoxigenic strains of *A. flavus* viz., Navjot 4NSt and Saktiman 3NSt (procured from Mycotoxin Laboratory, University of Bhalagpur, India) was tested at 500 μg/ml by the poisoned food technique (Mishra and Dubey, 1994) using Czapek’s medium. A requisite amount of essential oil was dissolved separately in 0.5 ml acetone and then mixed with 9.5 ml of autoclaved Czapek’s medium (NaNO₃, 2.0 g; K₂HPO₄, 1.0 g; MgSO₄·7H₂O, 0.5 g; KCl, 0.5 g; FeSO₄·7H₂O, 0.01 g; Sucrose 30.0 g; Agar 15.0 g; distilled water 1 L; pH 6.8±2) in Petriplates (9.0 cm diameter). The control sets were prepared subsequently using sterilized distilled water in place of the oil. The prepared plates were inoculated aseptically with assay disc (5 mm) of the aflatoxigenic strains of the test fungus. The plates were then incubated at 28±2 °C for seven days. The inhibition of the radial growth of the test fungus by the oils was calculated following Pandey et al. (1982).

2.2. Minimum inhibitory concentration and nature of toxicity of essential oil of *C. ambrosioides*

To find out the minimum inhibitory concentration (MIC) at which the oil showed absolute fungitoxicity, experiments were carried out by the above mentioned poisoned food technique using graded concentrations of the *Chenopodium* oil with Czapek’s medium, viz., 10, 50, 100, 500, 800 and 1000 μg/ml. The nature of toxicity (fungistatic/fungicidal) of the oil was determined following the method of Thompson (1989). The inhibited fungal discs of the oil treated sets were reincubated into the fresh medium and revival of their growth was observed.

2.3. Fungitoxic properties of the essential oil of *C. ambrosioides* and comparison with some synthetic fungicides

The mycotoxic spectrum of the *Chenopodium* oil was evaluated by poisoned food technique at 100 μg/ml against nine fungi, viz. *Aspergillus fumigatus*, *A. niger*, Botryodiplodia theobromae, *Cladosporium cladosporioides*, *Fusarium oxysporum*, *Helminthosporium oryzae*, Macrophomina phaseolina, *Phytophthium debaryanum* and *Sclerotium rolfsii* (procured from the Division of Mycology and Plant Pathology, IARI, New Delhi, India). The efficacy of the oil was compared with some synthetic fungicides procured from Sigma (St. Louis, USA), viz., benzimidazole (Benomyl), diphenylamine (DPA), phenylmercuric acetate (Ceresan) and zinc dimethyl dithiocarbamate (Ziram) by the poisoned food technique.

2.4. Efficacy of the *Chenopodium* oil in checking aflatoxin production

SMKY medium (Diener and Davis, 1966) was used to check the efficacy of oil against aflatoxin production. 25 ml of SMKY medium was taken in each Erlemeyer flask, to which a requisite amount of the *Chenopodium* oil was added so as to get 10, 100, 250 and 500 μg/ml concentrations. The flasks were aseptically inoculated with 7 day old culture of the aflatoxigenic strain Saktiman 3NSt of *A. flavus*. The control sets comprised the medium without the oil. The flasks were incubated for 10 days at 28±2 °C. After incubation, the content of each flask was filtered through Whatman filter paper No. 1. The mycelia were allowed to dry at 100 °C for 12 h. The mycelium dry weight (biomass) was used to compare fungal growth in treated and control sets. The filtrate was extracted with 20 ml chloroform in a separating funnel. The chloroform extract was passed through anhydrous sodium sulphate kept on a Whatman No. 42 filter paper. The extract was evaporated to dryness on water bath and the residue was dissolved in 1 ml chloroform. The amount of aflatoxin B1 (AFB1) produced in the treatment and control sets was determined by the TLC technique following Nabney and Nesbitt (1965). 50 μl of the chloroform extract spotted on TLC plate along with the standard of aflatoxin, was run in toluene:isooamyl alcohol:methanol (90:32:2 v/v). The developed plates were air dried and observed under longwave of UV light. Initial identification of different components of aflatoxins was made on visual basis by comparing the colour and intensity of
fluorescence of the sample and standard spots. The quantity of aflatoxin was estimated by a spectrophotometer (AOAC, 1984). The amount of aflatoxin B1 present in the sample was calculated according to the following formula:

\[
\frac{D \times M}{E \times I} \times 1000
\]

where,

- \(D\) absorbance,
- \(M\) molecular weight of aflatoxin (312),
- \(E\) molar extinction coefficient of aflatoxin B1 (21,800),
- \(I\) path length (1 cm cell was used).

