

Research Paper



## Detection of candida albicans virulence genes isolated from periodontitis patients in salah al-din city

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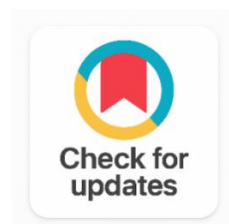
ALS1 Gene

Candida Albicans

HWP1 Gene

PCR

Periodontist



### ABSTRACT

**Background:** Candida albicans is an opportunistic fungal pathogen increasingly implicated in oral infections including periodontitis. Its virulence is partly attributed to adhesion proteins encoded by the ALS1 and HWP1 genes. This study aimed to isolate and characterize C. albicans from periodontitis patients and detect key virulence genes associated with pathogenicity.

**Objective:** To isolate and identify C. albicans from periodontal swab samples using microscopy, culture and molecular methods and to determine the prevalence of ALS1 and HWP1 virulence genes among confirmed isolates.

**Methods:** A total of 75 clinical swab samples were collected from patients aged 5–55 years diagnosed with periodontitis at Salah al-Din General Hospital and affiliated outpatient dental clinics, Iraq, between October 2024 and January 2025. Samples were subjected to direct microscopic examination, culture on Sabouraud's Dextrose Agar (SDA) and Chroma Garand biochemical testing (urease assay). Genomic DNA was extracted from confirmed colonies and polymerase chain reaction (PCR) was performed to detect ALS1 and HWP1 virulence genes. Hemolytic activity was assessed and analyzed statistically.

**Results:** Direct microscopy identified 55 positive samples (73%). Culture on SDA yielded 40 positive isolates (53%), with 35 samples (47%) showing no growth. All 75 samples (100%) were confirmed as C. albicans by combined diagnostic methods. PCR analysis revealed the ALS1 gene in 18 of 25 confirmed isolates (72%) and the HWP1 gene in 15 of 25 isolates (60%). Hemolysis production varied significantly among isolates ( $p = 0.0006$ ).

**Conclusion:** C. albicans was identified in a substantial proportion of periodontitis patients. The high prevalence of ALS1 (72%) and HWP1 (60%) virulence genes among isolates suggests that these adhesion-related proteins contribute significantly to periodontal infection pathogenesis. Inclusion of molecular virulence profiling in clinical mycological assessment may improve understanding of fungal involvement in periodontal disease.

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## 1. INTRODUCTION

Periodontitis is clinically characterized by the loss of attachment around teeth, resulting in the formation of periodontal pockets and the deterioration of bone. [1] The oral cavity serves as an indicator of general well-being and is susceptible to various adverse reactions caused by drug use. Multiple studies have established a link between *Candida* spp. yeasts and their possession of numerous virulence factors, which aid in their ability to disseminate and infect different areas of the human body [2]. Virulence factors are a measure of the extent of pathogenicity of a pathogen, as it is not capable of causing infection unless it is virulent. These factors may be in the form of cellular structures, enzymes, or mycotoxins that facilitate the infection process and protect the pathogen from immune responses and various surrounding conditions. The virulence factors in yeasts of the *Candida* genus are summarized in the property of adhesion, which is the first step in causing infection, followed by polymorphism, phenotypic change and the formation of chlamydial spores, Chlamydospores, hemplysin, the formation of the germ tube, which occurs under certain conditions and the production of secreted hydrolytic enzymes that facilitate the invasion process. And penetration by contributing to the analysis of peptide bonds that connect the plasma membrane proteins of host cells [3]. Virulence factors are a measure of the extent of pathogenicity of a pathogen, as it is not capable of causing infection unless it is virulent. These factors may be in the form of cellular structures, enzymes, or mycotoxins that facilitate the infection process and protect the pathogen from immune responses and various surrounding conditions. The virulence factors in yeasts of the *Candida* genus are summarized in the property of adhesion, which is the first step in causing infection.

