

Research Article

Efficacy of Antifungal Medicines Against Clinical Isolates of *Candida* Species Responsible for Vaginal Candidiasis from Regional Referral Hospitals in Tanzania

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Abstract

Vaginal candidiasis, caused by *Candida species* affects a significant proportion of women worldwide. Although different antifungal medicines are being used to treat the infection, the emergence of resistance against these medicines have been reported. This study assessed the efficacy of antifungal medicines which are recommended for treatment in the Tanzania Standard Treatment Guidelines against clinical isolates of *Candida spp.* Presumptive Isolates of *Candida spp.* collected from Regional Referral Hospitals (RRH) were transported to the Tanzania Medicine and Medical Devices Authority (TMDA) Microbiology laboratory for identification and confirmation by PCR. The confirmed isolates were used for susceptibility testing to establish the efficacy of antifungal medicines. Results indicate that *Candida albicans* (54%) was the most prevalent *Candida spp.* among isolates collected. Among the antifungal medicines tested, Miconazole showed the highest efficacy against 229 isolates of *Candida spp.* with 89.2% of the isolates being susceptible. This was followed by Clotrimazole, with 79.9% and Nystatin, 79.5% of isolates were susceptible, while Voriconazole showed moderate efficacy with 68.9%. Fluconazole demonstrated the lowest efficacy among the tested antifungals with 63.3%. Both *Candida albicans* and non-albicans *Candida spp.* displayed similar susceptibility patterns. Out of the 229 *Candida spp.* isolates tested, 4.4% were found to exhibit multidrug resistance. Findings from this study suggest that despite the observed resistance, the majority of antifungal medicines listed in the Standard Treatment Guidelines in Tanzania remain effective and are still considered reliable for treating vaginal candidiasis.

Keywords

Antifungal Efficacy, *Candida albicans*, Vaginal Candidiasis, Antifungal Resistance, Multidrug Resistance

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1. Introduction

Vaginal candidiasis, commonly referred to as a yeast infection, is a prevalent fungal infection affecting the mucosal surfaces of female genital tract [1]. The primary causative agent of vaginal candidiasis is *Candida albicans*, a commensal microorganism that reside in the gastrointestinal, respiratory, and genitourinary tracts [2]. It has been reported that *C. albicans* constitutes approximately 80.5% of the cases of vaginal candidiasis, with other *Candida spp.* such as *Candida glabrata* also plays a significant role [3].

Globally, vaginal candidiasis affects a significant proportion of women, causing considerable discomfort and disruption to daily activities. Studies in various countries have shown a high prevalence of this infection, highlighting its significant impact on women's health [4-6]. In Africa, the burden of vaginal candidiasis is similarly substantial, with many women experiencing recurrent infections that affect their quality of life [7]. Factors such as limited access to healthcare, lack of awareness, and varying socioeconomic conditions contribute to the challenges in managing this infection across the continent [8]. Similarly, in Tanzania, vaginal candidiasis remains a common health issue among women, although comprehensive data on its prevalence and the antifungal susceptibility of isolates of *Candida spp.* are limited. This lack of detailed epidemiological information hampers the development of effective treatment strategies and the management of antifungal resistance in the region [9].

Vaginal candidiasis is characterized by symptoms such as

itching, burning, soreness, and abnormal vaginal discharge [6]. This infection affects a significant proportion of women at some point in their lives. Several risk factors have been reported to contribute to the development of vaginal candidiasis, including the prolonged use of antibiotics, diabetes mellitus, pregnancy, immunodeficiency, use of oral contraceptives, sexual activity, and certain hygiene practices [10, 11]. These factors can disrupt the normal vaginal microflora, creating an environment conducive to *Candida* overgrowth and infection [12]. The management of vaginal candidiasis typically involves antifungal therapy. Fluconazole, which is an azole antifungal has been commonly used for treatment; however, the emergence of Fluconazole-resistant strains of *Candida* has been reported, posing a significant challenge to effective management [13]. Other antifungal agents such as Clotrimazole, Miconazole, Nystatin, and Terbinafine are also employed, with varying degrees of efficacy against different *Candida spp.* [14]. Given the increasing incidence of antifungal resistance, there is a pressing need to evaluate the susceptibility of clinical isolates of *Candida spp.* to commonly used antifungal medicines [9]. This is particularly important in countries like Tanzania, where data on the prevalence and antifungal susceptibility of isolates responsible for vaginal candidiasis is limited. Understanding the local epidemiology and resistance patterns of *Candida spp.* will aid in developing targeted treatment strategies and improve patient outcomes.

