Isolation and Identification of Pathogenic Fungi from Street Foods in Dhaka City: Antifungal Sensitivity Patterns and Effects of Star Anise Extract

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Abstract

Background: Street foods in South Asian countries, particularly Bangladesh, are popular yet pose significant food safety risks due to microbial contamination. These risks stem from unhygienic handling practices, inadequate storage conditions, and the use of harmful additives, leading to a high incidence of foodborne illnesses. This study investigates the microbial contamination of street foods in Dhaka and evaluates the efficacy of star anise (Illicium verum) as a natural antifungal agent. Methods: Fifteen street food samples were collected across Dhaka and analyzed for fungal contaminants. Star anise was extracted using methanol, and antifungal sensitivity tests were conducted using standard disk diffusion techniques against isolated fungi, including Aspergillus niger, Aspergillus fumigatus, and *Candida spp.* Results: Antifungal testing revealed that synthetic agents such as Amphotericin B and Ketoconazole effectively inhibited Aspergillus species. Star anise extracts demonstrated issues associated with street foods in Bangladesh and underscore the potential of star anise as a natural preservative. This research advocates for improved food safety practices and regulatory measures to mitigate health risks in street food consumption, contributing to moderate to high antifungal activity, particularly against Aspergillus niger, indicating its potential as a natural alternative to synthetic antifungal agents. Conclusion: The findings highlight critical food safety public health improvements in similar contexts.

Keywords: Street Food, Microbial Contamination, Star Anise, Antifungal Activity, Food Safety

Significance | Street Food, Microbial Contamination, Star Anise, Antifungal Activity, Food Safety

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Introduction

In South Asia, street foods are an essential aspect of urban culture, particularly in countries like Bangladesh, India, and Pakistan, where they serve as both a staple and a popular indulgence (Al, 2016). In Bangladesh, street foods such as bread, pastries, salty and sweet biscuits, cakes, chatpati, and various pickles are widely consumed, especially in tea stalls and open market setups (Rahman, 2014). These food items, however, are prone to microbial contamination

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due to their exposure to unsanitary conditions, limited food safety measures, and high potential for spoilage (Ali, Khan, & Saha, 2011). While food safety and consumer rights are strictly regulated in industrialized nations, these issues are often under-prioritized in developing countries like Bangladesh (Food and Agriculture Organization, 2012). Poor regulation, insufficient infrastructure, and lack of consumer awareness contribute to significant health risks associated with street food consumption, including gastrointestinal diseases and foodborne illnesses (Barro et al., 2006). Microbial pathogens, particularly those resistant to multiple drugs, further exacerbate the health threat posed by contaminated street food in public health contexts (Mensah, Yeboah-Manu, Owusu-Darko, & Ablordey, 2002).

Approximately 30 million people in Bangladesh are estimated to suffer from foodborne illnesses each year, with diarrheal diseases being the most prevalent and severe in some cases (Shrimali & Shah, 2017). Street foods are a significant vector of microbial pathogens due to traditional preparation methods, inadequate storage temperatures, and insufficient hygiene among food handlers (Muyanja, Nayiga, Brenda, & Nasinyama, 2011). In addition, the open-air environment, where street food vendors often lack protective measures against flies, dust, and other contaminants, aggravates the risk of contamination (Mamun, Rahman, & Turin, 2013). A 2010 FAO study on the socioeconomic and hygienic practices of Dhaka Street food vendors revealed that 25% of vendors were illiterate, and most (88%) operated with minimal sanitation and hygiene facilities (Food and Agricultural Organization of the United Nations, 2010). This study also identified the prevalence of aerobic bacteria, coliform bacteria, and other pathogens in food samples, drinking water, and hand swabs (Gorospe & Fadare, 2007). Adding to these challenges, some street food businesses in Bangladesh resort to using various additives, such as emulsifiers, artificial colors, and preservatives, which can introduce additional health hazards (Huk, Hammond, Kegechika, & Lincoln, 2013). Excessive consumption of these additives has been associated with toxic effects, such as Hypervitaminosis A, stomach disorders, and potential neurotoxicities, due to harmful chemicals like aniline and methiocrab in the food (Castaño, Etchart, & Sookoian, 2006). Mycotoxins, particularly aflatoxins produced by fungi such as Aspergillus flavus, also pose a serious health concern, as these toxic metabolites are commonly found in grains and nuts in warm, humid environments like Bangladesh (Minuk, Kelly, & Hwang, 1988). Consumption of these mycotoxins can lead to chronic liver diseases and other serious health complications (Levine, Delgado, Theise, & West, 2003). Furthermore, economic losses due to food spoilage and contamination significantly impact local vendors and consumers alike, as a considerable portion of the street food business in Bangladesh is susceptible to fungal infections from pathogens such as Aspergillus, Fusarium, and Penicillium species (Siddique & Anower, 2023).

