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Diversity and Antifungal Susceptibility of *Candida* spp. Strains Isolated from Soils in the City of Ouagadougou (Burkina Faso)

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Abstract: Introduction: *Candida* spp. are opportunistic yeasts found in various environments, including soil. Some species can cause human infections, particularly in immunocompromised individuals. Their therapeutic management is challenging due to resistance reported in numerous studies. This study aimed to explore the diversity and antifungal susceptibility of *Candida* spp. strains isolated from soils in Ouagadougou (Burkina Faso). **Methods:** A cross-sectional study conducted from August 2019 to February 2021. The soil sampling sites were chosen from uninhabited areas of the city of Ouagadougou. At each site, four composite subsamples of approximately 50 g of soil were taken from less than 10 cm deep by removing the top three (3) centimeters with a sterile spatula and placed in a sterile container. *Candida* species were identified using a chromogenic medium (CAN ID2) and Matrix-Assisted Laser Desorption/Ionization Time-of-Flight (MALDI-TOF) spectrometry. Antifungal susceptibility was performed by disk diffusion method and classified as susceptible, susceptible dose-dependent and resistant. **Results:** A total of 38 strains belonging to 6 species of the genus *Candida* were isolated. These species in order of frequency were *Candida tropicalis* (76.32%), *Candida glabrata* (10.53%), *C. lusinatinae* (5.26%), *C. krusei* (2.63%), *C. kefyr* (2.63%), and *C. orthopsilosis* (2.63%). The strains showed high resistance to itraconazole (93.2%) and fluconazole (48.3%) among azoles. For polyenes, the resistance of the strains was noted with amphotericin B with a high rate of 89.7%. **Conclusions:** This study reveals that the soils of the city of Ouagadougou harbor *Candida* spp. yeast species and can be a source of contamination for humans. These yeasts are resistant to some antifungals. This indicates the need to monitor their susceptibility to common antifungals.

Keywords: diversity; telluric strains; *Candida* spp.; antifungal susceptibility; Ouagadougou

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1. Introduction

Candida spp. are yeasts of the normal mucocutaneous flora of humans. They cause a wide range of diseases from superficial lesions of mucous membranes to life-threatening deep tissue infections in humans [1]. The treatment of these candidiasis involves the use of antifungal drugs, the choice of which depends on the sensitivity of the *Candida* species [2,3]. Resistance of *Candida* spp. to antifungal drugs has been observed in Ouagadougou with human clinical strains isolated from oral, vaginal, urine and stool samples [4]. Among the possible sources of human contamination by these yeasts, the telluric source is described. Their presence in the soil can promote their spread and constitute a source of contamination, particularly in areas with high human concentration such as markets, sports and play areas, and recreational facilities [4]. These yeast strains could have several origins: clinical, animal, or environmental. Several studies in Asia and in Latin America have shown that several species of the genus *Candida* are regularly isolated from the soil. Among these species, some are commonly isolated in human pathology. These include *C. albicans*, *C. tropicalis*, and *C. parapsilosis* [5,6]. Although most *Candida* species isolated from soil are recognized in human pathology, some authors report species still poorly understood in human pathology, also isolated from soil. Indeed, strains representing a new ascomycete yeast species, *Candida sanyaensis*, have been isolated from soil samples collected on the islands of Hainan and Taiwan, in China, and in Ireland. Analysis of the D1/D2 domains of the large subunit (LUS) rRNA gene and the internal transcribed spacer (ITS) regions of these strains showed that this species is related to *C. tropicalis* [5,6]. This is also the case for *Candida kantuleensis*, a d-xylose-fermenting yeast species isolated from peat in a tropical swamp forest in Thailand [7]. However, the virulence of this soilborne species in humans remains to be established.

In Africa, studies on soil fungal diversity are rare or even non-existent according to the literature. The few data that do exist on the subject report new species whose relevance to human pathology is completely unknown. These are *Candida mokoenaii*, *Candida lyxosophila*, and *Candida amidevorans* [6–8].

