EVALUATION OF *CANDIDA SPECIES* ON FOOD AND NON-FOOD CONTACT SURFACES AMONG STUDENTS RESIDING IN SCHOOL HOSTELS IN A TERTIARY INSTITUTION, ILE IFE, OSUN STATE, NIGERIA

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Abstract

Candida species are significant opportunistic fungal pathogens that can cause various diseases, particularly among individuals with compromised immunity. While there is plenty of literature on Candida in clinical and public settings, incidence on surfaces within student residence halls is still not well understood. The distribution and frequency of Candida species were assessed on surfaces that come into contact with food and non-food items at the Obafemi Awolowo University residence halls in Ile-Ife, Nigeria. Seven out of nine residence halls of the university were studied using a cross-sectional investigation. Sterile swabs were used to collect surface samples from 50 rooms, which were subsequently processed on Hi Chrome Candida Differential Agar and Sabouraud Dextrose Agar. Data analysis was done using the Chi-square test with a significance level of $p < 0.05$. It was found that Candida species were fairly common, with an occurrence rate of 86%. The contamination rate on non-food contact surfaces was 64% compared to 76% on food contact surfaces. Its dominating species was Candida glabrata, which comprised 28%, followed by Candida albicans 6%, and Candida tropicalis was also 6%. More pronounced co-infections were noticed at the postgraduate hall: food-contact surfaces between the Candida albicans and Candida glabrata comprised 28.6%. The Moremi Hall recorded the greatest percentage of total contamination at 26%. The results stress the need for improved hygienic practices, routine check-ups, and public health programs to avoid opportunistic infections among students, as well as the need to turn attention to the possible danger of fungal contamination in communal living facilities.

INTRODUCTION

Candida species are a leading cause of fungal infections (Staniszewska, 2020). These fungal inhabitants constitute a part of the human flora, establishing residence on skin, and mucous membranes within the oral cavity, gastrointestinal, and genitourinary tracts (Romo and

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Kumamoto, 2020). While Candida thrives harmoniously within the body's cavities, its opportunistic inclinations can pave the way for infections affecting diverse anatomical regions causing infections called candidiasis, often manifesting as secondary infections in individuals with compromised immune systems (Arya and Rafiq, 2023). It can affect the oral cavity, vagina, penis, or other parts of the body. In the context of the oral cavity, candidiasis takes the form of "thrush" evident by the appearance of characteristic white patches on the tongue, throat, and other oral surfaces. (Arya & Rafiq, 2023). This disrupts the aesthetics of the mouth and can induce discomfort, with symptoms extending to soreness and difficulties in swallowing. (CDC, 2022). While *Candida* prevalence in clinical and public settings has been extensively studied, its presence in communal living environments such as university residential halls remains underexplored. Communal spaces, characterized by shared facilities and diverse hygiene practices, create an ideal environment for microbial proliferation. Studies by Cristina et al., (2023), and Belizario et al., (2021), underline the significant fungal burden in non-clinical indoor settings. However, limited data exist on *Candida* prevalence in student hostels, where individuals with varying lifestyles and immune statuses cohabit.

While Candida infections often manifest superficially within urinary or oral mucosal cavities, these fungi possess the alarming ability to infiltrate the bloodstream, paving the path for deep-seated tissue infections (Pappas *et al.,* 2018). The spectrum of invasive candidiasis encompasses varying degrees of severity, spanning from symptomatic candidemia, which stands as the most frequently diagnosed form of invasive candidiasis (Barantsevich & Barantsevich, 2022), to the extremities of sepsis, where mortality rates soar beyond 70% (Pappas *et al.,* 2018). With substantially high mortality rates attributed to Candida infections and their potential for antifungal resistance, the urgency to investigate their prevalence in student residential halls is important. This study aims to bridge this gap by evaluating the prevalence and distribution of *Candida* species on food and non-food contact surfaces in student residential halls at Obafemi Awolowo University, Ile-Ife, Nigeria.