This study aims to examine the contamination of street foods by fungi and their sensitivity to antifungal agents. Specifically, the research explores the effectiveness of star anise (Illicium verum), known for its antimicrobial properties attributed to anethole, as a natural antifungal agent against fungi isolated from street foods. Through this investigation, we seek to identify prevalent fungal species, evaluate their resistance to both synthetic antifungal drugs and star anise extracts, and highlight the urgent need for improved food safety practices in Bangladesh.

Materials and Methods

Materials and Equipment

The study utilized various materials and equipment for the isolation and analysis of fungal contaminants from street foods, including micropipettes and tips, syringes, extra-fine tweezers, an alcohol lamp, 90 mm and 60 mm petri dishes with marked squares, centrifugal tubes, a vortex mixer, sterile gloves, a laminar flow cabinet, a microscope, culture media, and distilled water. Additional items included filter paper, star anise (Illicium verum), antifungal discs, and synthetic antifungal agents. The star anise was extracted using solvents including absolute methanol (100% MeOH) and a 50:50 mixture of methanol and distilled water.

Preparation of Star Anise Extract

Dried star anise fruits were ground to a fine powder. For each solvent extraction, 100 g of anise powder was combined with 500 mL of either absolute methanol or 50:50 methanol-water solution in tightly sealed flasks. The flasks were placed in a 37°C water bath for 24 hours with intermittent shaking. After 24 hours, the supernatant was collected and filtered through Whatman filter paper No. 1. This process was repeated until a clear solution was obtained. The final extract was evaporated to dryness at 45°C, weighed, and diluted to a concentration of 500 mg/mL or stored in a sealed container in a refrigerator until use. Before application, the extracts were centrifuged and filtered through a 0.22 µm Millipore membrane filter.

Sample Collection and Processing

Fifteen street food samples were collected from various locations across Dhaka city once daily between 7 a.m. and 2 p.m. during May 2024 (Figure 1). Food samples were collected in sterile plastic bags, following the methods outlined by Cheesbrough (1984). All samples were handled aseptically, stored in sterile containers, and transported with care to prevent contamination. Upon arrival at the laboratory, samples were homogenized; 5 g samples were used for homogeneous materials (e.g., flour), and 40 g for non-homogeneous materials (e.g., grains).

Fungal Isolation and Identification

For fungal isolation, 0.5 g of each sample was mixed with 4.5 mL of Tryptic Soy Broth (TSB) in sterile test tubes. The mixture was vortexed for 1 minute, then incubated at 121°C for 24 hours to encourage fungal growth. Following incubation, fungal isolates were transferred to sterilized plates for purification and identification (Figure 2). Samples were examined under a microscope, and fungal identification was based on colony morphology, spore characteristics, and physical features of the mycelia.

Replication of Pathogens

To ensure consistent results, Sabouraud Dextrose Agar (SDA) media was prepared and preserved at room temperature for fungal growth. Samples were initially incubated for three days in an in vitro glass chamber, allowing for open-air contamination. For further analysis, the samples were transferred to the laminar air flow for inoculation and incubated over several replications to ensure that preservatives did not inhibit fungal growth. Growth was observed over a 14-day period across three replications, with fungal growth checked every seven days (Figure 3 to Figure 5).

Preparation of Pure Cultures

The most prevalent fungal species, including Aspergillus niger, Aspergillus fumigatus, and *Candida spp.*, were isolated for pure culture preparation. Samples were directly plated onto SDA media and incubated at 25°C for five to seven days (Figure 6). These species were distinguished based on spore formation and colony appearance, with A. niger appearing black with a wooly texture, A. fumigatus showing a dry green appearance, and *Candida spp.* presenting creamy white colonies.

