Research Article

Profile of Fungi Isolated from Domestic Water Used by Street Vendors: The Public Health Implication

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Abstract:
This study aimed at establishing the profile of fungi isolated from domestic water used by street vendors in Owerri metropolis, Imo State from August 2020 to January 2021. Fiftynine water samples collected from 25 street vendors with reference to usage. Data obtained was statistically analyzed with p-value set at 0.05 significance level. The following fungi species were identified in the study: Coccidiodes spp. (5.08%), Penicillium spp. (23.73%), Drechsler spp. (8.47%), Candida spp (5.08%), and Paecilomyces spp. (5.08%). Three Aspergillus species were identified, namely A. flavus (16.95%), A. niger (15.25%) and A. fumigatus (11.84). The prevalence relative to fungi species was statistically significant. The result showed that 28(93.33%) of samples from water used for food preparation was contaminated with fungi, while 26 (89.66%) from drinking water were contaminated, however, the difference was not statistically significant. The result recorded (2.01±1.11 TCFU/100 ml) colony-forming units. The overall number of colonies formed by fungi species was significantly different (p<0.05). Drechsler spp had the highest count of 4.63±4.41TCFU/100 ml, while the least was observed in Aspergillus niger. 1.07±0.10TCFU/100 ml. The fungi total colony-forming units count was not dependent on the type of water usage, however, samples from water used for food preparation (2.56±2.19TCFU/100 ml) had higher counts than drinking water samples (1.43±0.20 TCFU/100 ml). The result has revealed the presence of some fungi of hazardous inclinations in water used by food vendors in Owerri. There is a need for concerted public enlightenment on the risk of fungi contaminated water and observance of sound safety and hygienic practices.

Keywords: fungus, Domestic water, food vendor, Owerri.

Introduction

Nigeria has a huge number of local eateries where many people eat daily (Oyeneho and Hedberg, 2013). In Owerri, the administrative capital of Imo State, there has also been an upsurge in the acceptance of ready-to-eat food sellers (Oyeneho and Hedberg, 2013). Their inadequately regulated businesses, however, create major concerns about food safety and sanitary standards. Owerri is a rapidly increasing metropolitan hub that thrives in unsanitary conditions (Barro et al., 2006). These circumstances necessitate a timely and inescapable examination of the safety and hygiene of street foods being sold in Owerri town to identify emerging food safety issues and prevent them from becoming health risks.

Fungi are ubiquitous, heterotrophic organisms existing as single-celled yeasts or multi-cellular filamentous forms. Fungi are natural inhabitants of composting plants, water and soil (Calvo-Polanco et al., 2016). They may be leached or released from farmland, soil or air, to contaminate surface water. Many fungal species that appear in surface and piped water often reside in the water system pipes as biofilms. The fungi in such biofilms periodically re-contaminate water sources that end up as tap water.

Fungal diseases in humans can arise from breathing-in aerosolized mold spores and hyphal fragments in indoor air when polluted water passes through shower-heads, taps, or toilet cisterns (Green et al., 2003) or dietary exposure to mycotoxin-contaminated food and feed products (Kanzler et al., 2007). Fungal species like Fusarium and Aspergillus species have been found to multiply in water reservoirs where they have been incriminated in water-borne infections (Kanzler et al., 2007).

Fungi are considered harmful to humans and they present a health risk, when consumed in contaminated water, food or inhaled. Some contagious species are known to be emphatically allergic (e.g., causing skin disturbance), or may cause contaminations in the immunocompromised (e.g., those experiencing AIDS, malignant growth, asthma or other respiratory illnesses, or recuperating from organ transfers) (Green et al., 2003). The prominent genera of fungi occurring in various water sources tested (e.g., reservoir) are of these genera: Cladosporium, Penicillium, Aspergillus, Fusarium, Trichoderma, Pithomyces, Alternaria, Phialophora, Paecilomyces, Acremonium, Epicoccum and Curvularia (Sammon et al., 2010).

Mycotoxins found in water may be much diluted and may not be of main concern. However, when water is kept in reservoirs, cisterns or even in bottles, for a long time their concentrations may rise (Siqueira, 2011). Immense amounts of water are taken daily, and daily intake over several years of even microscopic
amounts of mycotoxins may be risky to human health. Mycotoxins have serious and chronic impact on humans as several are believed to be carcinogenic, cytotoxic, mutagenic and can lead to immunosuppressive complexes (Arroyo-Manzanares et al., 2015). Furthermore, fungal infections are a challenge to manage as fungal cells are eukaryotic, just like human cells (Yamaguchi et al. 2007). Although there are reports regarding advances in antifungal therapy, it is worth noting that cases of infection and antifungal resistance are also alarmingly high, hence, fungal disease control does not indicate any promise of being attained soon (Pellon et al., 2018). Consequently, this research was undertaken to assess the profile of fungi isolated from domestic water used by street food vendors in Owerri. It is intended to highlight the public health implications of fungi contaminated water used for street foods.

