

Effects of Four Essential Oils on the Growth of Aflatoxin Producing Fungi

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Abstract

There have been records that many essential oils have shown antimicrobial properties. Some essential oils can inhibit the growth of aflatoxin producing fungi and aflatoxin production. In this study we compare the ability of 4 plant essential oils, i.e. ginger oil, anise star oil, cajuput oil and cinnamon oil for controlling aflatoxin producing fungi. The oils at concentrations of 0, 0.5, 1, 2, 3, 4 and 5% were tested against *Aspergillus flavus* IMI 242684 and *A. parasiticus* IMI 102566 on Potato Dextrose Agar (PDA). The fungi were cultured and incubated at 30° C for 7 days. The results show that anise star oil at all concentrations had the most inhibitory effect on both *Aspergillus flavus* IMI 242684 and *A. parasiticus* IMI 102566 with significant difference followed by cinnamon oil and cajuput oils. Ginger oil had the least inhibition effect.

Keywords: Essential oils, Aflatoxin, *Aspergillus flavus*, *Aspergillus parasiticus*

1. Introduction

Aflatoxins are hazardous to both humans and animals. Various methods have been investigated in order to prevent the growth of aflatoxigenic fungi, eliminate or reduce the toxin levels, and to degrade or detoxify the toxins in agricultural products. Natural plant extracts are of interest as a source of safer or more effective substitutes for synthetically produced antimicrobial agents and may provide an alternative way to prevent food or feed from fungal contamination [1-3]. Powders and extracts of various herbs, spices and essential oils have been reported to have antimicrobial activity and some also to inhibit aflatoxin formation [4-8]. In this study, we compare four types of essential oils at various concentrations for their ability to inhibit the growth of aflatoxin producing fungi such as *Aspergillus flavus* IMI 242684 and *A. parasiticus* IMI 102566 on Potato Dextrose Agar (PDA).

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2. Materials and Methods

2.1 Fungi

Aspergillus flavus IMI 242684 and *A. parasiticus* IMI 102566 obtained from the International Mycological Institute, England, were used throughout this study. The cultures were maintained in PDA slants.

2.2 Preparation of essential oils

Four commercial essential oils were purchased from Hong Huad Co. Ltd, Bangkok, Thailand, i.e. ginger (*Zingiber officinale*), anise star (*Illicium verum* Hook.f.), cajuput (*Melaleuca quinquenervia* (Cav.) S.T. Blake) and cinnamon (*Cinnamomum verum* J. Presl). Oils were stored at room temperature.

2.3 Effect of essential oils on growth of aflatoxin producing fungi

Essential oils at concentrations of 0, 0.5, 1, 2, 3, 4 and 5% were tested against *A. flavus* IMI 242684 and *A. parasiticus* IMI 102566 on Potato Dextrose Agar (PDA) by Poison medium method as described in Thanaboripat *et al.* [9]. The agar cultures were incubated at room temperature for 7 days. Diameters of fungal growth were measured using digital vernier caliper. Agar plate without essential oil served as control. The experiment was done in three replicates.

2.4 Statistical analysis

The experiments were designed and analyzed using three-factor factorial in Completely Randomized Design, and Multiple comparison of Tukey method was used to analyse the differences of mean in ANOVA.

3. Results and Discussion

Four essential oils were tested for the effect on the growth of *A. flavus* IMI 242684 and *A. parasiticus* IMI 102566 on PDA for 7 days. The results showed that anise star oil at all concentrations (0.5-5%) gave the most inhibitory effect on both *Aspergillus flavus* IMI 242684 and *A. parasiticus* IMI 102566 with significant difference followed by cinnamon oil and cajuput oils, respectively. Cinnamon oil and cajuput oil at concentrations of 1-5% completely inhibited the growth of aflatoxin producing fungi whereas anise star oil at all concentrations could inhibit both fungi. Ginger oil at all concentrations showed the least inhibition effect among four essential oils (Table 1 and Figures 1-8).