## 2. RELATED WORK

*Candida* species have various potential virulence factors, such as secreted aspartyl proteinases, phospholipases, cell wall glycoproteins (adhesins), ALS gene and hyphal wall protein HWP. *Candida albicans* possesses several characteristics that facilitate its adherence to diverse targets, such as cells of other microbes, inanimate surfaces and numerous host cells [4], [5]. The development of systemic candidiasis requires the expression of many genes, including ALS1, ALS3, ECE1 and HWP1 [6]. Virulence factors are a measure of the extent of pathogenicity of a pathogen, as it is not capable of causing infection unless it is virulent. These factors may be in the form of cellular structures, enzymes, or mycotoxins that facilitate the infection process and protect the pathogen from immune responses and various surrounding conditions. The virulence factors in yeasts of the *Candida* genus are summarized in the property of adhesion, which is the first step in causing infection, specifically, the gene HWP1 is responsible for encoding a prominent protein in *C. albicans* that plays a crucial role in various processes, including the formation of the cell wall, intracellular communication and the growth of hyphae. This protein achieves these functions by forming connections with the glucans present in the cell wall [7]. In addition, HWP1 enhances the adherence of *Candida* to epithelial cells, which is the initial step in colonization and it augments the severity of systemic candidiasis [8].

### 2.1. Aim of Study

To achieve the goal, the following steps were followed:

- A. Isolating the yeasts that cause Periodontitis in patients, diagnosing them using biochemical tests.
- B. Detection of some virulence factors of yeasts and their ability to produce hemolysis, cell wall glycoproteins (adhesions), ALS gene and HWP gene.

### 3. METHODOLOGY

#### 3.1. Materials and Method

75 clinical samples were collected during the period October 2024 to January 2024 from Periodontitis patients. They were collected from Salah al-Din General Hospital and some private clinics. Samples were collected for patients with Periodontitis whose ages ranged from (5-55). The initial diagnosis and examination for follow-up examinations were conducted with the assistance of the gynecologist. Samples were collected from Periodontitis using sterile cotton swabs from the moth. Samples were kept in special sterile containers until they were transported to the laboratory to conduct the necessary tests.

#### 3.2. Laboratory Examination of Samples

##### 3.2.1. Direct Microscopic Examination

A portion of the sample taken by swab cotton was placed on a glass slide and a drop of 10% KOH potassium hydroxide solution was added to it, then it was covered with a cover slide and then passed over the flame two or three times, after which it was examined with a microscope. Under 10X power and then 40X power in order to confirm the presence of yeast.

##### 3.2.2. Macroscopic Examination

The external appearance of the colonies growing on sabroid dextrose agar (SDA) medium was examined, in terms of color, texture, odor and the shape of the colony from both the plate and diameter sides [9].

#### 3.3. Virulence Factors

##### 3.3.1. Hemolysis Test

This test was conducted [9], to detect the ability of yeasts to analyze blood, sterile sabroid dextrose agar SDA medium was used and 7% sheep blood was added to it. Part of the colony was transferred to the dish using the planning method. The dishes were incubated at a temperature of 37°C for 24 hours. The results were recorded. Based on observing the decomposition area around the colony [10].

#### 3.4. DNA Extraction

The DNA was obtained via the Gene aid kit. As per the manufacturer's instructions, 4-6 colonies of yeast were combined with 1.5 mL of sterilized 0.9% NaCl. After subjecting the micro tubes to centrifugation at a force equivalent to 1,216,000 times the acceleration due to gravity for a period of 2 minutes, the liquid fraction containing the desired compounds was collected and then washed with a solution of 2-millimolar EDTA at a pH of 8. After subjecting the micro tubes to centrifugation at a force equivalent to 5000 times the acceleration due to gravity for a period of 10 minutes, separate the liquid portion above the sediment and save the solid residue. The name drop spectrophotometer quantifies the concentration and assesses the quality of DNA by detecting absorption at 260/280 nm.

#### 3.5. Primer and the Polymerase Chain Reaction with Uniplex Units

Using a primer from Table 1, uniplex polymerase chain reaction (PCR) detected molecules.