### 2.5. Antioxidant activity of Chenopodium oil

The antioxidant activity of essential oil was evaluated by the ABTS (2, 2-azino-bis-3-ethyl benzothiazoline-6-sulfuric acid) assay following Re et al. (1999) and Tiwari and Tripathi (2007). ABTS radical cation (ABTS \(^+\)) was freshly prepared by adding 5 ml of a 4.9 mM potassium persulphate solution to 5 ml of a 14 mM ABTS solution and kept for 16 h in dark. This solution was diluted with distilled water to yield an absorbance of 0.70 at 734 nm and the same was used for antioxidant assay. Stock solution of the Chenopodium oil was prepared in 1% methyl alcohol. The requisite amount of oil and ABTS \(^+\) solution was taken to make 1 ml of the final reaction mixture so as to get 500, 1000, 1500, 2000, 2500 and 3000 \(\mu\)g/ml concentrations. The reaction mixture was vortexed for 10 s and after 6 min absorbance was recorded at 734 nm by using an ELICO (SL150) UV–Vis Spectrophotometer and was compared with the control ABTS \(^+\) solution. Ascorbic acid was used as reference antioxidant compound. Appropriate solvent blanks were run in each assay. The total antioxidant activity (TAA) was calculated as percent inhibition of the ABTS \(^+\) quenching in relation to the aqueous control by the equation:

\[
\text{Inhibition of } A_{734}(\%) = \frac{1-Af}{A_0} \times 100
\]

where,

- \(A_0\) absorbance of uninhibited radical cation, and
- \(Af\) absorbance measured after 6 min upon addition of antioxidant samples.

### 2.6. In vivo efficacy of Chenopodium oil in the management of stored wheat samples against fungal deterioration

To find out the practical applicability of \(C. ambrosioides\) oil as fumigants for protection of stored wheat grain from biodeterioration caused by fungi, the freshly harvested wheat samples (var Malviya 234) were fumigated with the oil by the method adapted by Shaaya et al. (1997) and Varma and Dubey (2001). The fumigation of wheat samples with the oil was made in two sets. In one set (uninoculated treatment) requisite amounts of the oil were introduced into separate plastic containers (10 cm diameter \(\times\) 16) containing 500 g of wheat by soaking in a piece of cotton so as to procure 100 \(\mu\)g/ml (v/v). In another set (inoculated treatment), the wheat samples, prior to treatment with the oil, were inoculated with a standard spore suspension of \(A. flavus\). After 3 days of inoculation, the samples, similar to the first set, were separately treated by the Chenopodium oil. The control set also contained two sets—the uninoculated control and the inoculated control. In the uninoculated control set, the wheat was stored as such in plastic containers. In the inoculated control, the wheat sample was inoculated with a spore suspension of \(A. flavus\) and stored similarly. The inoculation of wheat seeds was done by preparing a standard spore suspension of \(A. flavus\). Seven days old culture of \(A. flavus\) was used to inoculate in wheat sample. Spore suspension of the fungal strain was prepared in 0.1% Tween-80 and the spore density was adjusted to \(285 \times 10^4\) spore/ ml. The seeds were dipped in the normal spore suspension for 10 min and then dried in an oven at 45 °C for 12 h. The moisture content of the dried wheat was 11.13%. Three replicates were taken for each individual set.

After 12 months of storage at laboratory conditions (temperature 10–46 °C and RH 30–80%) wheat samples of both treatment and control sets were analysed for fungi using the blotter technique of Varma and Dubey (2001). The isolates were then examined and identified following Funder (1968) and Moore and Jaciow (1979). After the analysis of fungi associated with wheat samples of treatment and control sets, the percent occurrence of each fungus among the samples was analysed and the percent protection of wheat samples in the uninoculated and inoculated treatments were observed by following formula

\[
\text{Percent occurrence of fungus} = \frac{\text{No. of colonies of the fungus}}{\text{Total no. of colonies of all the fungal species}} \times 100
\]

\[
\text{Percent protection of wheat samples} = \frac{D_c-D_t}{D_c} \times 100
\]

Where,

- \(D_c\) percent occurrence of total fungi in wheat samples of control set and
- \(D_t\) percent occurrence of total fungi of wheat samples in treatment set.