Antifungal Sensitivity Testing

The sensitivity of Aspergillus and Candida species to antifungal agents, including Nystatin, Econazole, Ketoconazole, Amphotericin B, Flucytosine, Miconazole, and Fluconazole, was assessed on Mueller-Hinton and SDA media using standard disk diffusion techniques. Star anise extract was also tested for its antifungal properties against A. niger, A. fumigatus, and *Candida spp.* as per the National Committee for Clinical Laboratory Standards (NCCLS, 2002).

Results

The results of the antifungal sensitivity testing shed light on the comparative effectiveness of synthetic and natural antifungal agents against fungi isolated from street food samples in Dhaka. This analysis focuses on the antifungal efficacy of seven synthetic agents Nystatin, Econazole, Ketoconazole, Amphotericin B, Flucytosine, Miconazole, and Fluconazole against fungal species like Aspergillus fusarium, Aspergillus niger, and *Candida spp.* Additionally, the study examines the potential of star anise extract, a natural antifungal, as an alternative. The findings are detailed in the measured zone of inhibition, sensitivity patterns, and concentration-based efficacy.

Synthetic Antifungal Agents

The study revealed that each synthetic antifungal agent displayed a unique spectrum of activity across the tested fungal strains. Notably, the zone of inhibition results demonstrated that Amphotericin B and Ketoconazole provided potent inhibitory effects against Aspergillus niger, highlighting their potential as effective treatments in mitigating fungal contamination in street food (Table 4). The zone of inhibition measurements for A. niger show that Econazole created the largest inhibition zone of 35 mm, suggesting superior efficacy compared to other agents. Conversely, Miconazole and Fluconazole did not exhibit any inhibition, highlighting the specific resistance patterns in these fungal isolates (Table 1).

For *Candida spp.*, Nystatin and Econazole demonstrated moderate efficacy, with inhibition zones of 2 mm and 15 mm, respectively. This observation suggests that Nystatin and Econazole might be more effective against yeast-related contaminants in food than against other fungal genera. In contrast, agents like Miconazole and Fluconazole failed to inhibit Candida, which points to a resistance profile consistent with prior findings on *Candida spp.* resistance to azole antifungals in food contexts.

Regarding Aspergillus fumigatus, Amphotericin B and Flucytosine demonstrated modest inhibitory effects with inhibition zones of 10 mm and 2 mm, respectively, while Econazole showed a reduced effectiveness. This variation suggests that different strains of Aspergillus may exhibit variable susceptibility patterns, requiring tailored antifungal treatment strategies. Such variability is important when considering food safety applications, where synthetic agents may need to be selected based on the specific fungal strains present in the food samples.

Sensitivity and Resistance Patterns

The sensitivity pattern, as shown in Table 2, highlights the complex resistance profiles of each fungal species to the tested synthetic antifungals. For instance, A. niger displayed resistance (R) to Nystatin, Ketoconazole, Flucytosine, and Amphotericin B, while showing sensitivity (S) only to Econazole. Interestingly, A. fumigatus was resistant to nearly all synthetic agents except Amphotericin B, to which it displayed intermediate (I) sensitivity. This intermediate sensitivity could suggest a limited application of Amphotericin B as a fungistatic rather than fungicidal agent in certain contexts.

On the other hand, *Candida spp.* showed resistance to most of the agents, including Miconazole, Ketoconazole, and Fluconazole, but displayed intermediate sensitivity to Econazole, indicating that this agent might provide some degree of inhibition but may not be sufficiently potent for complete eradication in food safety applications.

Natural Antifungal: Star Anise Extract (SAE)

The evaluation of star anise extract (SAE) against fungal isolates, especially Aspergillus niger, Aspergillus fumigatus, and *Candida spp.*, revealed promising results for this natural agent. SAE, tested at different concentrations (100, 250, and 500 µg/mL), exhibited concentration-dependent inhibitory effects against these fungi. Specifically, the highest concentration (500 µg/mL) demonstrated significant zones of inhibition, particularly for *Aspergillus fumigatus* (30 mm), indicating a potent antifungal effect. For Aspergillus niger, the inhibition zone increased from 12 mm at 100 µg/mL to 22 mm at 500 µg/mL, illustrating the concentration-dependent efficacy of star anise.