**Table 1.** The Conditions of the Primer and the Amplification Pathogenicity Genes of Candida Albicans Pathogen

C Albicans Genes	Sequence of Primer (5' ----- 3')	PCR Amplicon Size
ALS1	GACTAGTGAACCAACAAATACCAGA	318
F	CCAGAAGAAACAGCAGGTGA	

R		
HWP1	ATGACTCCAGCTGGTTC	503
F	TAGATCAAGAATGCAGC	
R		

### 3.6. The Mixture for Polymerase Chain Reaction

The procedure used by PCR to find the *C. albicans* genes was carried out in a finished volume that is shown in Table 2.

Table 2. Reaction Volume for the PCR

Content	Volume (MI)
Master Mix	7.5
DNA template	5
Forward Primer	2.5
Reverse Primer	2.5
Nuclease Free Water	2.5
Total	20

### 3.7. Polymerase Chain Reaction thermocycler Program

The PCR settings were employed to identify the pathogenic genes of *C. albicans*, as demonstrated in Table 3. Subsequently, the presence of the PCR amplicon was verified using agarose gel electrophoresis with a concentration of 1.5% agarose.

### 3.8. Statistical Analysis

The statistical study of the data was done with a piece of software called SPSS, which stands for Statistical Program for the Social Sciences. A version of the Pearson chi-square test was used to figure out how different the groups were from each other.

Table 3. PCR Detection of the Proportion of the *C. Albicans* Pathogenicity Gene

Gene	Positive Number	Negative Number	Total
<i>C. albicans</i> ALS1	18 (72 %)	7(28 %)	25(100%)
<i>C. albicans</i> HWP1	15 (60 %)	10(40 %)	25(100%)

## 4. RESULTS AND DISCUSSION

### 4.1. Samples of Yeasts Isolated During the Study

The results of the microscopic examination of the total number of samples (75) showed that there were (55) positive samples, at a rate of 73%, while the number of negative samples was 20, at a rate of 27%. As for the results of laboratory culture after culturing the samples on sabroid dextrose agar (SDA) medium, they showed (40) of the swabs were positive, at a rate of 53%, while (35) of the swabs were negative, showing no growth, at a rate of 47%, as in Table 4. The results of the statistical analysis showed that there were no significant differences, P-Value=0.122.

Table 4. Numbers and Percentages for Direct Microscopic Examination and Laboratory Culture of Samples

Type of Examination	N.	Positive Samples	%	Negative Samples	%
Direct microscopic examination	75	55	735%	20	27%
Laboratory culture	75	40	453%	35	47%
Chi-Square=0.881 ns			P-Value=0.122		

The reason for the appearance of negative results and the difference in results is due to the similarity in symptoms between candidiasis and bacterial or viral infections, the random use of antibiotics without consulting a doctor, or the inadequacy of the sample collected. It can also be attributed to inappropriate development conditions on the agricultural medium (SAD) [11]. The increase in the prevalence of vaginal candidiasis among women is due to lack of attention to personal hygiene, lack of awareness, poor nutritional habits, wearing tight underwear for some women and lack of effective treatment [12]. Hence, clinical diagnosis alone lacks the necessary precision for accurate diagnosis. It must be complemented by other diagnostic methods, such as direct microscopic examination. This method yields more precise results compared to clinical examination, as it relies on the detection of yeast cells, fungal hyphae, or any other component of the pathogen, making it a more accurate approach [13].



Figure 1. Candida Albicans Colonies on Sabouraud Chloramphenicol Media



Figure 2. Of C. Albicans Morphology on CHROM Agar

#### 4.2. Detection of the Ability of C. Albicans on the Production of Hemolysis

The results of the study, shown in Table 5, showed that the ability of Candida to decompose blood. The yeast *C. albicans* had the ability to decompose blood at a rate of 45%, with a rate of 34 out of 75, while rate of 55%, with a rate of 41 out of 75 did not have the ability to lyse blood. The results of the statistical

analysis showed that there were significant differences,  $p$ -value=0.0006, regarding the ability of *Candida* spp. on the production of hemolysis.