### 2.7. Statistical analysis

All the measurements were replicated three times for each treatment and the data are reported as mean \(\pm\) SE. The statistical analysis was performed by one way analysis of variance (ANOVA) using statistical software (SPSS, 10.0; Chicago, Ill, USA). The data also subjected to Students \(t\) test to analysed the effect of Chenopodium oil on protection of stored wheat with control and the linear regression analysis was done between
Table 1: Screening of essential oils against two aflatoxicogenic strains of *Aspergillus flavus*

<table>
<thead>
<tr>
<th>Essential oils</th>
<th>Families</th>
<th>Percent inhibition of growth of the <em>A. flavus</em> at 50 μg/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Navjot 4NSSt</td>
</tr>
<tr>
<td>Aegle marmelos Linn. (leaf)</td>
<td>Rutaceae</td>
<td>8.6±0.5</td>
</tr>
<tr>
<td>Artemisia nilagirica Clarke (leaf)</td>
<td>Asteraceae</td>
<td>49.6±1.0</td>
</tr>
<tr>
<td>Carum carvi Linn. (seed)</td>
<td>Apiaceae</td>
<td>55.3±0.9</td>
</tr>
<tr>
<td>Cymbopogon flexuosus (Stud., Wats. (leaf))</td>
<td>Poaceae</td>
<td>47.1±0.1</td>
</tr>
<tr>
<td>Cymbopogon martini (Roxb.) Wats. in Atkins (leaf)</td>
<td>Poaceae</td>
<td>78.5±1.2</td>
</tr>
<tr>
<td>Chenopodium ambrosioides Linn. (leaf)</td>
<td>Chenopodiaceae</td>
<td>100.0±0.0</td>
</tr>
<tr>
<td>Eupatorium cannabinum Linn. (leaf)</td>
<td>Asteraceae</td>
<td>9.1±1.2</td>
</tr>
<tr>
<td>Lavandula officinalis Chaix (leaf)</td>
<td>Lamiaceae</td>
<td>24.1±2.7</td>
</tr>
<tr>
<td>Lippia alba Mill N.Br (leaf) Verbenaceae</td>
<td>23.3±1.8</td>
<td>17.6±0.8</td>
</tr>
<tr>
<td>Mentha arvensis Linn. (leaf) Lamiaceae</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
</tr>
<tr>
<td>Melaleuca leucadendron Myrtaceae</td>
<td>31.7±1.8</td>
<td>40.2±1.8</td>
</tr>
<tr>
<td>Linn. Mart. (leaf)</td>
<td>Lamiaceae</td>
<td>65.1±1.4</td>
</tr>
<tr>
<td>Ocimum carum Sims (leaf) Geraniaceae</td>
<td>67.7±2.5</td>
<td>4.7±1.3</td>
</tr>
<tr>
<td>Pogostemon cablin Benth. (leaf) Lamiaceae</td>
<td>13.2±1.8</td>
<td>12.4±50.8</td>
</tr>
<tr>
<td>Santalum album Linn. (wood) Santalaceae</td>
<td>7.4±1.5</td>
<td>20.6±1.2</td>
</tr>
<tr>
<td>Thymus vulgaris Linn. (leaf) Lamiaceae</td>
<td>78.5±1.2</td>
<td>71.8±2.5</td>
</tr>
<tr>
<td>Vetiveria zizanioides Linn. (rhizome) Poaceae</td>
<td>1.4±3.2</td>
<td>6.3±0.6</td>
</tr>
<tr>
<td>Zingiber officinale Rosc. (rhizome) Zingiberaceae</td>
<td>21.2±4.8</td>
<td>13.0±1.4</td>
</tr>
</tbody>
</table>

Data are significantly different with each other at *P*<0.005.

3. Results

3.1. Fungitoxic activity of *Chenopodium* oil

During antifungal screening of essential oils isolated from 18 plant species against two aflatoxicogenic strains of *A. flavus* at 500 μg/ml, the oils of *C. ambrosioides* and *M. arvensis* exhibited 100% fungitoxicity against both strains of *A. flavus* (Table 1). The oils of *Cymbopogon martini* and *Thymus vulgaris* exhibited more than 70% fungitoxicity against both strains while those of *Aegle marmelos, Eupatorium cannabinum* and *Vetiveria zizanioides* were ineffective, showing less than 10% activity. *C. ambrosioides* Linn. was selected for further studies because of its luxuriant growth as weed all over India.

