Original Article

Study of Multiple Drug Resistance Pattern and Biofilm Formation of *Candida* Species Isolated from Iraqi Patients

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Abstract

Background: In the genus *Candida*, there are more than 200 yeast species, although only around 10% of them have been found to be dangerous to people and some other animals. Invasive candidiasis is the most prevalent invasive fungal infection examined, and *Candida albicans* (*C. albicans*) is the most common causal pathogen. **Objectives:** The current investigation is to isolate and identify *Candida* spp. from various clinical specimens and to calculate multiple drug resistance (MDR) index and the ability of biofilm formation. **Materials and Methods:** One hundred (100) different clinical samples (ear, mouth, vagina, skin, blood, and urine) were collected from patients who attended Gazi Al Hariri Hospital, Baghdad Teaching Hospital in Medical City and Al-Yarmouk Teaching Hospital. *Candida* spp. were identified using selective medium. Furthermore, antifungal susceptibility and MDR index were evaluated. **Results:** The results of isolation and identification for *Candida* species were revealed that *Candida parapsilosis* isolated in a high percentage (27.7%) followed by *Candida glabrata* (22.2%), the lowest percentage was recorded in *Candida tropicalis*, *Candida krusei* (5.50%), while the MDR index of isolated *Candida spp.* toward the antifungal in the current study showed that *Candida lusitaniae* and *Candida krusei* and *Candida parapsilosis* were (100%), the biofilm formation strength was different between the isolates *Candida tropicalis* and *Candida rugosa* showed strong biofilm formation strength. **Conclusion:** *Candida parapsilosis* was isolated in high percentage. *Candida lusitaniae*, *Candida krusei,* and Candida *parapsilosis* were the most resistant to the antifungal agents. *Candida lusitaniae*, *Candida glabrata*, *Candida tropicalis,* and *Candida rugosa* revealed strong biofilm formation.

Keywords: Antifungal, biofilm formation, *Candida spp*, MDR *Candida*

Introduction

Opportunistic yeast infections have been more prevalent over the past few decades, and they are now thought to be the cause of more than 1.5 million fatalities worldwide each year. These infections are more common in intensive care unit patients as well as those with a history of immunosuppressive medications, excessive antibiotic usage, hormonal treatment, or invasive procedures.[1]

The development of multiple drug resistance (MDR) *Candida*, although rare compared to antibacterials, is a matter of concern especially in light of the changing epidemiology of *Candida* infections, showing a shift toward species intrinsically resistant to the most commonly used antifungal drugs. In fact, MDR *Candida* mainly involves acquired resistance in species with intrinsic resistance.[2] These yeasts can also trigger superficial infections that damage the skin or mucous membranes, in addition to severe infections that can spread and be fatal,[3] also found in pelvic inflammatory disease[4] and as air borne microorganism.[5] According to Pfaller and Diekema,[6] there are roughly 250,000 new instances of immunosuppressants reported annually, more than 50,000 of which result in death. Other studies have estimated a mortality rate of more than 60%.[7,8] An invasive candidiasis

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is the most prevalent invasive fungal infection examined, and *Candida albicans* (*C. albicans*) is the most common causal pathogen (33.8%–60%) overall, despite an increase in *non–albicans Candida species*.[9] However, its usage in hospital laboratories has been constrained in part due to a lack of the required specialized infrastructure or because some tests are challenging methodologically. Therefore, it is essential to create novel assays that accurately identify *Candida* species utilizing methods that are specific, user-friendly, practical, inexpensive, and available to any laboratory. One of the key factors in the evolution of *Candida* species into significant human diseases is the production of biofilms.[10] Understanding and treating *Candida*-associated infections are necessary due to the rise in the prevalence of fungal infections, particularly those brought on by *C. albicans* and other *Candida* species. The main purpose of the present study was to isolate and identified *Candida* spp. from different clinical specimens and estimate MDR yeast and their ability to form biofilm.

Material and Methods

Sample collection

One hundred (100) different clinical samples (ear, mouth, vagina, skin, blood, and urine) have been collected from patients who visited the Al-Yarmouk Teaching Hospital, Baghdad Teaching Hospital in Medical City, and Gazi Al Hariri Hospital. The investigation was conducted for the period from December 2021 to February 2022.