**Table 5.** Detection of the Ability of *Candida* Spp. on the Production of Hemolysis

<b>Candida Spp.</b>	<b>The Total Number</b>	<b>Production of Hemolysis</b>	<b>%</b>	<b>Non Production of Hemolysis</b>	<b>%</b>
<i>C. albicans</i>	75	34	45%	41	55%
Chi-Square=19.10**			P-Value=0.0006		

Our results agreed with Jacob and D'Souza (2014), with regard to the species *C. albicans* produce hemolysis [14]. As well as our results agreed with the results of the researcher who showed that *C. albicans* produce hemolysis while *C. parapsilosis* does not produce hemolysis [15].

*Albicans* was subjected to gel electrophoresis on a 1.5% agarose gel at a voltage gradient of 7 volts per centimeter for a duration of 30 minutes. Lane 1 has a DNA fragment that is 1000 base pairs long.



**Figure 3.** The PCR Amplicon of ALS1 Genes (318 Base Pairs) Within C

With a length of 503 base pairs, was analyzed using gel electrophoresis. The electrophoresis was conducted on a 1.5% agarose gel with a voltage gradient of 7 volts per centimeter for a period of 30 minutes. Lane 1 has a DNA fragment with a length of 1000 base pairs.



**Figure 4.** The PCR Amplification, Consisting of HWP1 Genes

Periodontal disease is a complex inflammatory illness that impacts the tissues that provide support to the tooth and is linked to other inflammatory disorders in the body. The distinction between *C. albicans* and other *Candida* spp. was established by analyzing their morphological characteristics, such as colony shape, size, color and borders [16], [17]. A smooth and creamy white appearance can be observed on the *C. albicans* colony that is grown on the Sabouraud medium [18]. A higher prevalence of *Candida albicans* was detected in our analysis when compared to the rates reported [19] in Iraq. They discovered that the rates

of *Candida albicans* isolated from oral infections were 8 (7.4%) out of a total sample size of 108. Our investigation demonstrated that the prevalence of *Candida albicans* was higher.

#### 4.3. Discussion

There was a striking similarity between the molecular discovery of the ALS1 gene and the research carried out [20], in which they effectively isolated the ALS1 gene in 12 out of 25 samples. Unlike the findings of [21] in their study conducted in Iraq, the present investigation produced contrasting results. More precisely, it was noted that none of the *C. albicans* strains obtained from oral and vaginal infections exhibited a positive result for ALS1 [22], [23]. Moreover, scientific research has demonstrated that the virulence factors HWP1 and SAP4 play a critical role in the formation of biofilms, which can harm the host's tissues and promote the growth of hyphae [24].

Reports indicate that the HWP1 gene facilitates the attachment of *C. albicans* to epithelial cells via covalent bonding. Prior studies have demonstrated that the interaction between the ALS1/3 and HWP1 surface protein is essential for the onset and advancement of hemolysis production. Previous research has proposed that the ALS1, ALS3 and HWP1 genes have complementary roles in the synthesis of hemolysis.

## 5. CONCLUSION

1. Isolation of *C. albicans* species ranked first among the other isolated species from Periodontitis patients.
2. *C. albicans* was shown to be capable of producing hemolysis.
3. The majority of *C. albicans* isolates exhibited expression of the Als1 and HWP1 virulence genes, indicating that the ALS1 and HWP1 proteins had a significant impact on the development of infection.

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#### Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Humam Saadi Hussein	✓	✓	✓	✓		✓		✓	✓	✓	✓			✓
Mokhalad Sabah Khalaf Al-Doori		✓	✓		✓		✓		✓		✓		✓	
Noor Adnan Abdullah	✓		✓	✓		✓		✓		✓		✓		✓
Batol Imran Dheeb	✓	✓		✓	✓	✓	✓		✓		✓	✓	✓	

C : Conceptualization

M : Methodology

So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

R : Resources

D : Data Curation

O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

#### Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this paper.

#### Informed Consent

All participants were informed about the purpose of the study and their voluntary consent was obtained prior to data collection.