The antifungal activity of star anise is primarily attributed to its active compound, anethole, known for its antimicrobial properties. The presence of visible inhibition zones in the agar disk diffusion assays supports the potential of star anise extract as a viable alternative to synthetic agents, especially in settings where natural or food-grade antifungals are preferred. The results suggest that SAE could serve as a natural preservative, helping to control fungal contamination in foods while also appealing to consumers seeking natural solutions.

Comparison of Synthetic and Natural Antifungal Efficacy

The study's comparison between synthetic antifungal agents and star anise extract underscores the strengths and limitations of each approach in addressing fungal contamination in street food samples. Synthetic agents such as Econazole and Amphotericin B exhibited strong, strain-specific antifungal activity, which could be useful in controlled food safety applications. However, the resistance patterns observed in A. fumigatus and *Candida spp.* point to limitations in relying solely on these agents, as resistance mechanisms might reduce their long-term efficacy in food preservation.

In contrast, star anise extract exhibited consistent, concentration-dependent inhibition across all tested fungal species, providing evidence of its broad-spectrum antifungal activity. Particularly, its effectiveness against *Aspergillus fumigatus* at higher concentrations suggests that star anise could be applied as a natural food preservative, especially where consumers demand fewer synthetic additives. The findings indicate that star anise extract's natural composition offers a safer, consumer-friendly option for managing fungal contamination, although further studies would be needed to confirm its stability and efficacy in various food matrices over time.

Implications for Food Safety

This study highlights the potential of both synthetic and natural antifungal agents for addressing fungal contamination in street foods. The insights gained could guide food safety practices, especially in regions with limited access to synthetic antifungal agents or where there is a preference for natural solutions. Star anise extract, with its proven antifungal properties, offers a promising natural alternative that could be incorporated into preservation methods to reduce fungal contamination and improve food safety. The resistance of certain fungal isolates to multiple synthetic agents, as observed in this study, underscores the need for continuous monitoring of antifungal efficacy, particularly given the adaptive resistance mechanisms in fungi. Furthermore, combining synthetic and natural antifungal agents might offer a synergistic approach, potentially reducing the development of resistance while enhancing overall antifungal efficacy.

Discussion

The findings of this study showed the high prevalence of fungal contamination in street foods across Dhaka, where a range of food items from cakes and bread to traditional snacks like fuchka were found to harbor fungi such as Aspergillus niger, Aspergillus fumigatus, and *Candida spp.*. (Julie et al., 2009). This widespread contamination highlights critical public health risks associated with street foods, exacerbated by inadequate food handling and sanitation practices that leave foods susceptible to environmental contaminants (USEPA., 2013). Given the popularity of street foods and their role as a significant part of the urban diet, these findings indicate an urgent need for robust regulatory frameworks and improved food safety protocols in the street food sector (Keller et al., 2005). The study's insights into antifungal efficacy against these foodborne fungi further inform strategies for mitigating microbial risks and enhancing consumer safety.

Fungal Contamination in Street Foods: A Public Health Perspective

The isolation of fungal pathogens such as *Aspergillus niger* (Table 3), Aspergillus fumigatus, and *Candida spp.* from street food samples illustrates how poor food handling and inadequate environmental controls contribute to high fungal contamination rates (Schardl et al., 2006). These contaminants pose substantial health risks, as fungal infections can lead to severe complications, especially in immunocompromised individuals. Aspergillus species, known to produce mycotoxins under certain conditions, are particularly concerning due to their carcinogenic potential and potential to cause respiratory and allergic reactions (Egmond et al., 2007). Additionally, *Candida spp.* can lead to opportunistic infections, especially among individuals with compromised immune systems, further underscoring the health implications of fungal contamination in street foods (Table 5).