Identification and conformation of *Candida spp*

Chromagar media (*Candida* agar) is a medium used to identify organisms of the *Candida* species based on the color of the growing colonies.[11] This medium was prepared in accordance with the manufacturer's instructions, which stated that 47 g of powdered medium should be dissolved in 100 mL of distilled water, brought to a boil in a water bath, and then poured into Petri dishes to be stored until use. This medium was used to distinguish between types of *Candida*.[11] A confirmation diagnostic utilizing the Vitek-2 YST System was performed. VITEK®2 ID cards are disposable, self-contained cards designed for use with the VITEK®2 system. They are practical and secure.

Antimicrobial susceptibility and multiple drug resistance (MDR) *Candida*

Antibiotic susceptibility analysis will be performed utilizing antibiotic discs that are easily accessible on the market and a modified version of Kirby Bauer's Disk diffusion technique. According to the manufacturer's recommendations, the diameter of the inhibitory zone was used to classify stains as susceptible, moderately resistant, or resistant, which matched the interpretive criteria advised by Clinical and Laboratory Standards Institute (CLSI).[12] The list of antibiotics employed includes fluconazole, voriconazole, ketoconazole, clotrimazole, nystatin, and amphotericin B. The amount of antibiotics to which an isolate is resistant is divided by the total amount of antibiotics to which the organism has been exposed to produce the MDR index.

Quantitative biofilm formation assay[13]

The potential of (*Candida* spp) isolates to form biofilms was assessed using a 96-well microtiter plate test based on the crystal violet staining technique. Briefly, 20 L of suspended yeast from strains 0.5–0.7 McFarland (1.10^8 cfu/mL) were added to each well of a 96-well flat-bottomed sterile polystyrene microplate, which was previously filled with 199 L of Mueller-Hinton broth supplemented with 1% glucose. At 37°C, microplates are incubated for 48 h. The adhering cells were rinsed twice with phosphate-buffered saline (PBS), and wells were dried at 60°C for 1 h or less. The liquid media was then discarded. After that, it was stained for 15 min with 150 L of 2% crystal violet. The microplate wells treated with crystal violet were then rinsed twice with PBS to remove the stain. Following the air drying of the microplate's wells, 150 L of 95% ethanol were used to re-solubilize the dye from the biofilms that lined the plate's walls. A microplate reader measures the microplate spectrophotometrically at 570 nm after 5–10 min. At least three new samples were used each time the experiment was performed.

Ethical approval

The study was conducted in accordance with the ethical principles that have their origin in the Declaration of Helsinki. It was carried out with patients, verbal approval before samples were taken. The study protocol and the subject information and consent form were reviewed and approved by a local ethics committee at University of Baghdad.

Results

Isolation and identification of *Candida* spp

The findings of isolation and identification of *Candida* spp. in studied samples were reported. The results showed that *Candida parapsilosis* was isolated in high percentage 27.70%, followed by *Candida glabrata* 22.22% and *Candida lusitaniae* (16.60%), while both of *Candida albicans, Candida rugose* were (11.11%). Finally, the lowest percentage recorded in *Candida tropicalis*, *Candida krusei* (5.50%) [Figure 1].

All *Candida* spp. were identified using the CHROMagar *Candida* culture medium, which selective media identified some of the species involved. Figure 2 when compared to the CLSI technique (Clinical and Laboratory Standards Institute), the ViteK-2system, a system with great reproducibility and accuracy.[13] Due to their high repeatability and quick diagnostic tests with *Candida* spp, then followed by screening with the automated ViteK-2®