Although the literature indicates that the soil diversity of pathogenic yeasts of the genus *Candida* is poorly understood, these yeasts are nonetheless common in soil within human environments [9,10]. This constitutes a significant source of contamination for humans. Furthermore, the likely contact of these soil strains with antifungal pesticides could lead to cross-resistance with antifungal molecules used in human medicine [11,12]. Indeed, some authors have reported cross-resistance of soil-dwelling Candida strains to azole fungicides used in agriculture and to azole antifungals used in therapy [12]. It is thus also important to study their sensitivity to antifungals used in humans, as understanding this sensitivity will contribute to the fight against antimicrobial resistance within the context of One Health, an integrated approach to disease management.

Thus, the present study aimed to explore the diversity and antifungal susceptibility profile of *Candida* species isolated from soil samples in the city of Ouagadougou.

2. Materials and Methods

2.1. Study Site

Ouagadougou (12°21′14″ N, 1°30′41″ W), the capital of Burkina Faso, is located in the province of Kadiogo, a region of the central plateau. It covers an area of 2805 km^2 and is located in the Sudanian zone with a tropical climate. The average annual rainfall is 935 mm and rainfall are spread over a short period of 2 and 3 months from mid-June to mid-September. The temperature varies between 17 °C and 39 °C depending on the season. The population of Ouagadougou was estimated at 2,415,266 in 2019 according to the report of the last population census. The population density is 525.9 inhabitants per km^2 in the city. Administratively, Ouagadougou is a municipality with a special status [13]. It comprises fifty-five (55) sectors and seventeen (17) villages spread across twelve (12) districts. Our soil samples were collected from markets and open-air marketplaces (called yaars), places frequented by the population. These locations were chosen randomly. These sampling sites were selected based on purposive sampling of certain sectors of the city of Ouagadougou (Figure 1).