The prevalence of these fungi in street foods raises questions about the environmental conditions around street food vending areas (De et al., 2002). Many street vendors operate in open spaces where food is exposed to dust, moisture, and other contamination sources. Previous studies have linked such environmental factors with increased fungal contamination, which is consistent with our findings. Contaminated food serves as a vector for fungal

Table 1. Measurement of zone of inhibition (mm) in SDA media

Name of fungus	**Nystatin**	**Econazole**	**Ketoconazole**	**Amphotericine B**	**Flucytocine**	**Miconazole**	**Fluconazole**
A.nigar	0mm	35mm	2mm	2mm	0mm	0mm	0mm
A.fumigatus	2mm	10mm	0mm	10mm	2mm	0mm	2mm
Candida spp.	2mm	15mm	0mm	0mm	5mm	0mm	0mm

Table 2. Sensitive and resistant pattern

Name of fungus	**Nystatin**	**Econazole**	**Ketonazole**	**Amphotericine B**	**Flucytocine**	**Miconazole**	**Fluconazole**
A. nigar	R	S	R	R	R	I	I
A. fumigatus	R	R	R	I	R	R	R
Candida Spp.	R	I	R	R	R	R	R

Table 3. Isolation of different fungus genera

Sample No.	**Food Type**	**Fungal Genera**
1	Cake	*Aspergillus Fumigatus*and *Aspergillus Nigar*both
2	Fuchka	*Aspergillus Nigar*and *candida* both
3	Bread	*Aspergillus Nigar*only

Table 4. Inhibition zone of fungus spp.

Fungus Spp.	**SAE Concen.(100)**	**SAE Concen.(250)**	**SAE Concen.(500)**
Zone of inhibition(mm)			
Aspergillus Nigar	12mm	20mm	22mm
Aspergillus Fumigatus	12mm	16mm	30mm
Candida Spp.	10mm	14mm	16mm
SAE- (Star Anise Extract)			

Table 5. shows the sensitivity pattern of fungus isolated from the study participant

ORGANISMS	***Aspergillus Nigar*(n=3)**		***Aspergillus Fumigatus*(n=2)**		***Candida spp.*(n=2)**	
ANTIBIOTIC	N	%	N	%	N	%
Nystatin	0	0%	0	0%	0	0%
Econazole	2	80%	0	0%	0	0%
Ketonazole	0	0%	0	0%	0	0%
Amphotericine B	0	0%	0	0%	0	0%
Flucytocine	0	0%	0	0%	0	0%
Miconazole	0	0%	0	0%	0	0%
Fluconazole	0	0%	0	0%	0	0%

Figure 1. Sample processing for the nourishment in the nutrient broth.

Figure 2. Transferring fungi to sterile plate under LAF cabinet.

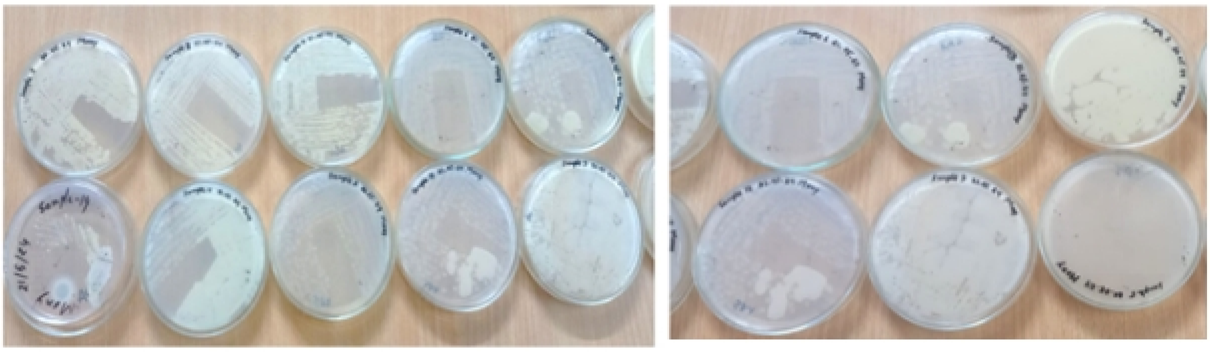

Figure 3. After 3rd days of 1streplication.

Figure 4. After 7th day of 2nd replication.

Figure 5. After 10th days of final replication, the fungal inoculation in the samples remarkably.