**Methodology**

**Study Area**

Owerri town, the capital of Imo State, located in the South-East geopolitical zone of Nigeria, lies within longitude 5°29'06"N and latitude 7°02'06"E occupying an area between the lower River Niger and the upper and middle Imo River (Government of Imo State, 2006). The Nigeria census in 2006 recorded 3.93 million (2.03 million males and 1.9 million females) as the population of Imo State and the populace is made up of the mainly Igbo ethnic group. The State has a population density of about 707.9 per square kilometer and occupies an area of 5289.49 square kilometers (Government of Imo State, 2006). The major sources of water in Owerri are surface water (Nworie and Otamiri Rivers), and numerous private / commercial bore holes that litter the town.

**Result**

Table 1 reveals the morphology of fungi found on the different SDA Plates, while Table 2 illustrates the occurrence rate of the fungi species isolated from water samples in the study. The following fungi species were identified in the study; Coccidiodes spp. (5.08%), Penicillium spp. (23.73%), Drechsler spp. (8.47%), Candida spp (5.08%), and Paecilomyces spp. (5.08%). Three Aspergillus species were identified, namely A. flavus (16.95%), A. niger (15.25%) and A. fumigatus (11.84%). The prevalence relative to fungi species was not statistically significant (p>0.05). The result also showed that 28(93.33%) of samples from water used for food preparation was contaminated with fungi, while 26 (89.66%) from drinking water were contaminated, however, the difference was not statistically significant.

The distribution of the total colony-forming units of fungi species isolated is illustrated in Table 3. The result showed the mean total colony-forming units recorded to be 2.01±1.11 TCFU/100 ml. Drechsler spp had the highest count of 4.63±4.14 TCFU/100 ml followed by Paecilomyces spp. (2.16±0.22 TCFU/100 ml), Candida spp (1.92±1.39 TCFU/100 ml) and Aspergillus fumigatus (1.74±0.09 TCFU/100 ml). Aspergillus flavus had 1.61±0.40 TCFU/100 ml, while Penicillium spp. recorded 1.65±0.12 TCFU/100 ml and Coccidiodes spp., 1.30±0.42 TCFU/100 ml. The result showed that 1.07±0.10 TCFU/100 ml was observed in Aspergillus niger. The overall number of colonies formed by fungi species was significantly different (p<0.05). The fungi total colony-forming units count was not dependent on the type of water usage, however, samples from water used for food preparation (2.56±2.19 TCFU/100 ml) had higher counts than drinking water samples (1.43±0.20 TCFU/100 ml).
3. *Paecilomyces* spp. Colonies are granular which develop to green-blue spores. 

4. *Aspergillus niger* Colonies appear purple to brown at early stage and turn mix white and purple-black at maturity.

5. *Aspergillus flavus* White soft velvety colonies that turn yellowish-green and may have a white border.

6. *Aspergillus fumigatus* Colonies has some shade of blue-green or green-brown colour with a powdery appearance from profuse production of pigmented spores.


**Table 2: Occurrence of fungi species isolated from the study samples**

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<tbody>
<tr>
<td>N=30 Street</td>
<td>Food preparation</td>
<td>2</td>
<td>9</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>28 (93.33)</td>
</tr>
<tr>
<td>N=29 Drinking</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>26 (89.66)</td>
<td></td>
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<tr>
<td>N=59 (%)</td>
<td>3(5.08)</td>
<td>14(23.73)</td>
<td>5(8.47)</td>
<td>10(16.95)</td>
<td>9(15.25)</td>
<td>7(11.84)</td>
<td>3(5.08)</td>
<td>3(5.08)</td>
<td>54 (91.52)</td>
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**Table 3: Distribution of the total colony-forming units of fungi species isolated in the study**

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<tbody>
<tr>
<td>N=26 Street</td>
<td>Food preparation (26)</td>
<td>1±0.0</td>
<td>1.73±0.52</td>
<td>7.75±4.66</td>
<td>1.89±0.73</td>
<td>1±0.0</td>
<td>1.81±0.8</td>
<td>2.96±0.48</td>
<td>2.31±0.43</td>
<td>2.56±2.19</td>
</tr>
<tr>
<td>N=25 Drinking (25)</td>
<td>1.59±0.0</td>
<td>1.56±0.79</td>
<td>1.51±0.91</td>
<td>1.33±0.51</td>
<td>1.15±0.44</td>
<td>1.67±0.8</td>
<td>1±0.0</td>
<td>2±0.0</td>
<td>1.43±0.20</td>
<td></td>
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<tr>
<td>N=51 Street</td>
<td>1.30±0.42</td>
<td>1.65±0.12</td>
<td>4.63±4.41</td>
<td>1.61±0.40</td>
<td>1.07±0.10</td>
<td>1.74±0.09</td>
<td>1.92±1.39</td>
<td>2.16±0.22</td>
<td>2.01±1.11</td>
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</tbody>
</table>