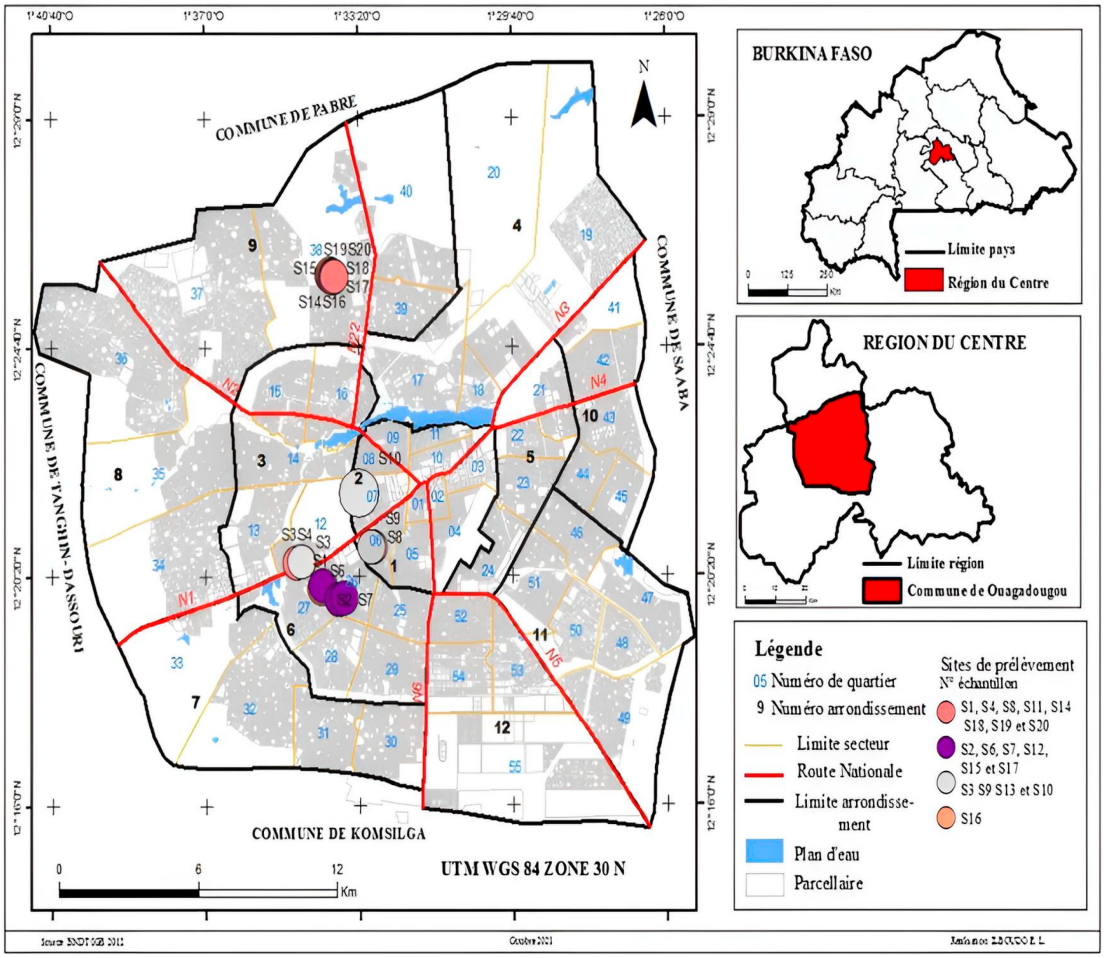

Figure 1: *Candida* spp. strain isolation sites.

2.2. Study Type

This descriptive cross-sectional study was conducted from August 2019 to February 2021. Species diversity from soil samples was explored in August and October 2019, and antifungal susceptibility testing was performed in February 2021.

2.3. Soil Sample Collection

Soil samples were collected from four types of sites: markets, schools, sports fields, and areas frequented by animals. The number of soil samples collected per site depended on the total area of the site, approximately 1 soil sample per 500 m^2. Each sample consisted of four composite subsamples of approximately 20 g of soil each, taken from a depth of less than 10 cm by removing the top 3 cm with a sterile spatula and placing them in a sterile container (Figure 2).

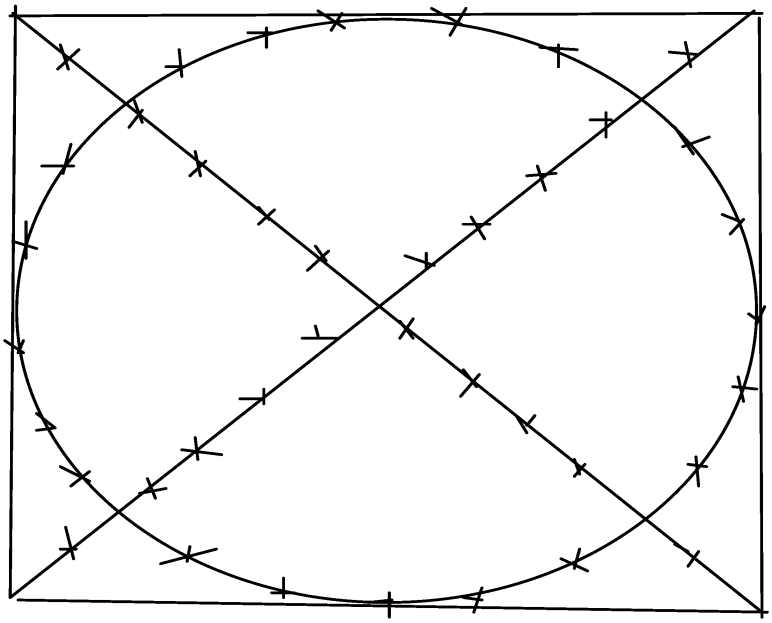

Figure 2: The path followed to obtain a soil sample.

Each point on the figure corresponds to a soil sampling point in the field: The first composite subsample is a mixture of ten (10) small samples taken along the first diagonal; the second composite subsample is a mixture of ten (10) small samples taken along the second diagonal; the third composite subsample is a mixture of ten (10) small samples taken along the first half of the perimeter; the fourth composite subsample is a mixture of ten (10) small samples taken along the second half of the perimeter. The number of samples taken per site depends on the area of the site. The minimum area required was one hectare.