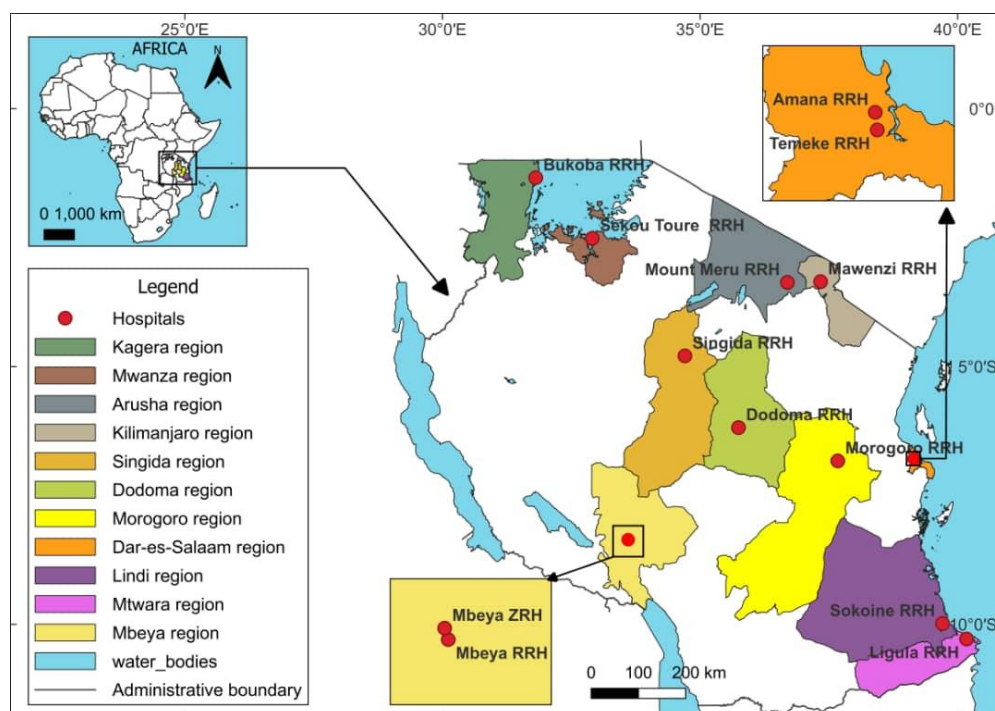


Figure 1. Map of Tanzania showing coverage of regions for sample collection.

The prevalence of vaginal candidiasis among women in Tanzania underscore the importance of ensuring that the treatments prescribed are effective in eliminating the infection and preventing recurrence [9]. Antifungal resistance is a growing global concern, and Tanzania is not exempted from this challenge. TMDA is tasked with function of ensuring that medicines used in Tanzania are of acceptable quality, safe and efficacious. To accomplish this role, TMDA utilizes different strategies such as medicines registration, inspection, post-market surveillance, pharmacovigilance and conducting various researches. Therefore, the objective of this study is to assess the efficacy of antifungal medicines listed in the Standard Treatment Guidelines against clinical isolates of *Candida* species from selected regional referral hospitals in Tanzania.

2. Methodology

2.1. Study Area

The study was conducted between September 2024 and June 2025 in Tanzania mainland, focusing on selected regional referral and zonal hospitals equipped with functional microbiological laboratories that perform microbial cultures as part of their diagnostic procedures.

2.2. Study Design and Sample Size Determination

A cross-sectional study design was employed, utilizing a purposive (selective) sampling technique. Only isolates confirmed to be *Candida spp.* obtained from various regional referral hospitals in Tanzania mainland were included in the study. TMDA issued official letters to eligible hospitals, requesting the isolates for use in the study. The targeted number was 30 isolates of *Candida spp.* per hospital.