MATERIALS & METHODS

STUDY A

Obafemi Awolowo University (OAU), situated in Ile-Ife, Osun State, Nigeria, provided the premises for the study. The study concentrated on seven of the university's nine residential halls, which encompass a variety of postgraduate, male, and female lodgings. Purposefully choosing these halls allowed for diversity in student demographics, such as gender and style of residence.

STUDY POPULATION

Out of the nine halls of residence, 7 were purposely selected for the research. Food-contact and non-food-contact surface samples were collected from fifty (50) rooms with a variety of students with distinct habits and lifestyles living within the residential halls of Obafemi Awolowo University, Ile-Ife were enrolled using a random sampling technique. Verbal consents were obtained from all the students and confidentiality was assured by using codes. The study was conducted between July and August 2023 by approaching students in their rooms.

SAMPLE COLLECTION

Before the commencement of the research work, permission and informed consent were taken from the student. Samples were collected using sterile swab sticks under strict aseptic conditions. The samples were obtained from surfaces in both food contact and non-food contact. The category of food contact surfaces comprises various items, namely plates, pots, frying pans, cups, bowls, knives, forks, spoons, spatulas, and handheld graters, which were collected from both washed and unwashed items. The non-food contact surfaces encompass gas cookers, hot plates, cupboards, the floor space surrounding the cooking area, plate racks, and tabletops.

ISOLATION AND IDENTIFICATION

The swab samples were then inoculated onto Sabouraud Dextrose Agar (SDA) and incubated aerobically for 24 hours at 37°C. The isolates were first identified by Gram staining before further culturing on Hi Chrome Candida Differential Agar (M1297A) for differentiation of Candida species based on colour. Gram staining aids in the identification and helps in distinguishing yeast-like organisms from other microorganisms. The identification procedure was based on the physical traits of the colonies and their colour responses on the selective agar.

DATA ANALYSIS

Chi-square analysis was used to survey the data and find the prevalence on the different surfaces of Candida species. The level at which the difference was declared to be statistically significant was if $p < 0.05$ to determine the association between variables. This study aimed at investigating whether the type of surface or residential hall and the prevalence of Candida species significantly correlated.

RESULTS

A total of 50 rooms were sampled across seven residential halls at Obafemi Awolowo University, Ile-Ife. Out of the 50 rooms sampled, 43 (86%) were positive for *Candida* species. This high prevalence highlights the significant contamination of surfaces within the student residential halls as shown in Table 1.

Of all the halls of residence, Moremi Hall has the highest number of samples 14 (28%) recorded in this research work. The Postgraduate and Akintola Halls of Residence both accounted for 14% of the data, ETF Hall accounted for 12%, Angola Hall accounted for 10% and Alumni Hall accounted for the lowest samples, 2%. Food contact surfaces had a frequency of 76%, but non-food contact surfaces had a slightly lower prevalence of 64%, according to our analysis of the prevalence of Candida species on these surfaces. Candida was most common on tabletops (24%) and floors (16%), then on gas cookers (8%) and cabinets (4%), as shown in Table 1.

The amount of Candida found within these 50 rooms has been ordered into 2 groups, food contact surfaces and non-food contact surfaces as shown in Tables 2 and 3 respectively.

Table 1: The prevalence of Candida species in halls residence among Food contact and Non-food contact surfaces in Obafemi Awolowo University.

HALL	OCCUPIED BY	NO. OF ROOMS EXAMINED	NO. OF ROOMS POSITIVE FOR CANDIDA SPECIES
AKT	Female	7 (14.0)	7 (14.0)
ALM	Female	1 (2.0)	1 (2.0)
ANG	Male	5 (10.0)	5 (10.0)
ETF	Male	6 (12.0)	6 (12.0)
FAJ	Male	10 (20.0)	6 (12.0)
MORE	Female	14 (28.0)	13 (26.0)
PG	Mixed	7 (14.0)	5 (10.0)
TOTAL		**50 (100.0)**	**43 (86.0)**

KEY: AKT= Akintola, ALM= Alumni, ANG= Angola, ETF= Education Trust Fund, FAJ= Fajuyi, MOR= Moremi, PG=Post Graduate Hall.