2.4. Isolation of Yeast Strains

Soil samples collected in conical tubes were kept in a refrigerator at +4 °C until analysis. Soil samples were cultured according to a protocol adapted from Sylvester et al. (Sylvester et al., *FEMS Yeast Research*) (Figure 3). Briefly, each sample was placed into 10 mL of Yeast extract Peptone Dextrose (YPD) (Sigma-Aldrich, Hamburg, Germany) medium supplemented with antibiotics (ampicillin, kanamycin, and chloramphenicol) (Sigma-Aldrich, Hamburg, Germany). Incubation was

performed at 30 °C alongside a control tube. After 24 h, the culture was assessed for turbidity and compared with the control. If the culture was positive, a subculture was performed on YPD/agar medium (Sigma-Aldrich, Hamburg, Germany). The resulting colonies were streaked onto Sabouraud dextrose agar and chromogenic CAN ID2 medium (BioMérieux, Nancy-L'Etoile, France) to differentiate morphotypes. Each morphotype was then subjected to MALDI-TOF mass spectrometry for precise species identification. MALDI-TOF identification was performed at the Nantes University Hospital (France) using a BioMérieux VITEK MS instrument. The performance of this device is based on an exhaustive database comprising up to 16,000 strains/species with a high concordance rate of 90 to 95%.

Each colony was then subcultured on Sabouraud medium at 30 °C and then on CAN ID2 medium at 35 °C for 48 h. The chromogenic medium allowed for the detection of morphotypes, which were identified using MALDI-TOF (Figure 3).