2.3. Sample Collection

The study focused on previously isolated and stored *Candida spp.* from vaginal swabs of patients diagnosed with vaginal candidiasis in the selected hospitals. TMDA laboratory analyst collected isolates from all the selected hospitals, transported them in transport media in cool temperature within 24 hours to the TMDA Microbiology Laboratory located in Dar es Salaam for subsequent analyses.

2.4. Laboratory Methods

2.4.1. Isolation of *Candida spp.*

Isolates were pre-enriched with Sabouraud Dextrose Broth (SDB) (Oxoid UK) at 32.5°C for 24 hours, followed by sub-culturing using a streaking method on primary media, Sabouraud Dextrose Agar (SDA) (Oxoid UK) at 32.5°C for 24 to 48 hours. Presumptive *Candida spp.* colonies on SDA

were smooth, creamy, and white to off-white in colour, soft or slightly pasty or mucoid texture, and medium to large size with well-defined edges. Gram staining was performed to observe the yeast cells.

2.4.2. Identification Test for *C. albicans* by Germ Tube Test

A germ tube test was performed to differentiate *C. albicans* and non-*albicans Candida spp.* the presumptive isolates were suspended in 1mL of human serum and incubated at 37 °C for 2 hours. After incubation, a drop of suspension was mounted on microscopic slides, covered and observed under a microscope ×10 objective for germ tube formation as previously reported by DN Anh. et al [5].

2.4.3. DNA Extraction and Molecular Detection by PCR

DNA was extracted from *Candida spp.* isolates identified by using the Fungi/Yeast Genomic DNA Isolation Kit (Norgen Biotek Corp.), following the manufacturer's instructions as described by Kumar & Mugunthan (2018) [15] for enhancing DNA yield and purity. The molecular identification of *C. albicans* was achieved through the amplification of a specific region within the *CALB* gene, which encodes an enzyme involved in the hydrolysis of β -glucosides in carbohydrates, as previously described by F. Mallus et. al [16]. The primers utilized for this amplification were CalB-F (5'-TTTATCAACTTGTCACACCAGA-3') and CalB-R (5'-ATCCCGCCTTACCACTACCG-3') (Inqaba Biotechnical Industries (Pty) Ltd, South Africa) with base pairs 273 was used. The polymerase chain reaction was performed PCR instrument Surecycler 8800 (Agilent Technologies) and conditions as described by Mallus et al. [16]. The reaction mixture contained 3 μ L aliquot of the extracted DNA in 10 mM Tris and 1 mM EDTA (TE buffer), 12.5 μ L of the master mix, 0.5 μ L each of the forward and reverse primers, and 7.5 μ L of nuclease-free water to reach the final volume of 25 μ L. The PCR amplification conditions were as follows: Initial step heating at 94°C for 15 seconds, followed by 40 cycles of 94°C for 30 seconds, 63°C for 1.5 minutes, and 72°C for 1.5 minutes, with a final extension step at 72°C for 10 minutes, yielding an expected amplicon size of 273 base pairs. A 5 μ L PCR product was stained with 0.5 μ g/mL Ethidium bromide and loaded into 1% agarose gel submerged in 1x Tris-acetate-EDTA (TAE) buffer for gel electrophoresis in a Biometra electrophoresis tank (Analytik Jena Company) for 45 minutes. The PCR product was visualized under UV light using a benchtop Trans Illuminator (BioDoc It TM) and images was captured.

2.4.4. Antifungal Susceptibility Testing

The antifungal susceptibility of isolated *C. albicans* was

evaluated as described in the CLSI guidelines M27M44S, third edition (2022) [17]. Suspensions of overnight cultures were prepared in sterile phosphate-buffered saline (Glenthams Life Sciences GX 8368). Turbidity was adjusted to a 0.5 McFarland standard using a calibrated UV-spectrophotometer (Thermo Scientific Helios Zeta UV-VIS-USA), resulting in an inoculum containing 1.5×10^6 CFU/mL. A 25 μ L aliquot of the suspension was inoculated onto Mueller-Hinton agar (Sigma Aldrich Lot BCCD 3626) supplemented with 2% glucose and 0.5 μ L/mL methylene blue dye and allowed to dry for 15 minutes at room temperature in a laminar air flow cabinet. Antifungal discs of Fluconazole 25 μ g (Biomaxima Lot 420/06/Z), Clotrimazole 10 μ g (Himedia Lot 0000614732), Miconazole 30 μ g (Himedia Lot 620845), Voriconazole 1 μ g (Himedia Lot 0000643162) and Nystatin 100 units (Oxoid U. K) were placed on the inoculated agar plates using sterile forceps. The plates were incubated at $35 \pm 2^\circ\text{C}$ for 24 hours in calibrated incubator (Mettler model 30-1060). After incubation time, the diameters of the growth inhibition zone were measured manually using a calibrated Vernier caliper. The results were interpreted according to CLSI guidelines M27M44S, third edition (2022) as either sensitive, resistant, or intermediate. *C. albicans* ATCC 10231 was used as a positive standard in all tests requiring a positive control.