### Ethical Approval

The study was conducted in compliance with the ethical principles outlined in the Declaration of Helsinki and approved by the relevant institutional authorities.

### Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.



### REFERENCES



- [1] N. Buduneli and D. F. Kinane, 'Host-derived diagnostic markers related to soft tissue destruction and bone degradation in periodontitis', *J Clin Periodontol*, vol. 38, pp. 85-105, 2011. [doi.org/10.1111/j.1600-051X.2010.01670.x](https://doi.org/10.1111/j.1600-051X.2010.01670.x)
- [2] A. D. Mccall, 'Candida albicans biofilm development is governed by cooperative attachment and adhesion maintenance proteins', *NPJ biofilms and microbiomes*, vol. 5, 2019. [doi.org/10.1038/s41522-019-0094-5](https://doi.org/10.1038/s41522-019-0094-5)
- [3] S. Silva, 'Adherence and biofilm formation of non-Candida albicans Candida species', *Trends in microbiology*, vol. 19, pp. 241-247, 2011. [doi.org/10.1016/j.tim.2011.02.003](https://doi.org/10.1016/j.tim.2011.02.003)
- [4] M. Roudbary, S. Roudbarmohammadi, B. Bakhshian and Z. Farhadi, 'Relation of ALS 1 and ALS 3 genes and fluconazole resistance in Candida albicans isolated from vaginal candidacies', *Int J Mol Clin Microbiol*, vol. 2, pp. 170-174, 2012.
- [5] M. C. Garcia, J. T. Lee, C. B. Ramsook, D. Alsteens, Y. F. Dufrêne and P. N. Lipke, 'A role for amyloid in cell aggregation and biofilm formation', *PLoS One*, vol. 6, 2011. [doi.org/10.1371/journal.pone.0017632](https://doi.org/10.1371/journal.pone.0017632)
- [6] A. Islam, Characterizing Genes of Candida albicans Involved in Invasiveness, Mating and Genotoxic Stress Response. Doctoral Dissertation. Concordia University, 2018.
- [7] A. V. De Melo, D. L. Zuzza-Alves, W. P. Da Silva-Rocha, L. De Souza, E. C. Francisco and A. S. De Azevedo Melo, 'Virulence factors of Candida spp. obtained from blood cultures of patients with candidemia attended at tertiary hospitals in Northeast Brazil', *J Mycol Med*, vol. 29, pp. 132-139, 2019. [doi.org/10.1016/j.mycmed.2019.02.002](https://doi.org/10.1016/j.mycmed.2019.02.002)
- [8] K. Pakshir, S. Sheykhi, K. Zomorodian, H. Nouraei, Z. Shahrabadi and F. Figueras, 'Evaluation of biofilm formation in the homozygous and heterozygous strains of vaginal Candida albicans isolates', *Curr Med Mycol*, vol. 5, pp. 45-49, 2000.
- [9] M. A. Jabber, Cytokines profiles among immunocompromised patients with fungal infections. 2015.
- [10] A. Arastehfar et al., Incidence and spectrum of yeast species isolated from the oral cavity of Iranian patient. 2018. [doi.org/10.1080/20002297.2019.1601061](https://doi.org/10.1080/20002297.2019.1601061)
- [11] Mikolajczyk, K.; Zimmer M.; Tomialowicz M.; Fuchs T. 2006. *Mikologia Lekarska*; 13 (3): 175-179.
- [12] A.-A. No, A study of Taxonomy and Epidemiology of pulmonary mycotic infections in Al-Qadisiya province 2005.
- [13] U. Jacobo et al., 'The efficacy of organo-selenium conjugated cellulose polymer dressing to inhibit Candida albicans biofilm formation', *Journal of Microbiological Methods*, vol. 202, 2022. [doi.org/10.1016/j.mimet.2022.106598](https://doi.org/10.1016/j.mimet.2022.106598)
- [14] L. L. Hacıoğlu, S. Scherer, A. R. Shatzman and G. P. Livi, 'Candida albicans ALS1: domains related to Saccharomyces cerevisiae sexual agglutinin separated by a repeating motif', *Mol. Microbiol*, vol. 15, pp. 39-54, 2019. [doi.org/10.1111/j.1365-2958.1995.tb02219.x](https://doi.org/10.1111/j.1365-2958.1995.tb02219.x)
- [15] I. Melek, A. Mustafa, Z. Burçin, O. E. Nizami and D. Vicdan, 'Investigations of ALS1 and HWP1 genes in clinical isolates of Candida albicans', *Turk J Med Sci*, vol. 43, pp. 125-130, 2013.
- [16] S. H. Ardehali, T. Azimi, F. Fallah, N. Aghamohammadi, S. Alimehrand A. M. Karimi, 'Molecular detection of ALS1, ALS3, HWP1 and SAP4 genes in Candida genus isolated from hospitalized patients in intensive care unit, Tehran, Iran', *Cell Mol Biol*, vol. 65, pp. 15-22, 2019. [doi.org/10.14715/cmb/2019.65.4.3](https://doi.org/10.14715/cmb/2019.65.4.3)