From Table 2, the result shows the prevalence of Candida on Non-Food Contact Surfaces and non-food contact surfaces and their respective contributions of overall 64%. For instance, among the contact areas which are not in direct contact with food, tabletops carried a higher risk of 24% contamination, followed by floors at 16%, a gas stove at 8%, and cabinets at 4%. The high incidence may be caused by the frequent interaction of these surfaces with cooking supplies and personal belongings of pupils. The presence of Candida on particular non-food contact surfaces also varied statistically significantly as shown by the Chi-square analysis. The correlations are very strong for knives and spatulas, for example, X2 = 50.000, p = 0.000, and X2 = 25.818, p = 0.000, respectively. Such items are highly polluted and thus require more focused cleaning procedures.

Table 2: The Prevalence of Candida species in Halls Residence among Food Contacts in Obafemi Awolowo University.

		NON–FOOD CONTACT POSITIVE FOR CANDIDA SPECIES				
HALL	**ROOMS POSITIVE FOR CANDIDA SPP (%)**	**GAS COOKERS (%)**	**HOT PLATES (%)**	**TABLE TOPS (%)**	**FLOORS (%)**	**CUPBOARDS (%)**
AKT	7 (14.0)	1 (2.0)	0 (0.0)	4(8.0)	2 (4.0)	0 (0.0)
ALM	1 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.0)	0 (0.0)
ANG	5 (10.0)	2 (4.0)	0 (0.0)	0 (0.0)	1 (2.0)	2 (4.0)
ETF	2 (4.0)	1 (2.0)	0 (0.0)	0 (0.0)	1 (2.0)	0 (0.0)
FAJ	5 (10.0)	2 (4.0)	1 (2.0)	1 (2.0)	1 (2.0)	0 (0.0)
MORE	10 (20.0)	2 (4.0)	0 (0.0)	6 (12.0)	3 (6.0)	0 (0.0)
PG	2 (4.0)	0 (0.0)	0 (0.0)	1 (2.0)	1(2.0)	0 (0.0)
TOTAL	**32 (64.0)**	**8 (16.0)**	**1 (2.0)**	**12 (24.0)**	**10 (20.0)**	**2 (4.0)**

KEY: AKT= Akintola, ALM= Alumni, ANG= Angola, ETF= Education Trust Fund, FAJ= Fajuyi, MOR= Moremi, PG=Post Graduate Hall

Table 3 shows the prevalence of Candida on Food Contact Surfaces clearly showed that Candida is highly prevalent on surfaces coming in contact with food plates, 54%; pots, 14%; spoons, 10%; and knives, 4%. This indicates that surfaces directly associated with food preparation and consumption are focal points for Candida infections. Furthermore, co-infections were commonly observed to occur on food-contact surfaces: in the PG, 28.6% of rooms were positive for both Candida albicans and Candida glabrata. The abundance of several Candida species on surfaces that are in contact with food reflects the possibility of cross-contamination between species. Table 3 gives the exact distribution of Candida species along the food contact surfaces; notable co-infections were observed in different halls.

Table 3: Prevalence of *Candida species* on various food contact surfaces in Obafemi **Awolowo University**

POSITIVE FOOD CONTACT SURFACES

Hall	Positive Rooms (%)	Plates (%)	Pots (%)	Spoons (%)	Grater (%)	Spatulas (%)	Forks (%)	Knives (%)	Cups (%)	Bowls (%)	Trays (%)
AKT	6 (12.0)	5 (10.0)	0 (0.0)	1 (2.0)	1 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.0)	0 (0.0)	1 (2.0)
ALM	1 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.0)	0 (0.0)	1 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)
ANG	4 (8.0)	2 (4.0)	2 (4.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.0)	0 (0.0)
ETF	5 (10.0)	2 (4.0)	1 (2.0)	2 (4.0)	1 (2.0)	0 (0.0)	1 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
FAJ	4 (8.0)	4 (8.0)	1 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
MORE	13 (26.0)	9 (18.0)	2 (4.0)	2 (4.0)	0 (0.0)	0 (0.0)	1 (2.0)	1 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)
PG	5 (10.0)	5 (10.0)	1 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total	**38 (76.0)**	**27 (54.0)**	**7 (14.0)**	**5 (10.0)**	**2 (4.0)**	**1 (2.0)**	**2 (4.0)**	**2 (4.0)**	**1 (2.0)**	**1 (2.0)**	**1 (2.0)**

KEY: AKT= Akintola, ALM= Alumni, ANG= Angola, ETF= Education Trust Fund, FAJ= Fajuyi, MOR= Moremi, PG=Post Graduate Hall.