2.5. Data Analysis

Data from laboratory tests were compiled in Microsoft Excel and analyzed using Statistical Product and Service Solutions (SPSS) V20 (IBM USA). Descriptive statistics

were used to summarize the frequencies of *Candida spp.* and their antifungal resistance patterns. A bivariate analysis using the Chi-square test was performed to assess variations in *Candida spp.* distribution and antifungal resistance patterns across hospitals, and the P-value <0.05 was considered statistically significant.

3. Results and Discussion

3.1. Sample Size and Response Rate

A total of 242 Isolates were collected from all selected hospitals. The collected isolates registered a response rate of 63% of the expected sample size ($N=384$) from all 14 hospitals. The expected sample size per hospital was at least 30 isolates. However, the actual number of isolates per hospital varied due to the local prevalence of *Candida spp.*

3.2. Isolation and Identification of *Candida spp.*

Among the collected isolates ($N=242$), 94.6% ($n=229$) were confirmed as *Candida spp.* based on the morphological characteristics when cultured on SDA plates. Colonies were observed to be creamy, smooth, and circular. The microscopical examination of the germ tube test and Gram staining as shown in Figure 3. Indicated that 52.4% ($n=120$) were *C. albicans*, while *Candida spp.* altogether were 47.6% ($n=109$). This study found that 5.4% ($n=13$) of the total hospital reported cases of *Candida spp.* were not *Candida spp.* suggesting diagnosis error.

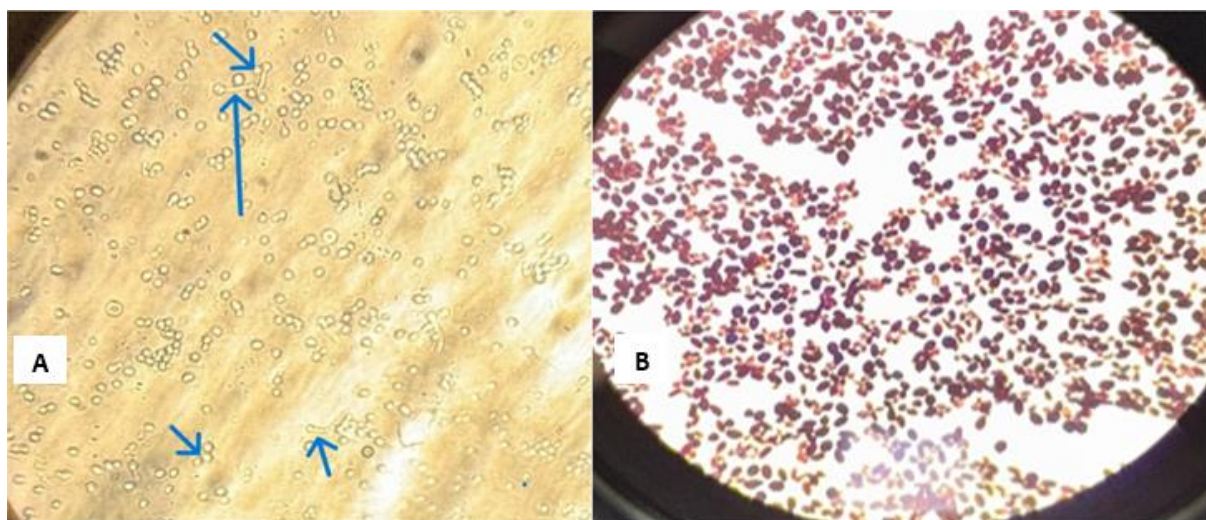


Figure 2. Microscopic identification of *Candida spp.* using wet mount image (A) and Gram staining image (B).