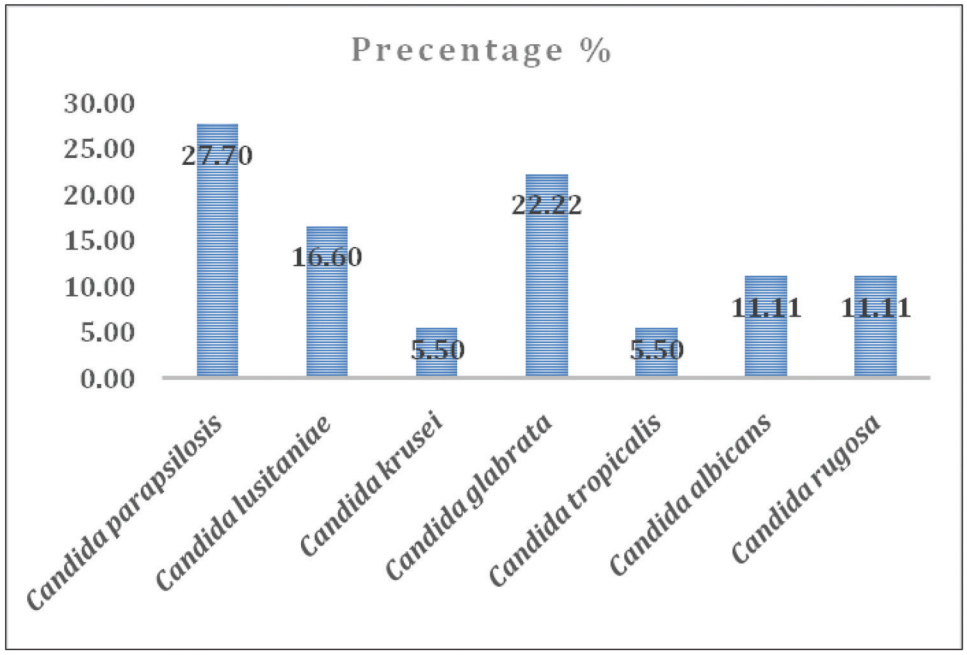

Figure 1: Percentage of *Candida* spp in samples

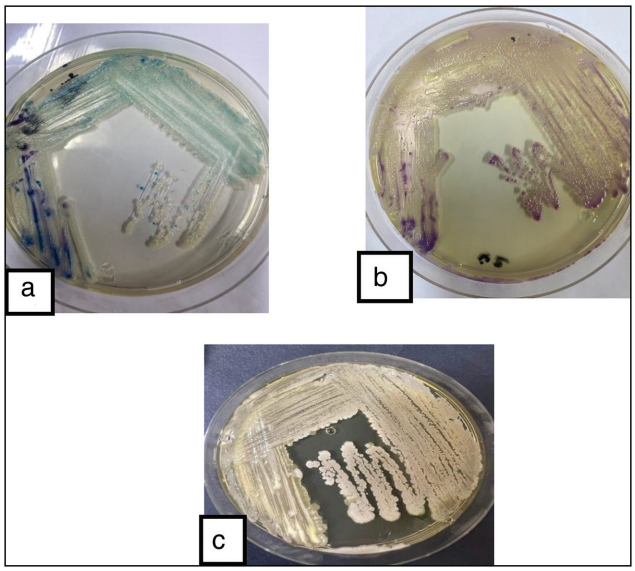

Figure 2: *Candida* spp. on CHROMagar. (a) Mixed sample. blue to purple: *candida tropicals*, Green: *Candida albicans*, white: *candida glabrata.* (b) *Candida lusitaniae.* (c) *Candid aparapsilosis*

and Etest® systems. Both methods are more complicated and time-consuming than the CLSI standardized broth microdilution method, which serves as a reference for antifungal susceptibility testing even after being challenging and labor-intensive to use on a regular basis. However, both methods have advantages over the CLSI method.[14]

Antifungal and multiple drug resistance index

From the other side of the current study MDR index of isolated *Candida* spp. toward the antifungal reported that in *Candida lusitaniae*, *Candida krusei* and *Candida parapsilosis* were 100%, followed by *Candida tropicalis* (66.6%) and *Candida albicans, Candida rugose,* and *Candida glabrata* (33.3%). However, some isolates of *Candida albicans* (50%) and *Candida parapsilosis* (83.3%) and *Candida glabrata* (16.6%) are shown in Figures 3 and 4.

Determination of biofilm formation

Moreover, the biofilm formation of isolated *Candida* spp. Figure 5, revealed various biofilm formation strengths as some of *Candida parapsilosis* were not able to form biofilm and some formed weak and moderate biofilm, while *Candida albicans* showed isolates not able to form biofilm and some formed a weak biofilm same in *Candida krusei* revealed a weak biofilm formation strength, *Candida lusitaniae* and *Candida glabrata* revealed weak to strong biofilm formation strength, *Candida tropicalis* and *Candida rugosa* showed strong biofilm formation strength, and *Candida albicans* with significant differences between isolates as shown in Table 1 and Figure 6.