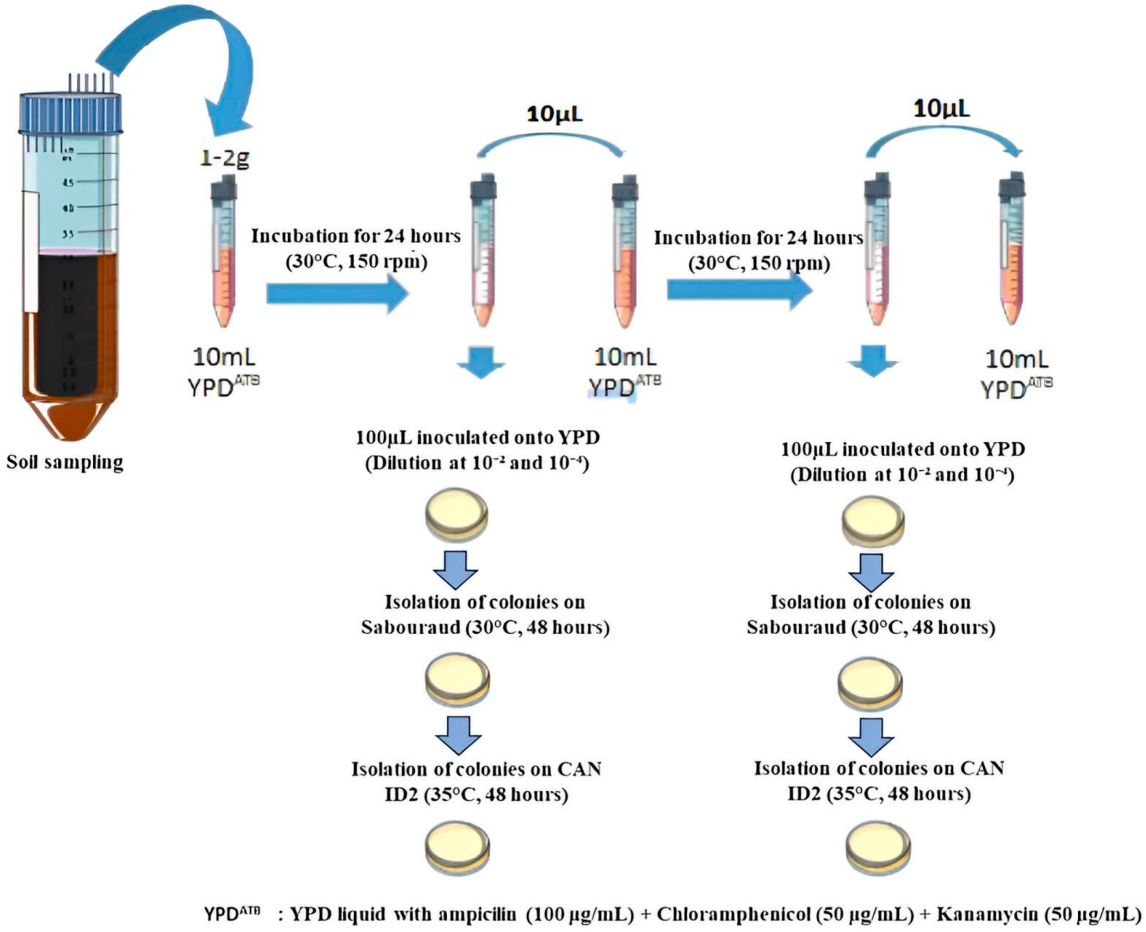

Figure 3: Protocol for culturing soil samples (adapted from Sylvester et al.).

2.5. Inoculum and Antifungal Susceptibility Testing

Antifungal susceptibility testing was performed using the disk diffusion method according to the Clinical and Laboratory Standards Institute (CLSI M44-A) guidelines for yeasts, formerly National Committee for Clinical Laboratory Standards (NCCLS) 2004 [14], and the manufacturer's instructions. The *C. albicans* isolates were subcultured on potato dextrose agar (PDA) (Sigma-Aldrich, Hamburg,

Germany) and incubated overnight at 37 °C for reactivation, as they had been stored after isolation for several weeks prior to antifungal susceptibility testing. Saline suspensions of the isolates were then prepared, and turbidity was adjusted to a 0.5 McFarland standard. A lawn culture was performed on freshly prepared Mueller–Hinton agar plates. Antifungal disks were placed on the surface of each inoculated plate. The plates were incubated at 37 °C and read after 24 and 48 h. The antifungal agents tested were as follows: fluconazole (FLU, 100 µg), itraconazole (ITC, 50 µg), econazole (ECN, 10 µg), clotrimazole (CLO, 50 µg), miconazole (MCL, 10 µg), amphotericin B (AMB, 20 µg), and nystatin (NYS, 100 IU). The antifungal disks were manufactured by Liofilchem® s.r.l, Livorn, Italy. Isolates were categorized as susceptible, susceptible dose-dependent, or resistant, based on interpretation criteria provided by the Clinical and Laboratory Standards Institute (CLSI, 2007; NCCLS, 2004) [15].

2.6. Data Analysis

The data were entered using Microsoft Excel 2013. They were then imported into Epi Info version 7.2.2.2, cleaned, and analyzed. The chi-square and Fisher's exact tests (for small sample sizes) were used to compare frequencies. A p-value < 0.05 was considered significant for all these tests.

3. Results

3.1. Frequency of *Candida* spp. Species

A total of 38 strains were isolated and allowed the identification of 6 yeast species. *C. tropicalis* (76.32%) predominated among these species. It was followed by *C. glabrata* (10.53%) and *C. lusinatinae* (5.26%). The other 3 species (*C. krusei*, *C. kefyr* and *C. orthosilopsis*) were encountered at low frequencies.

The frequency of strains isolated per site is presented in Table 1. *C. tropicalis* was found at all sites. However, this species was predominantly isolated from market soil. *C. glabrata* was found only in market and school soil. *C. krusei*, *C. kefyr*, and *C. orthopsilosis* were isolated only from school soil. *C. lusitaniae* was isolated only from market soil.

Table 1: Number of strains isolated by site.

Sites	Number of Soil Samples	Culture Positivity Rate (%)	Isolated Species	Frequencies (%) N = 38
Markets	8	100	*C. tropicalis*	12 (31.6)
			C. glabrata	2 (5.3)
			C. lusitaniae	2 (5.3)
Schools	6	100	*C. tropicalis*	9 (23.7)
			C. glabrata	2 (5.3)
			C. krusei	1 (2.6)
			C. kefyr	1 (2.6)
			C. orthopsilosis	1 (2.6)
Sports fields	2	100	*C. tropicalis*	3 (7.9)
Places frequented by animals *	4	100	*C. tropicalis*	5 (13.1)
Total	20	100		38 (100)

* Sheep, cattle, goats.

Analysis of the distribution of isolated species according to site did not show a statistically significant link (Table 2).