Spatulas**:** $X^2 = 50.000$, *p = 0.000*; K

Table 4 shows Candida species distribution across selected residence halls in the Obafemi Awolowo University. The result shows that 76% of rooms where samples were collected from the halls tested positive for the presence of Candida. *Candida glabrata* was the most prevalent species of Candida, predominant in 28% of rooms of the halls of residence, with 35.7% recorded in Moremi Hall showing the highest prevalence.

Candida glabrata was the most common species in the study (28%), followed by Candida tropicalis (6%), and Candida albicans (6%). Co-infection was prevalent, particularly on surfaces that came into touch with food. For instance, co-infection between Candida albicans and Candida glabrata was found in 28.6% of rooms, mostly in the Postgraduate Hall (PG). According to Table 4, Moremi Hall had the highest prevalence of C. glabrata (35.7%), followed by Akintola Hall (28.6%) and PG Hall (16.7%). The study employed chi-square analysis to see whether there was a significant correlation between the kind of surface and the prevalence of Candida species. According to the findings, some surfaces—like knives and spatulas—exhibited statistically significant correlations with the presence of Candida species (X2 = 0.000, p = 0.000, and X2 = 25.818, p = 0.000, respectively) as shown in Table 4. This emphasizes the significance of specific kitchen tools in spreading Candida infection.

Table 4: Distribution of *Candida species* on various food contact surfaces in Obafemi Awolowo University

HALL	No. of Positive Rooms (%)	*C. alb (%)*	*C. glab (%)*	*C. trop (%)*	*C. Krus (%)*	*C.alb & C. glab (%)*	*C. glab & C.krus (%)*	*C. alb & C. trop (%)*	*C. glab & C. trop (%)*	*C. alb, C. glab and C. trop (%)*	*C. glab, C. trop and C krus (%)*
AKT	6 (12.0)	1(14.3)	1 (14.3)	0 (0.0)	1(14.3)	1(14.3)	1 (14.3)	0 (0.0)	0 (0.0)	1 (14.3)	0 (0.0)
ALM	1 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)
ANG	4 (8.0)	1(40.0)	2 (40.0)	1 (20.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
ETF	5 (10.0)	0 (0.0)	2 (33.3)	0 (0.0)	1(16.7)	1(16.7)	0 (0.0)	0 (0.0)	1 (16.7)	0 (0.0)	0 (0.0)
FAJ	4 (8.0)	0 (0.0)	4 (40.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
MORE	13 (26.0)	1(33.3)	5 (35.7)	1 (7.1)	0 (0.0)	1 (7.1)	1 (7.1)	1 (7.1)	1(7.1)	0 (0.0)	2 (14.3)
PG	5 (10.0)	0 (0.0)	0 (0.0)	1 (14.3)	0 (0.0)	2(28.6)	2 (28.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
TOTAL	**38 (76.0)**	**3 (6.0)**	**14 (28.0)**	**3 (6.0)**	**2 (4.0)**	**5(10.0)**	**4 (8.0)**	**1 (2.0)**	**3 (6.0)**	**1 (2.0)**	**2 (4.0)**

KEY: AKT= Akintola, ALM= Alumni, ANG= Angola, ETF= Education Trust Fund, FAJ= Fajuyi, MOR= Moremi, PG=Post Graduate Hall.
Key: *C. alb = Candida albican*, *C. glab = Candida glabrata*, *C. trop = Candida tropicalis*, *C. krus = Candida krusei*

Table 5, shows the distribution of Candida on Non-Food Contact Surfaces, highlighting species specificity on different surfaces. At a 50% contamination rate in Moremi Hall, Candida glabrata was the most prevalent species on non-food contact surfaces. Other surfaces with notable contamination included floors at 6% and gas cookers at 10%. The most polluted hall was Moremi Hall, which had 20%, while Akintola Hall had 14%. This difference might be because of different cleaning practices, occupancy, or hygiene expectations along the corridors. Moreover, 42% of rooms tested positive for Candida glabrata, showing dominance across non-food contact surfaces. These results imply that even surfaces that are not used directly for food preparation nevertheless pose a serious possibility of contamination.