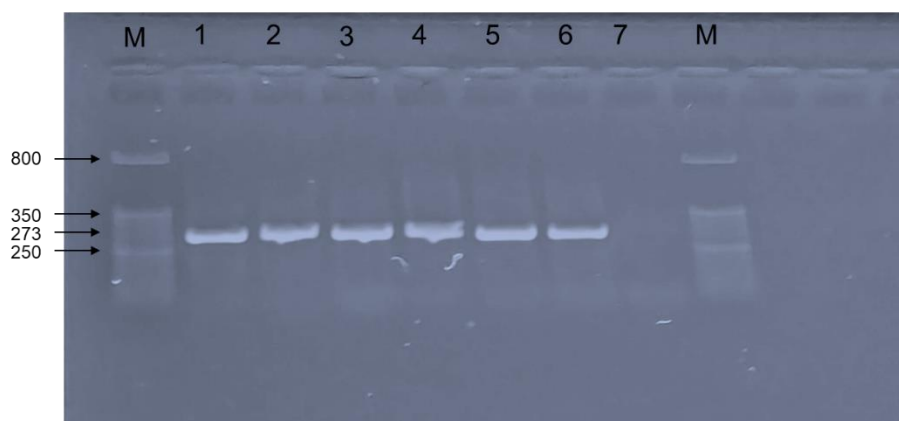


Figure 3. Gel electrophoresis image of PCR product of *CalB* gene (273 bp) for identification of *C. albicans*, whereby Lane M marker; Lane 1 Standard *C. albicans* ATCC 10231 (positive control) Lane 2-6 positive samples of *C. albicans* isolates, Lane 7 negative control.

3.3. Confirmation of *C. albicans*

Confirmation for *C. albicans* were performed by PCR on 229 samples collected from 14 Regional Referral Hospitals as shown in Figure 3. Results of PCR confirmed that 52.4% (n=120) of the isolates were *C. albicans*, while 47.6% (n=109) were non *albicans Candida spp.*

3.4. Prevalence of *C. albicans* Across Regional Referral Hospitals

The prevalence of *C. albicans* varied across hospitals. Sekou Toure RRH had the highest prevalence with 100% (n=5) of isolates identified as *C. albicans*, followed by Amana RRH at 83.3% (n=6), Morogoro RRH at 82.6% (n=23), and Dodoma RRH at 66.7% (n=23). Other hospitals with high prevalence included Bukoba RRH 64.0% (n=16) and Singida

RRH 61.1% (n=11). In contrast, the lowest prevalence was observed at Mwananyamala RRH 0% (n=0), Mbeya Zonal Hospital 11.1% (n=9) and Mount Meru RRH 15% (n=3) as represented in Table 1. There was a statistically significant variation in *C. albicans* prevalence across hospitals ($\chi^2 = 44.47$, p value = 0.001), in such that Sekou Toure and Amana RRH showed the highest proportions.

Overall, the findings confirm that *C. albicans* was more prevalent among the *Candida spp.* isolates from patients with candidiasis, with notable variation in prevalence across different healthcare facilities. A similar prevalence has been reported in other studies [18-20]. However, findings from this study indicated that there is no serious gap between the prevalence of *C. albicans* and other *Candida spp.* Hence, this study suggests that other *Candida spp.* are gaining more ground on the prevalence scale, contrary to previous reported cases [3].

Table 1. Comparison of *C. albicans* and Non-*albicans Candida spp.* prevalence across hospitals using Chi-Square Test (N=229).

Hospital Name	Prevalence of <i>Candida spp.</i>		χ^2	p - value
	<i>C. albicans</i> n (%)	Non- <i>albicans Candida spp.</i> n (%)		
Amana RRH	5 (83.3)	1 (16.7)	44.468	<0.001
Bukoba RRH	16 (64)	9 (36)		
Dodoma RRH	22 (66.7)	11 (33.3)		
Ligula RRH	12 (44.4)	15 (55.6)		
Mawenzi RRH	3 (42.9)	4 (57.1)		
Mbeya RRH	8 (53.3)	7 (46.7)		
Mbeya Zonal	1 (11.1)	8 (88.9)		
Morogoro RRH	19 (82.6)	4 (17.4)		
Mount Meru RRH	3 (15)	17 (85)		
Mwananyamala RRH	0 (0)	2 (100)		