Our findings showed that plant essential oils such as anise star, cinnamon and cajuput at certain concentrations could inhibit aflatoxin producing fungi such as *A. flavus* and *A. parasiticus*, hence, aflatoxin production could also be inhibited due to no growth of fungi. Our previous study showed that cajuput or white wood and cinnamon at certain concentrations inhibited the growth of *A. flavus* [10]. Sinha *et al.* [11] found that clove oil at 50 and 100 µg/ml and cinnamon oil at 50 µg/ml stimulated the growth of *A. flavus* in liquid media whereas the higher concentrations reduced the mycelia growth. A number of compounds and substances have been found to be effectively inhibit fungal growth and aflatoxin production, while others have stimulatory properties [12]. In many instances low concentrations of test compounds stimulated fungal growth and/or toxin production, while higher concentrations were completely inhibited.

Table 1. Statistical analysis of growth inhibition of *Aspergillus flavus* IMI 242684 and *A. parasiticus* IMI 102566 on PDA by 4 essential oils at various concentrations.

Fungal strains	Conc. Type	Diameters of fungal colonies (mm)*						
		0 (control)	0.5	1	2	3	4	5
<i>A. flavus</i> IMI 242684	Ginger	66.4 ^g	50.6 ^f	39.8 ^c	24.4 ^c	19.6 ^c	20.8 ^c	21.6 ^c
	Anise Star	68.6 ^g	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a
	Cajuput	66.6 ^g	18.2 ^c	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a
	Cinnamon	50.0 ^f	15.4 ^b	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a
<i>A. parasiticus</i> IMI 102566	Ginger	60.2 ^g	54.0 ^f	41.0 ^c	40.0 ^c	29.4 ^d	27.8 ^d	20.0 ^c
	Anise Star	67.2 ^g	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a
	Cajuput	64.6 ^g	16.0 ^b	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a
	Cinnamon	50.8 ^f	10.2 ^b	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a

*Means with different superscripts are significantly different at 0.05 level ($p < 0.05$)

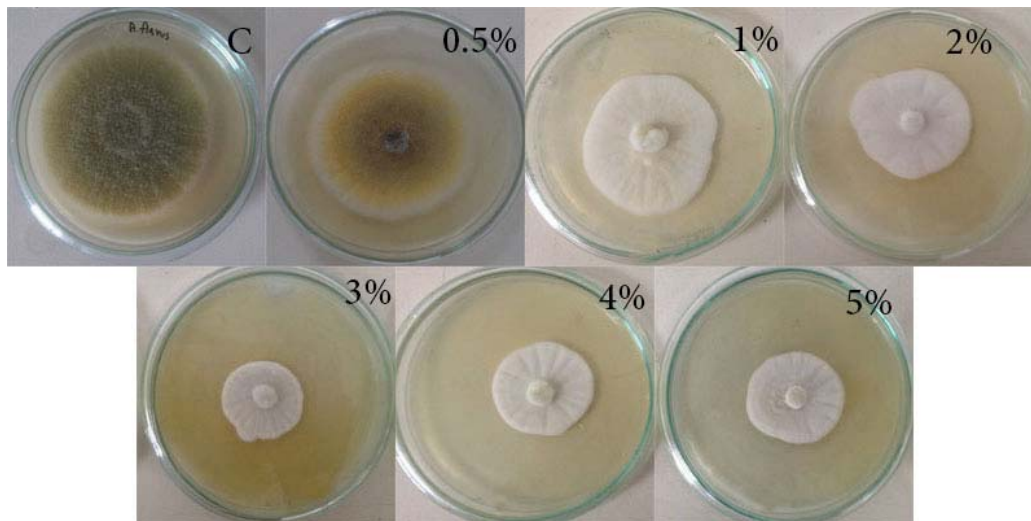


Figure 1. Effect of ginger oil at concentrations of 0.5, 1, 2, 3, 4 and 5% on the growth of *Aspergillus flavus* IMI 242684 compared to the control.