Table 2: Analysis of the distribution of isolated species by site.

Isolated Species	Sites	Frequencies (%) n = 38	*p*-Value
C. tropicalis	Markets	31.6	$X^2 = 3.62$, $p = 0.306$
	Schools	23.7	
	Sports fields	7.9	
	Places frequented by animals	13.1	
C. glabrata	Markets	5.3	$p = 0.48$
	Schools	5.3	
	Sports fields	0.0	
	Places frequented by animals	0.0	
C. lusitaniae	Markets	5.3	$p = 0.29$
	Schools	0.0	
	Sports fields	0.0	
	Places frequented by animals	0.0	
C. krusei	Markets	0.0	$p > 0.99$
	Schools	2.6	
	Sports fields	0.0	
	Places frequented by animals	0.0	
C. kefyr	Markets	0.0	$p > 0.99$
	Schools	2.6	
	Sports fields	0.0	
	Places frequented by animals	0.0	
C. orthopsilosis	Markets	0.0	$p > 0.99$
	Schools	2.6	
	Sports fields	0.0	
	Places frequented by animals	0.0	

3.2. Susceptibility of Isolated Strains to Azole Agents

Antifungal susceptibility testing was performed on 29 strains, as 9 strains could not be recultured after storage in a freezer at −20 °C.

Susceptibility testing revealed high rates of resistance to itraconazole (93.2%) and fluconazole (48.3%). Species-specific resistance rates to itraconazole ranged from 95.8% for *C. tropicalis* to 100% for 4 species (*C. glabrata*, *C. lusitaniae*, *C. orthopsilosis,* and *C. krusei*) (Table 3). Resistance to fluconazole was only encountered with *C. tropicalis* (53.8%).

Table 3: In vitro susceptibility profile of *Candida* spp. to five antifungal azole soil isolates.

Isolates	FLU			ITRA			ECO			CLO			MIC		
	S	SDD	R	S	SDD	R	S	SDD	R	S	SDD	R	S	SDD	R
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
C. tropicalis (n = 24)	10 (41.7)	0 (0.0)	14 (58.3)	0 (0.0)	1 (4.2)	23 (95.8)	24 (100)	0 (0.0)	0 (0.0)	24 (100)	0 (0.0)	0 (0.0)	24 (100)	0 (0.0)	0 (0.0)
C. glabrata (n = 1)	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100)	1 (100)	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)	0 (0.0)
C. lusitaniae (n = 1)	0 (0.0)	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100)	1 (100)	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)	0 (0.0)
C. orthopolosis (n = 1)	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100)	1 (100)	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)	0 (0.0)
C. krusei (n = 1)	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100)	1 (100)	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)	0 (0.0)
C. kefyr (n = 1)	1 (100)	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)	0 (0,0)	1 (100)	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)	0 (0.0)
Total (n = 29)	14 (48.3)	1 (3.4)	14 (48.3)	1 (3.4)	1 (3.4)	27 (93.2)	29 (100)	0 (0.0)	0 (0.0)	29 (100)	0 (0.0)	0 (0.0)	29 (100)	0 (0.0)	0 (0.0)

FLU: fluconazole; ITRA: itraconazole; ECO: econazole; KET: ketoconazole; CLO: clotrimazole; MIC: miconazole.

3.3. Sensitivity of Isolated Strains to Polyene Agents

Resistance to polyenes was found with amphotericin B (89.7% for all strains). With the exception of *C. lusitaniae*, this resistance concerned all the *Candida* species identified. It was 91.6% for *C. tropicalis* and 100% for *C. glabrata*, *C. orthopslosis, C. krusei,* and *C. kefyr* (Table 4).

Table 4: In vitro susceptibility profile of *Candida* spp. soil isolates to the two antifungal polyenes.

Isolates	NYS			AMB		
	S	SDD	R	S	SDD	R
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
C. tropicalis (n = 24)	24 (100)	0 (0.0)	0 (0.0)	1 (4.2)	1 (4.2)	22 (91.6)
C. glabrata (n = 1)	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100)
C. lusitaniae (n = 1)	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100)	0 (0.0)
C. orthopsilosis (n = 1)	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100)
C. krusei (n = 1)	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100)
C. kefyr (n = 1)	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100)
Total (n = 29)	29 (100)	0 (0.0)	0 (0.0)	1 (3.4)	2 (6.9)	26 (89.7)

AMB: amphotericin B; NYS: nystatin.