Discussion

The isolation results were consistent with those reported by Montes *et al.*,[15] who revealed during culture from different clinical samples. Our findings showed that *C. parapsilosis*, not *C. albicans*, was the most common species isolated from blood (41.7%). This finding is intriguing since *C. parapsilosis* is complex and has become a more prevalent cause of fungemia[16] because of its ability to colonize skin and spread to patients when medical professionals manipulate intravascular catheters. Another investigation using 11 different clinical specimens taken

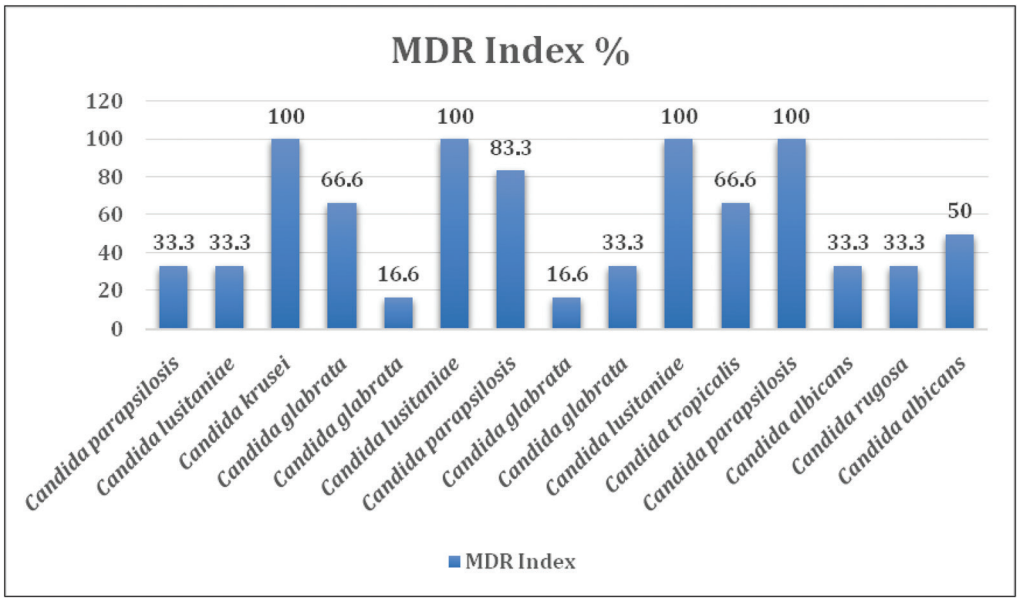

Figure 3: Multiple drug resistance index of isolated *Candida* spp. Antifungls: fluconazole, voriconazole, ketoconazole, clotrimazole, nystatin, and amphotericin B

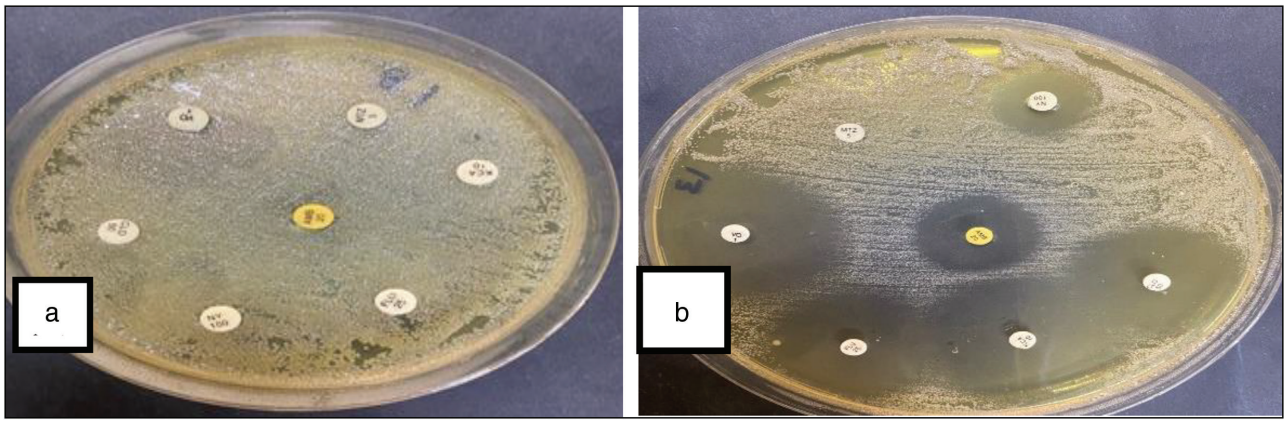

Figure 4: Antimicrobial susceptibility of isolated *Candida* spp. (a) *Candida parapsilosis*, (b) *Candida glabrata*