**Discussion**

The result of this research identified isolates from six (6) genera (*Penicillium, Aspergillus, Paecilomyces, Candida, Drechslera* and *Coccidioides*). The most frequently isolated genus is *Penicillium* (23.73%), followed by *Aspergillus* with three species identified, namely *A. flavus, A. niger* and *A. fumigatus* while *Paecilomyces* and *Coccidioides* were the least with occurrence rate of 5.08% each (Table 2). This agrees with findings by Okpako *et al.* (2009) on sachet and borehole drinking water in Calabar, Nigeria which showed *Aspergillus* (29.4%) as the major genus isolated in their study. Anaissie *et al.* (2003) noted that species of *Aspergillus* and *Penicillium* have been the fungi most often found. The World Health Organization (WHO) and Food and Agricultural Organization (FAO) allowable limit of bacteria count for potable water and Standards Organization of Nigeria (SON) permissible level of coliform did not address fungi.
however, wholesome water for human consumption should be free from any micro-organisms, parasites or substances which in numbers or concentrations constitute a potential danger to human health.

The fungal counts recorded in this study may be attributed to the fact that most street food sellers operate in open structures and side streets under very gross conditions with little attention paid to hygiene practices. Hence, the ease of contamination via exposure to dust, insects, the hands of the food handlers and customers is high. In some instances, water fetchers and cups were seen dropped carelessly on the floor with no safety precautions, while some vendors displayed bottled and sachet water on bare ground, under the sun and even on dirty slabs while some water storage vessels were noted to be uncovered or poorly covered with periodic cleaning of these water containers not guaranteed.

Further analysis showed that higher fungal counts were observed in water samples used for food preparation than those for drinking by customers. This may be as a result of the belief that the cooking process will eliminate possible contaminants in water for food preparation hence priority is not placed on the water source and its handling. Another possible contributory factor is the fact that most of the vendors served packaged water (bottled or sachet water) for drinking which to an extent had undergone some level of treatment during its processing and packaging. The use of packaged water especially bottled water by food vendors is merely based on the assumption of purity and this can be misleading. Over the years, the use of packaged water has grown astronomically in Nigeria with several hundreds of million litres of these water products consumed every year by Nigerians (Ogundipe, 2008). This high demand for packaged water by consumers has led to springing up of many water producing industries where water is packaged without proper regard for hygiene. Therefore concerns about the safety, microbial quality and public health implications of these products have been raised (Olaoye and Onilude, 2009; Onoja et al., 2015).

Research suggests that some of the sachet water products sold in Nigeria are non-compliant with the NAFDAC (National Agency for Food and Drug Administration and Control) and/or NIS (Nigerian Industrial standard) standards for drinking quality (Akunyili, 2003; Onoja et al.,2015). The presence of different species of fungi in supposedly “fungi-free” bottled water is of great concern. Whether the species of fungi present in the water samples are pathogenic or not, the fact that these are present, the hazards of contamination, and health risks to consumers should not be taken for granted (Abed and Alwakeel, 2007).

Fungal contaminants are known to cause allergies, opportunistic infections and intoxications. *Asperillus* spp., the most prevalent fungi isolated in this study are opportunistic and can cause health problems in immune-compromised patients. *Asperillus fumigatus* is the most common cause of all forms of invasive and non-invasive aspergillosis (Morgan et al., 2005). *A. flavus* produces mycotoxins called aflatoxins, which are toxic to humans and animals (Mesquita-Rocha et al., 2013). Aflatoxins are potent carcinogens which are responsible for many thousands of human deaths mostly in non-industrialized tropical countries (Shephard, 2006). *Penicillium* species are opportunistic and capable of causing infections such as allergies, asthma and other respiratory problems in immune-compromised patients (Schwab and Strauss, 2004). *Coccidioides* species is associated with systemic mycosis which can run a fulminating course. The fungal species isolated in this study may have these potentials if susceptible individuals are exposed to it.

The result has revealed the presence of some fungi of hazardous inclinations in water used by street food vendors in Owerri. There is a need for concerted public enlightenment on the risk posed by consumption of fungi contaminated water and observance of sound food safety and hygienic practices.

**References**


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