Just as with the distribution of species by site, there was no statistically significant link between the sensitivity of *C. tropicalis* to antifungals by site (Table 5). The results of the antifungal susceptibility testing showed that 10/24 of *C. tropicalis* were susceptible to fluconazole.

Table 5: Analysis of the sensitivity of *C. tropicalis* to antifungals by site.

Sites	Frequency of Susceptible Strains n (%)	*p*-Value
	Fluconazole	
Markets	4/10 (40)	*p*-value = 0.420
Schools	2/7 (28.6)	
Sports fields	1/3 (33.3)	
Places frequented by animals	3/4 (75)	
	Itraconazole	
Markets	0/10 (0)	–
Schools	0/7 (0)	
Sports fields	0/3 (0)	
Places frequented by animals	0/4 (0)	
	Clotimazole	
Markets	10/10(100)	–
Schools	7/7 (100)	
Sports fields	3/3 (100)	
Places frequented by animals	4/4 (100)	
	Amphotéricin B	
Markets	1/10 (10)	*p*-value = 0.417
Schools	0/7 (0.0)	
Sports fields	0/3 (0.0)	
Places frequented by animals	0/4 (0.0)	
	Nystatin	
Markets	7/10 (100)	*p*-value = 0.267
Schools	7/7 (100)	
Sports fields	3/3 (100)	
Places frequented by animals	4/4 (100)	

4. Discussion

To our knowledge, this study is the first to explore the yeast species present in soils in Burkina Faso. In addition to inoculation on chromogenic medium (CAN ID2), we used MALDI-TOF (Matrix-Assisted Laser Desorption/Ionization Time-of-Flight) mass spectrometry to increase the sensitivity and specificity of mycological analyses. MALDI-TOF is a technique widely used in medical microbiology, but which remains inaccessible in our context in Burkina Faso. Six (6) yeast species were isolated (*Candida tropicalis*, *C. glabrata*, *C. lusitaniae*, *C. krusei*, *C. kefyr*, and *C. orthosilopsis*).

This study therefore provides epidemiological data indicating that the soil of the city of Ouagadougou constitutes a reservoir for several *Candida* species, primarily *C. tropicalis* [16]. The presence of *Candida* species frequently isolated from humans in the soil provides an idea of the diversity of these yeasts' habitats and indicates a significant telluric reservoir [16]. In Burkina Faso, prior to this study, no data on the soil reservoir of *Candida* fungi were available, although the importance of this reservoir has already been described elsewhere. Indeed, according to the literature, *C. tropicalis* is one of the most frequently isolated pathogenic species of the *Candida* genus from soil in Asia and South America [17].

Some of these species of yeast in the soil in this study conducted in Ouagadougou, Burkina Faso, and in other countries are frequently implicated in human infections. Indeed, *C. tropicalis, C. glabrata* and *C. krusei* have been isolated in studies conducted in Burkina Faso on vaginal candidiasis and digestive candidiasis [18,19]. Their involvement in human pathology is well known. In humans, *C. tropicalis, C. glabrata* and *C. krusei* are found in the gastrointestinal tract and genitourinary tract. They cause superficial candidiasis, deep candidiasis and candidemia [20]. *Candida lusitaniae*, *C.*

kefyr and *C. orthopsilosis* are rarer in human pathology. In humans, in addition to colonizing the skin and digestive and genitourinary mucosa, several species of *Candida* found in the soil can cause more serious illnesses. For example, *C. tropicalis*, the most isolated species in the soil of the city of Ouagadougou, causes superficial and systemic candidiasis. In Asia and in certain Latin American countries, this species is one of the species most frequently associated with candidemia, and mortality rates are generally higher than 40% [16]. It is therefore important to take into consideration the telluric reservoir of these species in the fight against candidiasis, particularly systemic candidiasis in people at risk. *C. albicans*, the species most frequently found in human pathology, was not isolated in the present study. Indeed, according to the literature, *C. albicans* is almost exclusively found in humans, to whom it is well adapted. And its presence in the soil indicates contamination of human origin, particularly through feces [16]. The distribution of *candida* species according to site did not show any statistically significant difference. The isolated species were therefore distributed in the soil independently of their specific characteristics, whether the sites were regularly frequented by humans or animals.