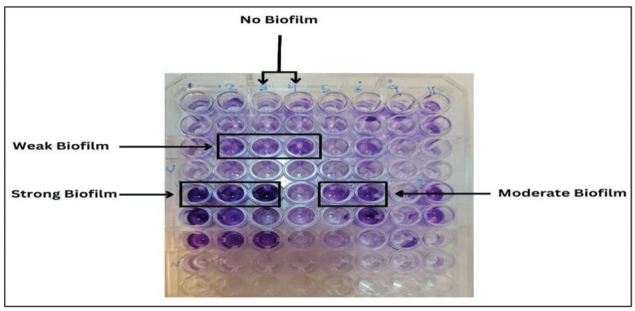

Figure 5: Microtiter plate assay of biofilm formation

from hospitalized persons in Mexico City with probable fungal infections revealed that *C. albicans* was more common, followed by *C. tropicalis* and *C. glabrata*.[17] One hundred and five urine samples from patients with renal failure were collected by Othman *et al.*[18] using a sterile urinary cap. Various diagnostic methods were employed to characterize the isolated *Candida spp.*, including *C. albicans* (20%), *C. parapsilosis* (20%), *C. glabrata* (32.72%), and *C. krusei* (27.27%). However, a study was conducted by Arya and Naimshree.[19] revealed variations in the percentage of *Candida* spp. identified by CHROM agar from different clinical samples, with *C. albicans* being isolated in 48.4% of species. 248 samples were collected, where urine sample was the most common sample (68.1%) followed by pus (13.3%) and blood, which the species were isolated *C. glabrata*, *C. krusei,* and *C. tropicalis.*

Moreover, the results were compatible with El-Ganiny *et al.*[20] regarding antifungal susceptibility. In this study, the highest level of resistance was observed against fluconazole. The *candida* spp. showed that fluconazole (FLU) resistance was *C. glabrata* (66.6%), *C. krusei* (16%), *C. tropicalis* (12.5%), and *C. albicans* (10%). Furthermore, the results showed an agreement with Terças *et al.*[21] who revealed that results showed that all

strains of *C. guilliermondii*, *C. parapsilosis*, *C. albicans*, and *C. tropicalis* displayed as sensitivity to all antifungals drugs tested. Four of the six *C. krusei* isolates exhibited intermediate susceptibility to flucytosine , four of them showed resistance to fluconazole, and all of them were susceptible to amphotericin and voriconazole. Three different *C. glabrata* isolates were positive for resistance to fluconazole, amphotericin B and voriconazole. Furthermore, *C. krusei* naturally resists FLU.[22] The observed fluconazole resistance in *C. tropicalis* ranges from 0% to 83% and from 4% to 9% in the USA, according to several perspective studies.[23,24] Fluconazole is the antifungal, that is, prescribed most frequently, and due to its extensive use in treating *Candidiasis*, all *Candida* spp. have developed a resistance to the antibiotic.[24]

Table 1: The biofilm formation values of *Candida* spp

Isolates	Mean	SE
Candida parapsilosis	0.24	0.010
Candida lusitaniae	0.36	0.090
Candida krusei	0.35	0.020
Candida glabrat	0.41	0.131
Candida glabrata	0.31	0.043
Candida lusitaniae	0.35	0.039
Candida parapsilosis	0.30	0.029
Candida glabrata	0.36	0.035
Candida glabrata	3.89	0.161
Candida lusitaniae	2.69	0.322
Candida tropicalis	3.15	0.694
Candida parapsilosis	0.23	0.029
Candida albicans	0.29	0.084
Candida rugosa	1.78	0.095
Candida albicans	0.20	0.041
Candida parapsilosis	0.13	0.000
Candida parapsilosis	0.64	0.098

*P value = 0.00

*P value: highly significant

In accordance with the previous research, the current investigation found *C. lusitaniae* to be resistant.[25] Echinocandins usually have success against *C. lusitaniae*. The *FKS genes* encode beta-1,3-glucan synthase, which is the target of echinocandins. A few missense mutations have been discovered in the *C. lusitaniae* FKS1 hot spot 1. (HS1). Using amphotericin B (AMB), caspofungin (CAS) and azoles to treat chronic candidemia in a child with immunosuppressed enterocolitis and visceral adenoviral disease, the rapid emergence of antifungal resistance in *C. lusitaniae*. FCZ resistance can be built up in *C. glabrata* after first coming into contact, whereas it is already present in *C. krusei*. The findings of this study are consistent with several investigations that showed that *C. krusei* has innate resistance to FCZ and that *C. glabrata* and *C. famata* had greater resistance. The findings of this study are in agreement with numerous investigations that showed that *C. krusei* has intrinsic resistance to FCZ and that *C. glabrata* and *C. famata* species had greater resistance to this antifungal medication.[26]