Hospital Name	Prevalence of <i>Candida spp.</i>		X ²	p - value
	<i>C. albicans</i> n (%)	Non-albicans <i>Candida spp.</i> n (%)		
Sekou Toure RRH	5 (100)	0 (0)		
Singida RHH	11 (61.1)	7 (38.9)		
Sokoine RRH	12 (35.3)	22 (64.7)		
Temeke RRH	3 (60)	2 (40)		
Total	120 (52.4)	109 (47.6)		

3.5. Antifungal Susceptibility Test by Disc Diffusion

The clear zones of inhibition observed surrounding the antifungal disks indicated the effectiveness of the respective antifungal agent against the *Candida spp.* isolates. The larger the zones the higher the susceptibility. Meanwhile, the smaller or no clear zones suggest resistance when the same antifungal is tested against all isolates. The varying sizes of the inhibition zones demonstrate differences in susceptibility patterns of the isolates to the tested antifungal agents. Results from this study were found to be in the zone limits for resistant, intermediate and susceptible as prescribed in the CLSI guidelines M27M44S, third edition (2022). This suggest that the obtained results are scientifically acceptable.

3.6. Antifungal Susceptibility Profile of *Candida spp.* Isolates (All Isolates Combined)

The antifungal susceptibility of *Candida spp.* isolates (N=229) was assessed against five commonly used antifungal agents, out of which Miconazole showed the highest efficacy,

with 89.2% (n = 204) of isolates classified as susceptible, 6.1% (n = 14) displayed resistance, while 4.9% (n=11) were intermediately resistant. Similarly, Clotrimazole and Nystatin demonstrated good performance, with 79.9% (n = 183) and 79.5% (n = 182) of isolates susceptible, respectively. Voriconazole showed moderate efficacy, with 68.9% (n = 156) of isolates susceptible. Fluconazole demonstrated the lowest efficacy among the tested antifungals, with 63.3% (n = 145) of isolates classified as susceptible and 31.0% (n = 71) resistant while 5.1 (n=13) were intermediate. This indicates a concern about the possibility of reduced efficacy, as shown in Table 2. These results suggest that while most *Candida spp.* isolates remain susceptible to azoles and polyenes, there is an observable trend of increased resistance, particularly to Fluconazole and Voriconazole. Findings from similar studies elsewhere [16, 21] also agree that resistance toward fluconazole is a growing concern, hence the need for monitoring. Surveillance of antifungal drug resistance displayed dynamism and inconsistency between institutions and countries [22]. This report from a localized study in Tanzania contributes to the global picture of emerging resistance toward antifungal drugs and hence supports the need for stern action.

Table 2. Susceptibility Distribution of *Candida spp.* Isolates (N=229) to antifungal medicine recommended in the Standard Treatment Guideline.

Antifungal agent	Susceptible (S) n (%)	Intermediate (I) n (%)	Resistant (R) n (%)
Miconazole (MIC)	204 (89.19)	11 (4.9)	14 (6.1)
Voriconazole (VRC)	156 (68.9)	4 (1.7)	69 (30.1)
Clotrimazole (CC)	183 (79.9)	16 (7)	30 (13.1)
Fluconazole (FLC)	145 (63.3)	13 (5.7)	71 (31)
Nystatin (NS)	182 (79.5)	6 (2.6)	41(17.9)

3.7. Antifungal Susceptibility Profile of *C. albicans*

The highest susceptibility of *C. albicans* was observed with Miconazole at 86.7% (n=104), followed by Nystatin at 84.2% (101) and Clotrimazole at 80.8% (97). In contrast, Voriconazole and Fluconazole exhibited relatively higher resistance rates of 29.2% (n=35) and 30.8% (n=37), respectively, as shown in Figure 4 below. These findings suggest that while most *Candida albicans* isolates remain susceptible to azoles and polyenes, there is a growing concern of resistance, particularly to Fluconazole and Voriconazole, indicating the need for continuous antifungal resistance monitoring and prudent

antifungal usage. This study suggests that, given the observed emerging resistance to Fluconazole among *C. albicans* isolates, clinicians may need to prioritize agents like Miconazole and Nystatin, which demonstrated >80% efficacy. Although similar trends have been observed elsewhere [23, 24], the current study showed varied susceptibility such that both *C. albicans* and non albicans *Candida spp.* present a similar susceptibility profile. This phenomenon suggests for establishment of phylogenetic relationships among species and possibly the responsible resistant genes.