Considering the susceptibility of the *candida* strains isolated in this study, we found that it was variable depending on the species and the antifungal tested. Indeed, resistance to fluconazole was encountered in *C. tropicalis* (53.8%), the predominant species in our isolates, and absent in *C. glabrata*, the 2nd most frequent species. In a recent study conducted in Cameroon, the resistance rate of *C. tropicalis* to fluconazole was slightly lower (50%), while *C. glabrata* showed low resistance (3%) [21]. Besides fluconazole, azole resistance concerned itraconazole with several species involved (*C. glabrata*, *C. lusitaniae*, *C. orthopsilosis* and *C. krusei*) [21]. The azole resistance profile of our soil-borne isolates is thus similar to the resistance profile of human clinical strains that were previously tested in Ouagadougou [4]. These observations show a probable circulation of isolated strains between the environment and humans and raises concern in the management of candidiasis in Burkina Faso. Indeed, *C. tropicalis* is part of the *Candida* genus, along with *C. albicans*, species frequently isolated during candidiasis in humans, and fluconazole is the main molecule used in the treatment of deep candidiasis [4]. Several authors report that selection pressure from the widespread use of fluconazole could be responsible for the cross-resistance to other azoles such as itraconazole observed in the present study [22–24]. Furthermore, fluconazole is established as a first-line treatment for esophageal candidiasis and is administered free of charge to immunocompromised patients by the Ministry of Health of Burkina Faso [25]. In addition to having relative safety and high oral bioavailability, this triazole also remains a less expensive antifungal (around 500 FCFA for the generic tablet form in pharmacies in Ouagadougou) in Burkina Faso and is then mostly prescribed for the management of candidiasis. Another source that could explain this high rate of resistance to azoles, in the context of a One Health approach, is the animal origin of *Candida* strains isolated from the soil [26]. Some authors have reported multi-resistant strains of *Candida* isolated from some animals. According to a study conducted in sheep in China, some isolated species of the genus *Candida*, including *Candida tropicalis*, showed a high level of resistance to antifungals, particularly to azoles such as itraconazole and fluconazole [27].

Regarding polyenes, while all our isolates were sensitive to nystatin (100%), the majority of strains were resistant to amphotericin B (89.7%). The absence of resistance to nystatin in our study confirms the observations of several authors who note that this resistance is still rare. In fact, the genetic mutations conferring resistance to nystatin in yeasts of the genus *Candida* are lethal, thus slowing down the selection of resistant strains [28]. Thus, the few studies that have found it report low rates of strains resistant to nystatin: 3% in Brazil with clinical strains of oral origin and 0.61% in Uganda with strains of vulvovaginal origin [29,30]. Resistance to amphotericin B, which was also considered rare, is increasingly found in studies. Zarei et al. (2014) found a rate of 42.5% with clinical isolates [31]. Just as with the distribution of *Candida* species according to the site, there was no statistically significant link between their sensitivity to antifungals, particularly that of *C. tropicalis*, the species predominantly isolated in the present study, and the site.

5. Conclusions

This study allowed us to isolate six species of *Candida* from the soils of the city of Ouagadougou. Some of these species are sometimes found in human diseases. The antifungal susceptibility profile of these soil-based isolates is quite similar to the profiles regularly obtained with human isolates. Because yeasts isolated from soil can be a source of contamination and colonization for humans, it is useful to monitor their susceptibility to common antifungal agents.

Author Contributions: P.M.S. designed the study, wrote the protocol, and wrote the first draft of the manuscript. K.T.G. performed the statistical analysis. N.Z. and A.Z. managed the literature searches. J.A.K. performed the statistical analyses of the revised version. He also proofread the revised version. F.M. conducted the study from start to finish. All authors have read and agreed to the published version of the manuscript.

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