In addition, the findings of biofilm formation were corroborated by the study conducted by Marak and Dhanashree,[27] who reported that *C. albicans* (45.5%) was found to be the most prevalent species among the 90 *Candida* species that were isolated, followed by *C. parapsilosis* (2.22%), *C. glabrata* (3.33%), *C. krusei* (20%), *C. tropicalis* (28.88%), and *Candida* spp. were found in the following samples: pus, bile aspirate, deep tissue, high vaginal swabs, suction tips, blood, wound swabs, and urine, the age range of 51–60 years was more prone to candidiasis, and more women than men were affected. The most isolates were *C. albicans* then *C. parapsilosis*, *C. tropicalis*, and *C. krusei* isolates which generated biofilm while *C. glabrata,* did not exhibit any biofilm generation.

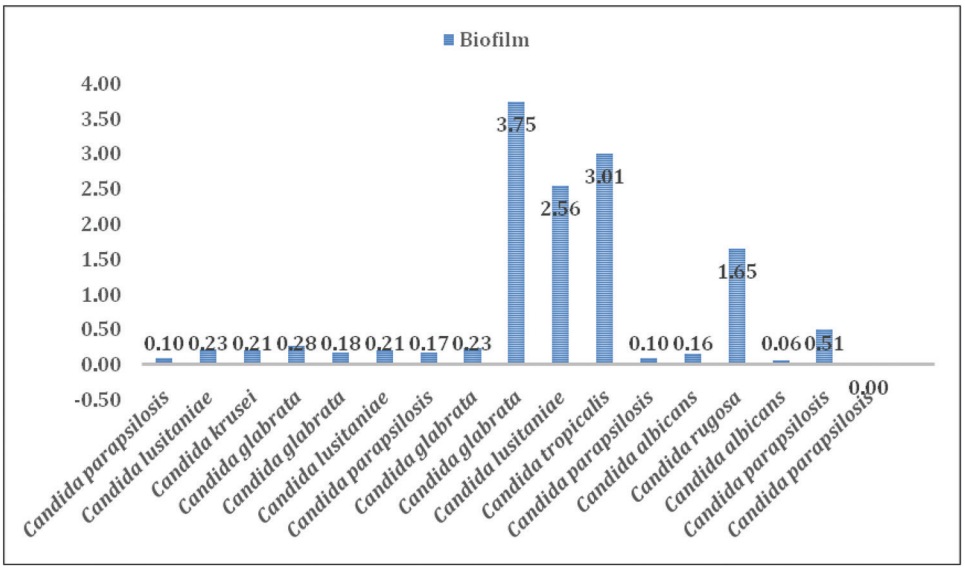

Figure 6: Biofilm formation of *Candida* spp

However, Kuhn *et al.*[28] found that *C. parapsilosis* produced biofilms at a rate of 100%, followed by *C. krusei* and *C. tropicalis* among the *non-Candida albicans* species. However, demonstrated that compared to other *Candida* species, *C. albicans* forms quantitatively more biofilms.

According to Tulasidas *et al.*,[29] a total of 176 clinical isolates were tested for biofilm development; of the 74 blood culture isolates, 55 (74%) produced biofilms; *C. haemulonii* (100%), *C. tropicalis* (22%), and *C. krusei* (21%), equation 1, displayed the strongest adherence. 45 (44.11%) of the 102 cervical swab isolates produced biofilms, while *C. tropicalis* (43%) showed high adhesion. Sahal and Bilkay[30] noted a high biofilm development rate. *Candida* species including *C. orthopsilosis C. tropicalis*, *C. glabrata,* and *C. parapsilosis* were discovered to be the most prevalent species, and isolates of *Candida tropicalis* with a high ability for biofilm formation were shown to have higher rates of fluconazole resistance.[31]