Table 5: Distribution of Candida species on various Non-food contact surfaces in Obafemi **Awolowo University**

HALL	Number of positive rooms (%)	*Candida albican* (%)	*Candida. glabrate* (%)	*Candida tropicalis* (%)	*Candida krusei* (%)	*Candida albican & Candida glabrata* (%)
AKT	7 (14.0)	0 (0.0)	2 (9.5)	1 (33.3)	1 (14.3)	1 (14.3)
ALM	1 (2.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)
ANG	5 (10.0)	0 (0.0)	3 (60.0)	1 (20.0)	0 (0.0)	1 (20.0)
ETF	2 (4.0)	0 (0.0)	2 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)
FAJ	5 (10.0)	1 (10.0)	4 (40.0)	0 (0.0)	0 (0.0)	0 (0.0)
MORE	10 (20.0)	0(0.0)	7 (50.0)	1 (7.1)	2 (14.3)	0 (0.0)
PG	2 (4.0)	0 (0.0)	2 (28.6)	0 (0.0)	0 (0.0)	0 (0.0)
TOTAL	**32 (64.0)**	**1 (2.0)**	**21 (42.0)**	**3 (6.0)**	**5 (10.0)**	**2 (4.0)**

KEY: AKT= Akintola, ALM= Alumni, ANG= Angola, ETF= Education Trust Fund, FAJ= Fajuyi, MOR= Moremi, PG=Post Graduate Hall.

Discussion

The study findings, as obtained from the surfaces that come into contact with food and non-food in the residence halls of students at Obafemi Awolowo University in Ile-Ife, Nigeria, reveal a very high frequency of Candida species. With an 86% total contamination rate, these results have pointed out the importance of fungal contamination in shared living environments where a variety of hygiene practices and shared amenities provide the perfect conditions for microbial growth. Especially for the immunocompromised students, the high prevalence of Candida species, particularly on surfaces that are frequently in contact with food, underlines the potential public health risks in these settings. In our study, the prevalence of non-food contact surfaces, such as floors and tabletops, was relatively lower (64%) compared to the prevalence of food contact surfaces (76%). This is in agreement with the work of Belizario et al. (2021), which also reported high levels of fungal contamination in indoor non-clinical environments. However, the high prevalence of Candida on surfaces not involved in food contact shows that contamination is not just a problem in places where food is prepared. These findings align with various other studies that have shown how fungal species can successfully colonize a wide variety of surfaces even on those not necessarily handled by the handler of food (Cristina et al., 2023).

The distribution showed that Candida glabrata was the most prevalent species from food and non-food contact surfaces, closely followed by C. albicans and C. tropicalis. This distribution agrees with the results of other investigations that have found C. glabrata to be a common contaminant in environmental samples (Pappas et al., 2018). The complexity of fungal contamination in these environments is further demonstrated by the presence of multiple Candida species, including co-infections. Co-infections can increase the chances of infection by promoting the spread of fungal species among students, particularly on surfaces that are exposed to food. This is probably because of a difference in cleaning practices, room usage, or hygiene habits in Moremi Hall. Generally, cleanliness for Candida contamination reduction and sticking to cleaning schedules are very important, as this study has established. Some environmental and behavioral factors, though linked to fungal species proliferation in communal living spaces, also need further study.