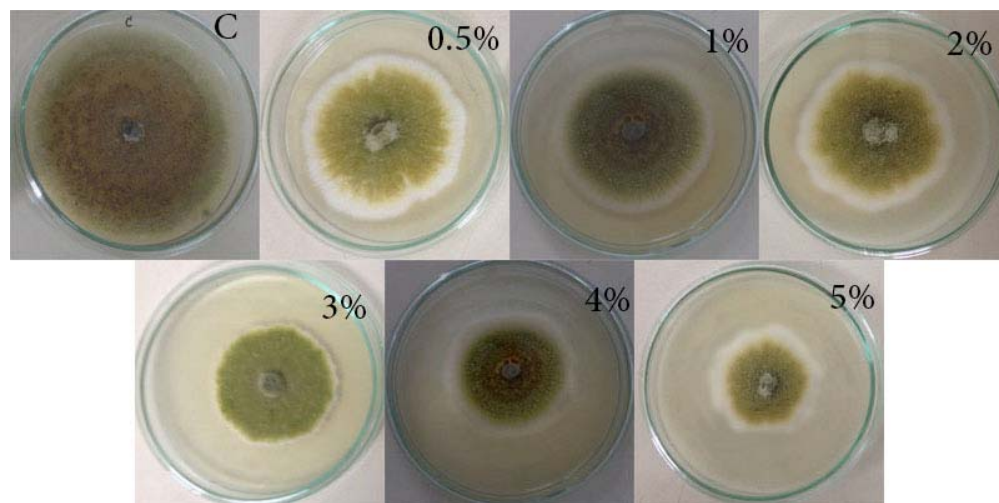


Figure 2. Effect of ginger oil at concentrations of 0.5, 1, 2, 3, 4 and 5% on the growth of *Aspergillus parasiticus* IMI 102566 compared to the control.

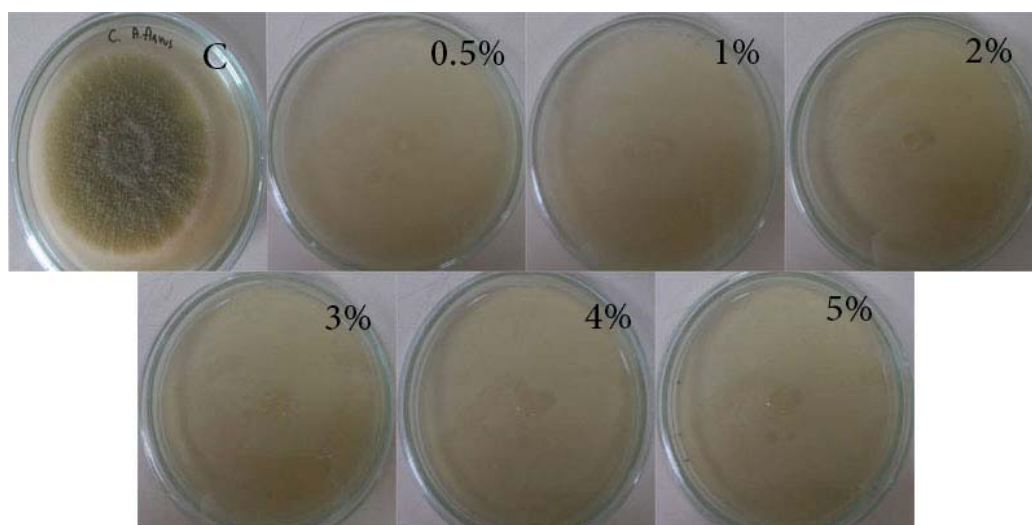


Figure 3. Effect of anise oil at concentrations of 0.5, 1, 2, 3, 4 and 5% on the growth of *Aspergillus flavus* IMI 242684 compared to the control.

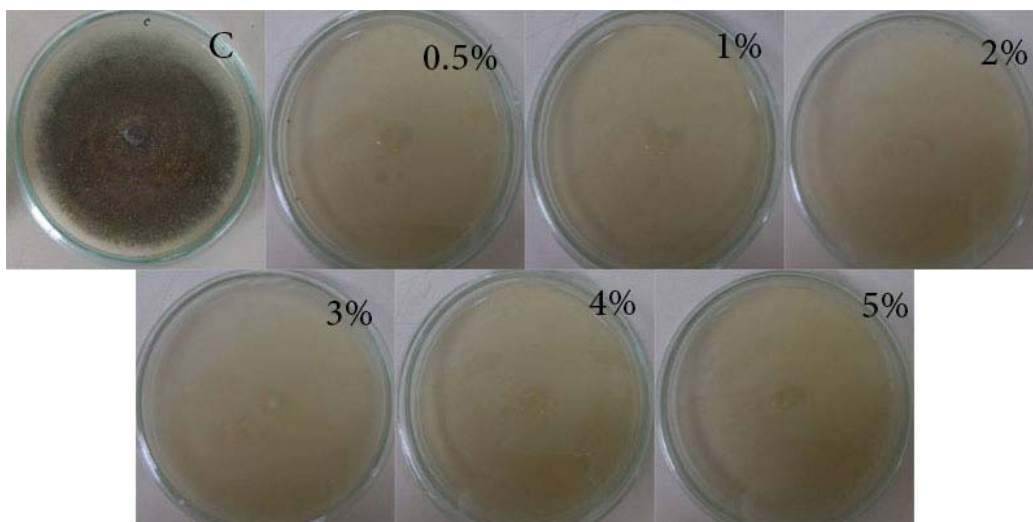


Figure 4. Effect of anise oil at concentrations of 0.5, 1, 2, 3, 4 and 5% on the growth of *Aspergillus parasiticus* IMI 102566 compared to the control.