*C. ambrosioides* oil inhibited the mycelial growth of the both strains of test fungi at 100 μg/ml. Therefore, the minimum inhibitory concentration (MIC) of oil was assigned to be 100 μg/ml. The oil of *C. ambrosioides* showed fungistatic nature of toxicity against both strains of *A. flavus*. *Chenopodium* oil was found to be more effective than the synthetic fungicides. The MICs of synthetic fungicides benimidazole, zinc dimethylthiocarbamate and phenylmercuric acetate against both strains were >5000, >5000 and 100 μg/ml, respectively. MIC of diphenylamine was 2000 μg/ml against Navjot 4NSSt, but it was 3000 μg/ml against Saktiman 3NSSt. The *Chenopodium* oil exhibited broad fungitoxic spectrum against all the tested fungi and it absolutely inhibited the growth of *A. fumigatus, B. theobromae, F. oxysporum, P. debaryanum* and *S. rolsii* (Table 2).

Table 3: Effect of *C. ambrosioides* oil on mycelial biomass (g) and AFB1 production (μg/kg) against aflatoxicogenic strain of *A. flavus*

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Concentration of <em>C. ambrosioides</em> oil (μg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control 10 100 250 500</td>
</tr>
<tr>
<td>Mycelial biomass (g)</td>
<td>0.25±0.01 0.21±0.00 0.21±0.00 0.19±0.01 0.00±0.00</td>
</tr>
<tr>
<td>AFB1 (μg/kg)</td>
<td>447.48±12.39 0.00±0.00 0.00±0.00 0.00±0.00 0.00±0.00</td>
</tr>
</tbody>
</table>

Data are significantly different with each other at *P*<0.005.

3.2. Anti-aflatoxicogenic property of *Chenopodium* oil

Effect of *C. ambrosioides* oil on production of aflatoxin B1 by the aflatoxicogenic strain Saktiman 3NSSt of *A. flavus* in SMKY medium is presented in Table 3. The oil completely inhibited the aflatoxin B1 production at 10 μg/ml. Mycelial growth was recorded up to 250 μg/ml in *Chenopodium* treated sets, but aflatoxin B1 production was completely inhibited. Thus, *C. ambrosioides* oil showed potential anti-aflatoxicogenic property.

Fig. 1. Effect of *Chenopodium* oil and ascorbic acid on radical scavenging activity of ABTS radical cation; *Chenopodium* oil (-•–) and ascorbic acid (-○–). There was a significant relationship between the concentration and percent inhibition of radical cation (*R*=0.88; *P*<0.05).
Table 4
Mycoflora of stored wheat samples treated with Chenopodium oil after 12 month of storage at 100 μg/ml

<table>
<thead>
<tr>
<th>Fungi isolated</th>
<th>Percent occurrence of fungi</th>
<th>Uninoculated Control</th>
<th>Treatment</th>
<th>Inoculated Control</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspergillus candidus</td>
<td></td>
<td>3.7±0.2 a</td>
<td>0.0±0.0</td>
<td>4.3±0.3 a</td>
<td>0.0±0.0</td>
</tr>
<tr>
<td>A. flavus</td>
<td></td>
<td>46.7±1.7 a</td>
<td>0.0±0.0</td>
<td>89.0±2.7 a</td>
<td>8.3±0.8 b</td>
</tr>
<tr>
<td>A. niger</td>
<td></td>
<td>14.3±1.2 a</td>
<td>0.0±0.0</td>
<td>0.0±0.0</td>
<td>0.0±0.0</td>
</tr>
<tr>
<td>A. parasiticus</td>
<td></td>
<td>9.7±0.3 a</td>
<td>0.0±0.0</td>
<td>0.0±0.0</td>
<td>0.0±0.0</td>
</tr>
<tr>
<td>A. terreus</td>
<td></td>
<td>1.3±0.3 a</td>
<td>0.0±0.0</td>
<td>0.0±0.0</td>
<td>0.0±0.0</td>
</tr>
<tr>
<td>Penicillium citrinum</td>
<td></td>
<td>42.7±1.8 a</td>
<td>0.0±0.0</td>
<td>0.0±0.0</td>
<td>0.0±0.0</td>
</tr>
</tbody>
</table>

Within individual row values with different superscripts are significantly different with each other of control and treatment of uninoculated and inoculated sets respectively (P<0.05, Students t test).

ambrosioides oil was found effective in checking aflatoxin B1 production at a very low concentration.