The current research also highlights the need to improve sanitary standards in dorms where students reside. Preventing the spread of Candida and other microorganisms requires regular cleaning and disinfection of surfaces, especially those coming into contact with food such as plates, pots, and utensils. Students should also be made aware of the risks of fungal infections and the importance of maintaining personal hygiene, especially among immunocompromised individuals. There are several limitations with this study, despite it offering quite useful information about Candida contamination in student dorms. This study was only conducted for one university, thus limiting general applicability in other settings. Further studies are needed to investigate the incidence of Candida in student dorms in different geographical regions and institutes. The effect of environmental conditions such as Fungal growth is favoured by moisture and aeration. Future studies can also be done on the pathogenicity of the isolated isolates, focusing on virulence factors or resistance to antifungals. This study provides valuable information on the occurrence of Candida species in student residence halls and emphasizes the need for better hygiene procedures and routine monitoring to prevent fungal contamination and protect students' health. Understanding the dynamics of fungal contamination in shared living spaces could help public health concerns regarding opportunistic infections.

Conclusion

This study considers the prevalence of Candida species on food and non-food contact surfaces within residence halls of students in Obafemi Awolowo University in Ile-Ife, Nigeria. The results from this investigation indicate that in all rooms investigated, a high prevalence of Candida contamination was recorded (86%), with a contamination rate slightly higher in food contact surfaces compared to non-food contact surfaces, being 76% and 64%, respectively. Many species are found to co-infect surfaces, especially in areas where food comes into contact with the surface. Candida glabrata was the most common species, followed by Candida albicans and Candida tropicalis. The high contamination rates in this study point out the potential health risks that Candida infections can pose, especially to people with weakened immune systems. The hygiene standards in the students' hostels should be improved, particularly in terms of washing and sanitizing the frequently used surfaces like kitchenware, pots, and plates. These settings need to be periodically assessed to prevent the spread of Candida and to avert potential infections.

This study recommends enhanced public health education for students, especially regarding personal hygiene and the risks of fungal infection, considering the high prevalence of Candida species both on surfaces that come into contact with food and those that do not. Future studies should be directed at ascertaining the causes of fungal contamination in shared living areas, including the part played by environmental factors such as moisture and ventilation. Further studies are needed to determine the pathogenic potential of the isolated Candida strains and their resistance to antifungal drugs in order to understand the implications of these findings for students' health. In conclusion, this study points out the necessity of effective intervention methods to minimize fungal infection transmission in communal living environments and contributes to the growing literature on Candida contamination outside clinical settings.

References

1. Arya, R. N, and Rafiq, N. B. (2023). Candidiasis. In *StatPearls*. StatPearls Publishing. http://www.ncbi.nlm.nih.gov/books/NBK560624/
2. Barantsevich, N., and Barantsevich, E. (2022). Diagnosis and Treatment of Invasive Candidiasis. *Antibiotics*, *11*(6). https://doi.org/10.3390/antibiotics11060718
3. Belizario, J. A., Lopes, L. G., and Pires, R. H. (2021). Fungi in the indoor air of critical hospital areas: a review. *Aerobiologia*, *37*(3), 379-394.
4. Centres for Disease Control and Prevention (CDC). (2022). "Vaginal Candidiasis". Fungal Diseases. United States: Centers for Disease Control and Prevention. https://www.cdc.gov/fungal/diseases/candidiasis/genital/index.html
5. Cristina, M. L., Spagnolo, A. M., Sartini, M., Carbone, A., Oliva, M., Schinca, E., and Pontali, E. (2023). An overview of Candida auris in healthcare settings. *Journal of Fungi*, *9*(9), 913.
6. Pappas, P. G., Lionakis, M. S., Arendrup, M. C., Ostrosky-Zeichner, L. and Kullberg, B. J. (2018). Invasive candidiasis. *Nature Reviews Disease Primers*, *4*(1), Article 1. https://doi.org/10.1038/nrdp.2018.26
7. Romo, J. A., and Kumamoto, C. A. (2020). On Commensalism of Candida. *Journal of Fungi (Basel, Switzerland)*, *6*(1), 16. https://doi.org/10.3390/jof6010016
8. Staniszewska, M. (2020). Virulence factors in Candida species. *Current Protein and Peptide Science*, *21*(3), 313-323.

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+ Authors contribution:

Olaniran, O = Perform experimental and statistical analysis of the manuscript
Adewoyin, A. A = wrote the manuscript
Awoniyi, S.O, Bidmus, A.B and Boriwaye, O.C = collect the Samples