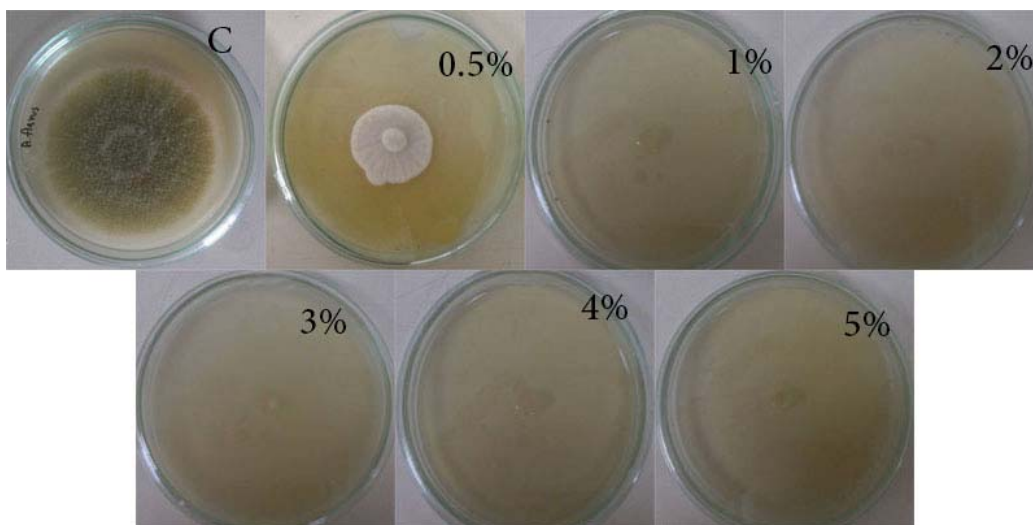


Figure 5. Effect of cajuput oil at concentrations of 0.5, 1, 2, 3, 4 and 5% on the growth of *Aspergillus flavus* IMI 242684 compared to the control.

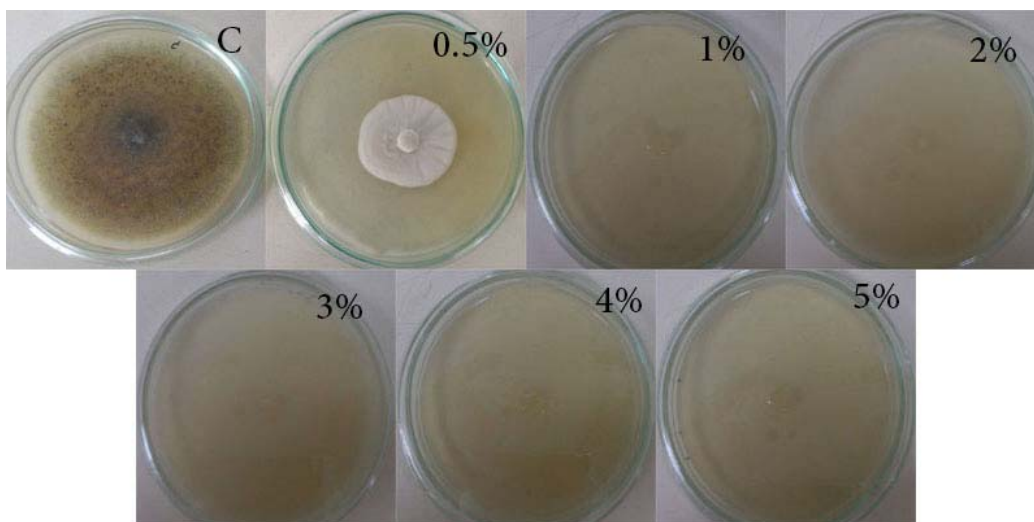


Figure 6. Effect of cajuput oil at concentrations of 0.5, 1, 2, 3, 4 and 5% on the growth of *Aspergillus parasiticus* IMI 102566 compared to the control.