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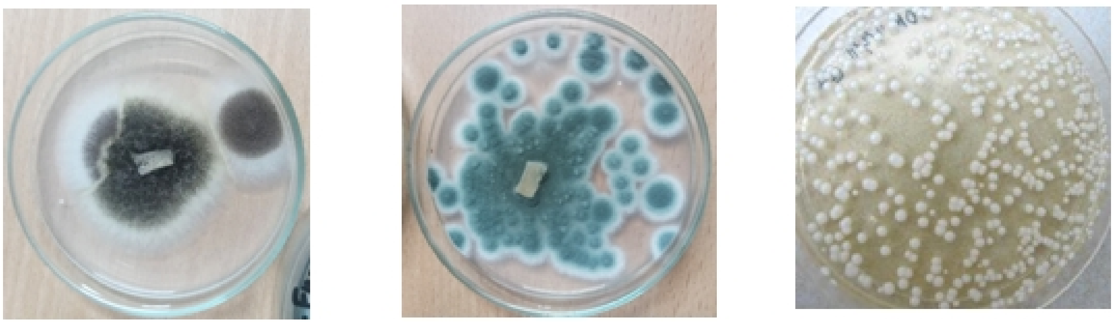

Aspergillus Nigar *Aspergullus Fumigatus* *Candida Spp.*

Figure 6. Pure culture preparation of Aspergillus Nigar, Aspergillus Fumigatus, Candida Spp.

Figure 7. Antibiotic sensitivity of A.nigar, A.fumigatus, Candida Spp.

Figure 8. positive sensitivity of fungus to the Star anise extract.

pathogens, endangering consumers who may lack the resources or knowledge to assess food safety (Salem et al., 2007). Given these risks, there is an urgent need for targeted interventions in the street food sector, including enhanced hygiene training for vendors, stricter regulatory oversight, and public awareness campaigns focused on food safety (PCAMF., 2011).

Efficacy of Synthetic Antifungal Agents Against Foodborne Fungi

In this study, synthetic antifungal agents including Nystatin, Econazole, Ketoconazole, and Amphotericin B showed variable effectiveness against fungal isolates from street foods (Johannessen & Trop., 2005). For instance, Amphotericin B and Ketoconazole exhibited strong inhibitory effects against Aspergillus niger, suggesting their potential as effective antifungal agents in food safety applications. However, resistance patterns among different fungal strains indicate that antifungal susceptibility is not uniform, necessitating tailored approaches in treating fungal contamination (Pitt et al., 2009).

The observed variations in antifungal effectiveness highlight the adaptive nature of foodborne fungi, which may develop resistance to certain synthetic agents. This phenomenon aligns with findings from Alam et al. (2019), which reported that environmental fungi are often more resilient against commonly used antifungal drugs, a fact that complicates the management of fungal contamination in food (Lasztity., 2004). The potential for resistance emphasizes the importance of rotating antifungal agents and using combination therapies to mitigate resistance development. These findings also suggest the need for ongoing monitoring of antifungal sensitivity patterns in foodborne fungi (Figure 7), especially as fungal resistance can significantly hinder food safety measures and increase public health risks (Bhat & Vasanthi., 2003).

The study further notes that while certain agents, like Econazole, were effective against *Candida spp.*, other agents such as Flucytosine and Miconazole exhibited limited activity against Aspergillus strains (Filtenborg & Thrane et al., 1996). These variations may be attributed to the structural and functional differences among fungal species, as well as the specific mechanisms of action of each antifungal agent (University of Exeter., 2020). For instance, azole antifungals, which target fungal cell membrane synthesis, may be less effective against certain species that can modify their cell wall structure in response to environmental stresses, further illustrating the adaptive capabilities of fungi. Therefore, adopting a multifaceted approach to antifungal treatment, considering both the specific fungal species and environmental context, is crucial in improving food safety in street food settings (Singh et al., 2006).

Natural Antifungal Alternatives: The Potential of Star Anise Extract

The study's exploration of natural antifungal agents, particularly star anise extract, reveals promising results. Star anise, widely recognized for its medicinal properties and culinary applications, demonstrated notable antifungal activity, especially against *Aspergillus niger* and *Aspergillus fumigatus* (Figure 8). The agar disk diffusion method used to test star anise extract showed visible inhibition zones, indicating its potential as a natural antifungal alternative. Anethole, the primary active compound in star anise, is believed to disrupt fungal cell membranes and inhibit cell growth, as supported by Wu et al. (2021). These findings highlight star anise's potential not only as a preservative but also as a natural solution for managing fungal contamination in food products.