Given the significant resistance to Fluconazole among *C. albicans* isolates, clinicians may need to prioritize agents like Miconazole and Nystatin, which demonstrated >80% efficacy.

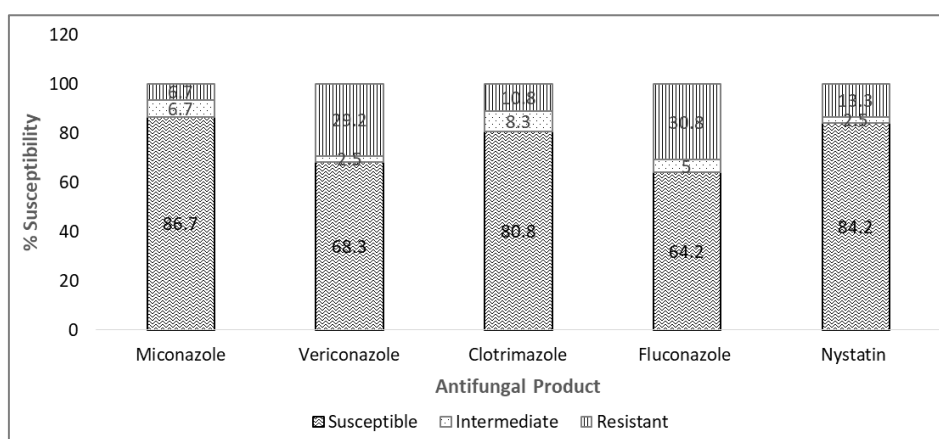


Figure 4. Susceptibility Profile of *Candida albicans* Isolates to Commonly Used Antifungals.

3.8. Antifungal Susceptibility Profile of Non-albicans *Candida spp.*

The antifungal susceptibility profile of *Candida spp.* isolates tested against five commonly used antifungal agents: Miconazole, Voriconazole, Clotrimazole, Fluconazole, and Nystatin. The results indicate that Miconazole exhibited the highest susceptibility rate with 91.7% (n=100) of isolates being sensitive, followed by Clotrimazole 78.9% (n=86) and

Nystatin 74.3% (81). However, Voriconazole and Fluconazole demonstrated higher resistance rates of 31.2% (n=34) each, as shown in Table 3. These findings suggest that while most *Candida spp.* isolates were still susceptible to commonly used antifungals, the emerging concern of resistance, particularly towards Fluconazole and Voriconazole, highlighting the need for continuous antifungal resistance monitoring and rational drug use in clinical settings. Similar patterns have been reported elsewhere [25-27] and these rise concerns about the need for a wider global picture of the situation.

Table 3. Antifungal Susceptibility Profile on non- albicans *Candida spp.* Isolates (N=109).

Drug	Susceptible n (%)	Intermediate n (%)	Resistant n (%)
Miconazole	100 (91.7)	3 (2.8)	6 (5.5)
Voriconazole	74 (67.9)	1 (0.9)	34 (31.2)
Clotrimazole	86 (78.9)	6 (5.5)	17 (15.6)
Fluconazole	68 (62.4)	7 (6.4)	34 (31.2)
Nystatin	81 (74.3)	3 (2.8)	25 (22.9)

3.9. Prevalence of Multi-drug Resistance (MDR) Among *Candida spp.* Isolates

The MDR results indicate that out of the *Candida spp.* isolates (N=229) analyzed, 4.4% (n=10) of isolates were found to exhibit multidrug resistance (MDR) defined as resistance to two or more classes of antifungal agents. The remaining 95.6% (n=219) of isolates were classified as non-Multi Drug Resistant (Non-MDR). The distribution of MDR cases across the participating hospitals (N=14) is presented in Table 4. While the majority of hospitals reported non-MDR cases, a few facilities (n=4) showed a presence of multidrug-resistant isolates. Notably, among the isolates, Ligula RRH N=27 reported the highest MDR prevalence at 14.8% (n = 4), followed by isolates from Bukoba RRH (N=25) at 12.0% (n=3), and isolates from Mount Meru RRH (N=20) at 10.0% (n=2) and isolates from Mbeya RRH (N=15) re-

ported MDR of 6.7% (n=1). The rest of the hospitals recorded no MDR isolates.