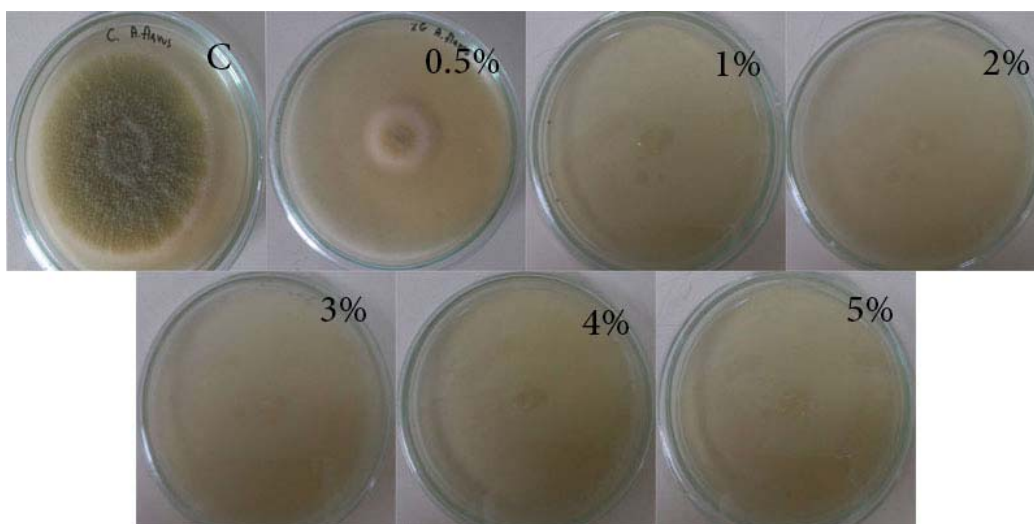


Figure 7. Effect of cinnamon oil at concentrations of 0.5, 1, 2, 3, 4 and 5% on the growth of *Aspergillus flavus* IMI 242684 compared to the control.

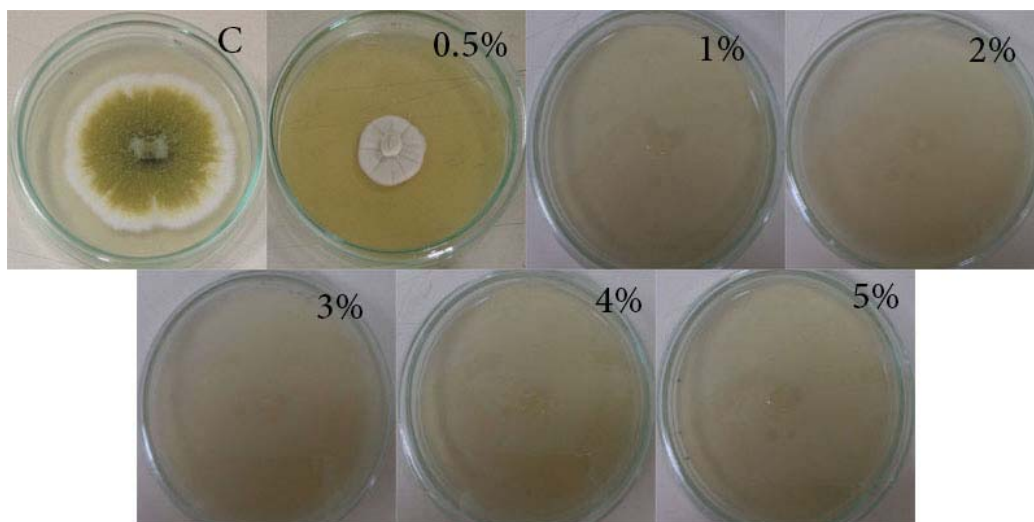


Figure 8. Effect of cinnamon oil at concentrations of 0.5, 1, 2, 3, 4 and 5% on growth of *Aspergillus parasiticus* IMI 102566 compared to the control.

4. Conclusions

It could be concluded that anise star oil, edible oil, is the most active oil for inhibiting aflatoxin producing fungi such as *A. flavus* and *A. parasiticus* when compared to cinnamon, cajuput and ginger oils. It showed potential use as antifungal agent. However, further study has to be investigated for practical use.

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