The antifungal activity of star anise extract is particularly relevant in the context of developing countries, where synthetic antifungals may be less accessible due to cost or availability constraints. Integrating natural antifungal agents like star anise could be a feasible, low-cost alternative to synthetic agents, especially in regions where consumer preference for natural and organic products is growing. Star anise's efficacy suggests that plant-based antimicrobials could offer sustainable and safe solutions to enhance food safety (Salam et al., 2024). However, additional studies are needed to further evaluate the safety, potency, and practical applications of star anise in food preservation and fungal contamination control.

Furthermore, the success of star anise extract against multiple fungal species in this study underscores the broader potential of botanical antimicrobials. Exploring the antifungal properties of other plant extracts and essential oils could yield additional natural agents capable of managing microbial contamination in food (De et al., 2002). Future research should also focus on optimizing extraction methods to enhance the efficacy of plant-based antifungals, as well as investigating potential synergies between natural and synthetic agents to develop more effective, sustainable antifungal treatments.

Sociocultural and Economic Implications of Street Food Contamination.

The findings from this study extend beyond scientific implications to sociocultural and economic dimensions, as street food is a critical part of the local economy and urban lifestyle in Dhaka. Street vendors often operate in informal settings with limited regulatory oversight, which can exacerbate food safety challenges (Yang et al., 2010). The widespread fungal contamination observed in this study may be symptomatic of deeper issues in the street food ecosystem, including inadequate infrastructure, limited access to clean water, and a lack of formal training for vendors. Addressing these challenges requires a holistic approach that combines public health interventions with economic and educational support for street vendors.

Education and training programs focused on hygiene, safe food handling, and awareness of contamination risks could significantly improve food safety outcomes. Such initiatives should be accessible and tailored to the needs of street vendors, many of whom may lack formal education or resources. By fostering a culture of food safety and empowering vendors with practical skills, authorities can create a safer food environment that benefits both vendors and consumers (Baik et al., 2008). Additionally, collaboration between public health agencies, local governments, and community organizations could facilitate the implementation of regular food safety inspections and the establishment of standardized practices for street food vending.

Implications for Future Research and Policy Development

The study underscores the necessity of developing comprehensive policies and regulatory frameworks to manage fungal contamination in street foods. Policies focused on food safety standards, hygiene practices, and antifungal treatment protocols can create a more consistent approach to mitigating contamination risks (Easa., 2010). Moreover, establishing guidelines for the use of natural antifungal agents like star anise could provide a safer and more sustainable alternative to synthetic agents. Policymakers should consider the economic realities of street food vendors and prioritize practical, low-cost interventions that can be easily integrated into the existing street food infrastructure.

Future research should build on the findings of this study by exploring the antifungal properties of other plant-based agents, evaluating their effectiveness in different food matrices, and assessing their impact on food quality and safety. Furthermore, longitudinal studies are needed to monitor the antifungal resistance patterns of foodborne fungi and to identify emerging risks associated with fungal contamination. By advancing knowledge in these areas, researchers and policymakers can develop targeted interventions to enhance food safety, protect public health, and support the economic sustainability of the street food sector.

Conclusion

The study demonstrated the critical need for improved food safety practices in Bangladesh, particularly regarding street food vendors, who often operate under unsanitary conditions that foster microbial contamination. Antifungal tests on samples collected in Dhaka reveal significant fungal contamination by species such as Aspergillus niger, Aspergillus fumigatus, and *Candida spp.* Synthetic antifungal agents showed variable effectiveness, with Amphotericin B and Ketoconazole proving potent against certain strains. Additionally, star anise, a natural antifungal agent containing anethole, demonstrated promising inhibitory effects, especially against Aspergillus niger. This finding suggests that natural extracts like star anise could serve as effective, accessible alternatives to synthetic preservatives, supporting the development of safer food practices and regulatory measures in regions with limited food safety infrastructure.

Author contributions

F.A.M. and M.M.R. conceptualized the project and developed the methodology. M.A.R. and D.N.K. conducted a formal analysis and drafted the original writing. B.B. contributed to the methodology. M.A.I. and M.A.M. conducted investigations, provided resources, visualized the data. D.C.D. contributed to reviewing and editing the writing.

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Competing financial interests

The authors have no conflict of interest.

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