There was no statistically significant difference in MDR occurrence between hospitals ($X^2 = 14.842$, p value = 0.129) as illustrated in Table 4 indicating that the observed differences may be due to random variation. These findings suggest that, although overall MDR prevalence was low (4.4%), some hospitals, Ligula RRH, Bukoba RRH and Mount Meru RRH showed disproportionately higher rates. While not statistically significant (p -value = 0.129), these sites may benefit from targeted surveillance due to potential clustering. Although several studies have reported on the resistance towards antifungal medicines [18], the current study highlighted the possibility of emerging multidrug resistance, a case also highlighted in other reports [26]. The observed phenomena may need to be studied in different global regions to contribute to the recent global picture of the situation.

Table 4. Prevalence of Multidrug Resistance (MDR) Among *Candida spp.* Isolates Across Hospitals.

Hospital Name	MDR Status		X^2	p - value
	MDR n (%)	Not MDR n (%)		
Amana RRH	0 (0)	6 (100)	14.842	0.129
Bukoba RRH	3 (12)	22 (88)		
Dodoma RRH	0 (0)	33 (100)		
Ligula RRH	4 (14.8)	23 (85.2)		
Mawenzi RRH	0 (0)	7 (100)		
Mbeya RRH	1 (6.7)	14 (93.3)		
Mbeya Zonal	0 (0)	9 (100)		
Morogoro RRH	0 (0)	23 (100)		
Mount Meru RRH	2 (10)	18 (90)		
Mwananyamala RRH	0 (0)	2 (100)		
Sekou Toure RRH	0 (0)	5 (100)		
Singida RHH	0 (0)	18 (100)		
Sokoine RRH	0 (0)	34 (100)		
Temeke RRH	0 (0)	5 (100)		
Total	10 (4.4)	219 (95.6)		

4. Conclusion

This study generally demonstrated that *Candida albicans* were slightly more prevalent than other *Candida spp.* among the isolates collected from selected regional referral hospitals

in Tanzania. However, a significant variation in prevalence was observed across hospitals. Antifungal susceptibility testing revealed a good efficacy of Miconazole, Clotrimazole, and Nystatin while resistance was observed in Fluconazole and Voriconazole. The prevalence of multidrug-resistant *Candida spp.* was low, but isolated hotspots were identified.

Despite the observed emerging resistance, the majority of antifungals listed in the Standard Treatment Guideline are efficacious, hence still reliable for the treatment of vaginal candidiasis against all *Candida spp.* Findings from this study recommend strengthening continuous surveillance of *Candida species* and their antifungal susceptibility profiles across healthcare facilities in Tanzania.

Abbreviations

ATCC	American Type Culture Collection
CLSI	Clinical and Laboratory Standards Institute
MDR	Multi Drug Resistance
PCR	Polymerase Chain Reaction
RRH	Regional Referral Hospital
SDA	Sabouraud Dextrose Agar
SDB	Sabouraud Dextrose Broth
SPP	Species
SPSS	Statistical Product and Service Solutions
TAE	Tris-acetate-EDTA.
TMDA	Tanzania Medicines and Medical Devices Authority

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Author Contributions

Adelard Bartholomew Mtenga: Conceptualization, Data curation, Formal Analysis, Methodology, Supervision, Writing – original draft, Writing – review & editing

Adam Mitangu Fimbo: Funding acquisition, Project administration, Resources, Supervision, Writing – review & editing

Danstan Hipolite Shewiyo: Formal Analysis, Project administration, Supervision, Writing – review & editing

Saxon Joseph Mwambene: Data curation, Investigation, Methodology, Writing – review & editing

Revocatus Evarist Makonope: Data curation, Investigation, Methodology, Writing – original draft

Shaban Bikiz Kombo: Data curation, Investigation, Methodology

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Data Availability Statement

The data supporting the outcome of this research work has

been reported in this manuscript.

Conflicts of Interest

Authors declares no conflict of interest.

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