Alikhani *et al*.[32] found that biofilm manufacturing was applied to all 50 clinical isolates. 19 (48.7%) of the 39 *C. albicans* isolates were shown to produce biofilms. Of the 11 *C. glabrata* isolates (54.5%) produced biofilms. Biofilms are ubiquitous, intricate, interdependent groups of surface-associated microbes that can grow on any surface, including medical equipment.[33] A crucial predictor of virulence during candidiasis, the pathogenicity of *Candida species* is linked to their capacity to create biofilms.[34-37]

Conclusion

The findings of isolation and identification of *Candida* spp. in studied samples were reported. *C. parapsilosis* was isolated in a high percentage, in same time, *C. lusitaniae*, *C. krusei,* and *C. parapsilosis* were the most resistance to the antifungal. Finally, *C. lusitaniae*, *C. glabrata*, *C. tropicalis,* and *C. rugosa* revealed a strong biofilm formation strength.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Jenks JD, Cornely OA, Chen SC, Thompson III GR, Hoenigl M. Breakthrough invasive fungal infections: Who is at risk? Mycoses 2020;63:1021-32.
2. Arendrup MC, Patterson TF. Multidrug-resistant *Candida*: Epidemiology, molecular mechanisms, and treatment. J Infect Dis 2017;216:S445-51.
3. Yang ZH, Song YG, Li RY. A ten-year retrospective study of invasive candidiasis in a tertiary hospital in Beijing. Biomed Environ Sci 2021;34:773-88.
4. Salih D Y, Said R, Ahmed H. Compatibility of prescribed antibiotics to patients with pelvic inflammatory diseases with microbial sensitivity test in Duhok, Iraq. Med J Babylon 2020;17:253.
5. Hussain HH, Ibraheem NT, Al-Rubaey NK, Radhi MM, Hindi NK, AL-Jubori RH, *et al*. A review of airborne contaminated microorganisms associated with human diseases. Med J Babylon 2022;19:115-22.
6. Pfaller MA, Diekema D. Epidemiology of invasive candidiasis: A persistent public health problem. Clin Microbiol Rev 2007;20:133-63.
7. Zeng ZR, Tian G, Ding YH, Yang K, Liu JB, Deng J, *et al*. Surveillance study of the prevalence, species distribution, antifungal susceptibility, risk factors and mortality of invasive candidiasis in a tertiary teaching hospital in Southwest China. BMC Infect Dis 2019;19:1-2.
8. Guo LN, Yu SY, Xiao M, Yang CX, Bao CM, Yu YH, *et al*. Species distribution and antifungal susceptibility of invasive candidiasis: A 2016–2017 multicenter surveillance study in Beijing, China. Infect Drug Resist 2020;13:2443-52.
9. Kmeid J, Jabbour JF, Kanj SS. Epidemiology and burden of invasive fungal infections in the countries of the Arab League. J Infect Public Health 2020;13:2080-6.
10. Ramage G, Martínez JP, López-Ribot JL. Candida biofilms on implanted biomaterials: A clinically significant problem. FEMS Yeast Res 2006;6:979-86.
11. Khan ZU, Ahmad S, Mokaddas E, Chandy R. Tobacco agar, a new medium for differentiating *Candida dubliniensis* from *Candida albicans*. J Clin Microbiol 2004;42:4796-8.
12. Clinical and Laboratory Standards Institute. Reference Method for Broth Dilution Antifungal Susceptibility Testing of Yeasts. Approved standard M27-A3; 2008.
13. Alzaidi JR, Hussien FH, Al-Charrakh AH. The effect of vaginal bacillus (*Lactobacillus acidophilus*) towards candida spp. isolated from women with candidiasis. New Arme Med J 2021;15:77-83.
14. Kaur R, Dhakad MS, Goyal R, Haque A, Mukhopadhyay G. Identification and antifungal susceptibility testing of candida species: A comparison of Vitek-2 system with conventional and molecular methods. J Glob Infect Dis 2016;8:139-46.
15. Montes K, Ortiz B, Galindo C, Figueroa I, Braham S, Fontecha G, *et al*. Identification of candida species from clinical samples in a Honduran tertiary hospital. Pathogens 2019;8:237.
16. van Asbeck EC, Clemons KV, Stevens DA. *Candida parapsilosis*: A review of its epidemiology, pathogenesis, clinical aspects, typing and antimicrobial susceptibility. Crit Rev Microbiol 2009;35:283-309.
17. Camacho-Cardoso JL, Martínez-Rivera MA, Manzano-Gayosso P, Méndez-Tovar LJ, López-Martínez R, Hernández-Hernández F, *et al*. Molecular detection of candida species from hospitalized patient's specimens. Gac Med Mex 2017;153:581-9.
18. Othman KI, Abdullah SM, Ali B, Majid M. Isolation and identification Candida spp. from urine and antifungal susceptibility test. Iraqi J Sci 2018;59:1981-8.
19. Arya AN, Naimshree. Isolation and Identification of candida species by using chrome agar from various clinical samples. Saudi J Pathol Microbiol 2020;8:323-27.
20. El-Ganiny AM, Yossef NE, Kamel HA. Prevalence and antifungal drug resistance of nosocomial candida species isolated from two university hospitals in Egypt. Curr Med Mycol 2021;7:31.
21. Terças AL, Marques SG, Moffa EB, Alves MB, de Azevedo CM, Siqueira WL, *et al*. Antifungal drug susceptibility of candida species isolated from HIV-positive patients recruited at a public hospital in São Luís, Maranhão, Brazil. Front Microbiol 2017;8:298.
22. Whaley SG, Berkow EL, Rybak JM, Nishimoto AT, Barker KS, Rogers PD, *et al*. Azole antifungal resistance in *Candida albicans* and emerging non-albicans candida species. Front Microbiol 2017;7:2173.
23. Bassetti M, Peghin M, Timsit JF. The current treatment landscape: Candidiasis. J Antimicrob Chemother 2016;71:ii13-22.
24. Berkow EL, Lockhart SR. Fluconazole resistance in candida species: A current perspective. Infect Drug Resist 2017;10: 237-45.
25. Asner SA, Giulieri S, Diezi M, Marchetti O, Sanglard D. Acquired multidrug antifungal resistance in *Candida lusitaniae* during therapy. Antimicrob Agents Chemother 2015;59:7715-22.
26. Patil S, Rao RS, Majumdar B, Anil S. Clinical appearance of oral candida infection and therapeutic strategies. Front Microbiol 2015;6:1391.