3.3. Antioxidant activity of Chenopodium oil

ABTS⁺⁺ scavenging activity was enhanced with oil concentration, exhibited antioxidant activity of C. ambrosioides (Fig. 1). At 500, 1000, 1500, 2000, 2500 and 3000 μg/ml, the scavenging activity increased to 20.00, 70.00, 74.56, 82.30, 89.03 and 95.66%, respectively. The oil showed highest antioxidant activity at 3000 μg/ml concentrations.

3.4. In vivo fumigant efficacy of Chenopodium oil against fungal deterioration in stored wheat

The Chenopodium oil showed its efficacy in control of fungal association of wheat samples when it was tested as fumigant. The wheat samples of the uninoculated control set showed the presence of six fungi. A. flavus was found to be the dominant fungus, followed by Penicillium citrinum, A. niger and A. parasiticus. The C. ambrosioides oil checked the appearance of all the fungi appearing in uninoculated sets. In the case of inoculated control, two fungi were isolated. The oil completely checked the appearance of A. candidus while it significantly protected the wheat samples from A. flavus in the treatment set. The results indicate that there was 99.42% protection of wheat samples from storage fungi in uninoculated sets while 91.17% in inoculated sets (Table 4).

4. Discussion

The present findings indicate the possible exploitation of Chenopodium oil in treatment of food commodities against fungal infestations as well as lipid peroxidation. A fungitoxicant possessing broad fungitoxic spectrum may be employed successfully in controlling fungal infestations of stored food commodities incited by different fungi. Hence, the broad fungitoxic spectrum of Chenopodium oil would enhance its market value. The MIC of Chenopodium oil was comparatively lower than that of the synthetic fungicides tested, thereby, its potency as antifungal product of higher plant origin would be economical. A perusal of literature shows that the MIC of Chenopodium oil (100 μg/ml) was also lower than other oils i.e. Ocimum gratissimum, Thymus vulgaris, Cymbopogon citrates, Zingiber officinalae and Monodora myristica (Nguefack et al., 2004), Alpinia galanga (Tripathi et al., 1983), Cinnamomum camphora (Mishra et al., 1991) tested against A. flavus.

Some plant products have earlier been reported for their different biological properties mostly based on preliminary investigations. However, this is the first report on Chenopodium oil showing three virtues viz. in checking fungal deterioration of food commodities, inhibitory effect on aflatoxin synthesis and as antioxidant. Correlation in antifungal and antioxidant activity has been expressed in the case of some synthetic compounds (Thompson, 1991) and this has also been made in the present investigation with Chenopodium oil. The shelf life and quality of food commodities are affected by microbial infestation as well as the release of free radicals causing auto oxidation of unsaturated lipids (Kaur and Perkins, 1991). The Chenopodium oil was inhibitory to the growth of A. flavus as well as it checked the production of aflatoxin B1. The findings of the present study are relevant in enhancing shelf life of commodities by controlling micro organisms as well as free radical scavenging.

Lysis of the mycelia and spores of the toxigenic fungus is one of the characteristics of aflatoxin deactivation process which may proliferate under favourable conditions (Namazi et al., 2002). The results of the present investigation comply with the above mentioned characteristics. Food products are usually held at refrigerator temperature during their manufacture, storage and distribution. However, this provides opportunity for growth of psychrotolerant micro organisms. Essential oil components have been recommended in vegetable based food systems to explore their value as secondary preservatives (Shelef, 1984).

As C. ambrosioides widely grows in India as wasteland weed, its essential oil may be recommended as an easily available and renewal source of fungitoxicant and antioxidant in place of synthetic chemical compounds used for this purpose. C. ambrosioides has been used for a long time in the Indian system of medicine as vermicide (Cheryl et al., 2006; Mishra, 2002). Its oil may be thus recommended in food protection and food processing. In general concern for residues of essential oil on food commodities may be mitigated by the growing body of evidence that some essential oil constituents acquired through the diet are actually beneficial to human health (Huang et al., 1994). However, some experiments are further required to standardise for its safety limit and organoleptic tests with Chenopodium oil.

Acknowledgement

The authors are thankful to the Department of Science and Technology, New Delhi, India for financial assistance.

References