- [17] P. S. Bhavan, R. Rajkumar, S. Radhakrishnan, C. Seenivasanand S. Kannan, 'Culture and identification of *Candida albicans* from vaginal ulcer and separation of enolase on SDS-PAGE', *Int J Biol*, vol. 2, 2010. [doi.org/10.5539/ijb.v2n1p84](https://doi.org/10.5539/ijb.v2n1p84)
- [18] J. C. Sardi, C. Duque, J. F. Hoflingand R. B. Gonçalves, 'Genetic and phenotypic evaluation of *Candida albicans* strains isolated from subgingival biofilm of diabetic patients with chronic periodontitis', *Sabouraudia*, vol. 50, pp. 467-475, 2012. [doi.org/10.3109/13693786.2011.633233](https://doi.org/10.3109/13693786.2011.633233)
- [19] A. S. Ali, A. A. Al-Attraqhchiand A.-A. Sd, 'Molecular detection of ALS1 virulence gene of *Candida albicans* isolated from groups of Iraqi patients', *J Fac Med Baghdad*, vol. 57, pp. 79-83, 2015. [doi.org/10.32007/med.1936/jfacmedbagdad.v57i1.18](https://doi.org/10.32007/med.1936/jfacmedbagdad.v57i1.18)
- [20] N. A. Mohammed, H. A. Ajahand N. J. Abdulbaqi, 'Detection the prevalence of adhesins and extracellular hydrolytic enzymes genes in *Candida albicans* biofilm formation', *Iraqi J Sci*, vol. 58, pp. 988-1000, 2017. [doi.org/10.24996/ij.s.2017.58.2C.3](https://doi.org/10.24996/ij.s.2017.58.2C.3)
- [21] C. Murciano, D. L. Moyes, M. Runglall, P. Tobouti, A. Islamand L. L. Hoyer, 'Evaluation of the role of *Candida albicans* agglutinin-like sequence (Als) proteins in human oral epithelial cell interactions', *PLoS One*, vol. 7, 2012. [doi.org/10.1371/journal.pone.0033362](https://doi.org/10.1371/journal.pone.0033362)
- [22] B. Moeckli, Influence of CgPDR1 hyperactivity on the expression of EPA-family adhesins in *Candida glabrata* (Doctoral dissertation) 2014.
- [23] A. Khodavandi, F. Alizadeh, N. S. Harmal, S. M. Sidik, F. Othmanand Z. Sekawi, 'Expression analysis of SIR2 and SAPs1-4 gene expression in *Candida albicans* treated with allicin compared to fluconazole', *Trop Biomed*, vol. 28, pp. 589-598, 2011.
- [24] Sundstrom P. Adhesion in *Candida* spp. *Cell Microbiol* 2002; 4:461-9. [doi.org/10.1046/j.1462-5822.2002.00206.x](https://doi.org/10.1046/j.1462-5822.2002.00206.x)

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