27. Marak MB, Dhanashree B. Antifungal susceptibility and biofilm production of Candida spp. isolated from clinical samples. Int J Microbiol 2018;2018:1-5.
28. Kuhn DM, Chandra J, Mukherjee PK, Ghannoum MA. Comparison of biofilms formed by *Candida albicans* and *Candida parapsilosis* on bioprosthetic surfaces. Infect Immun 2002;70:878-88.
29. Tulasidas S, Rao P, Bhat S, Manipura R. A study on biofilm production and antifungal drug resistance among candida species from vulvovaginal and bloodstream infections. Infect Drug Resist 2018;11:2443-8.
30. Sahal G, Bilkay IS. Distribution of clinical isolates of Candida spp. and antifungal susceptibility of high biofilm-forming candida isolates. Rev Soc Bras Med Trop 2018;51:644-50.
31. Deorukhkar SC, Saini S, Mathew S. Virulence factors contributing to pathogenicity of *Candida tropicalis* and its antifungal susceptibility profile. Int J Microbiol 2014;2014:456878.
32. Alikhani T, Ghazvini RD, Mirzaii M, Hashemi SJ, Fazli M, Rafat Z, *et al*. Drug resistance and biofilm formation in candida species of vaginal origin. Iran J Public Health 2022; 51:913.
33. Jabra-Rizk MA, Falkler WA, Meiller TF. Fungal biofilms and drug resistance. Emerg Infect Dis 2004;10:14-9.
34. Rodríguez-Cerdeira C, Martínez-Herrera E, Carnero-Gregorio M, López-Barcenas A, Fabbrocini G, Fida M, *et al*. Pathogenesis and clinical relevance of candida biofilms in vulvovaginal candidiasis. Front Microbiol 2020;11:544480.
35. Abbas NF. Comparison between conventional methods and molecular diagnosis for candida albicans and *Candida dubliniensis* isolated from cancer patients infected with oral candidiasis. Med J Babylon 2024;21:S276-81.
36. Salih AA, Obaid HM, Jasim WM. Candida isolation and identification from pregnant women in Kirkuk city. Med J Babylon 2023;20:S123-9.
37. Taiban ZK, Kadhum SW. Isolation and identification of Candida sp. from cancer patients in Al-Najaf governorate. Med J Babylon 2024;21:S107-10.