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Incidence of oral fungal infections in Gharyan area

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DEDICATION

I dedicate this work to my father and mother, whose prayers support me in every step I take. To my small family, my husband and lovely kids, you have always been my support and my help throughout my life.

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATION

ABBREVIATION	DEFINITION
AD	Alzheimer’s Disease
AIDS	Acquired Immunodeficiency Syndrome
Am B	Amphotericin B
ANOVA	Analysis Of Variance
COVID-19	Coronavirus Disease 2019
CRP	C-Reactive Protein
HbA1c	Hemoglobin A1C
HIV	Human Immune Virus
HSD	Honestly Significant Difference
IFIs	Invasive Fungal Infections
MAFLD	Metabolic dysfunction-Associated Fatty Liver Disease
MFLs	Minimal Fungal Levels
MHA	Muller Hinton Agar
MICs	Minimum Inhibitory Concentrations
NCA	Non *Candida albicans*
NETs	Neutrophil Extracellular Traps
NGS	Next-Generation Sequencing
OFI	Oral Fungal Infection
OLP	Oral Lichen Planus
OPC	Oropharyngeal Candidiasis
PCR	Polymerase Chain Reaction
Ph	Potential of hydrogen
PLHIV	People Living with HIV
SARS-CoV-2	Sever Acute Respiratory Syndrome Coronavirus 2
SD	Standard Deviation
SDA	Sabouraud Dextrose Agar
SAPs	Secreted aspartyl proteinases
spp.	Species
SPSS	Statistical Packages for Social Sciences
US	United State
UTT	Universal Test and Treat
VLBW	Very Low Birth Weight
WHO	World Health Organization

ABSTRACT

Oral fungal infections have become frequently happened, especially among immunocompromised patients, this thesis aimed to study incidence and prevalence of oral *Candida* infection in Gharyan area. A total of 140 oral samples were collected using sterile cotton swabs from patients. Samples were cultured on Sabouraud Dextrose Agar, *Candida* spp. were cultivated and identified by using chrome-agar into different species, and the incidence of oral candidiasis was 47.9% (67/140). Most predominant species was *C. albicans* (85%), *C. glabrata* (6%), while *C. krusei*, *C. parapsilosis*, *C. tropicalis* (3% for each one). Statistical analysis showed that most variables resulted in no statistical significance, regarding the occurrence of infection(age, gender, dental procedure, diabetes, hypertension, smoking, cancer, and oral hygiene), except for pregnancy cases. All Isolates of *Candida* spp. are susceptible to experimental antibiotics which was Amphotericin B, Miconazole, and Nystatin, with different degrees of sensitivity among *Candida* spp. On other hand, regarding the effectiveness of clove extract, whether aqueous or alcoholic, it showed effectiveness that even surpassed commonly used antibiotics by varying degrees with each *Candida* spp. The study indicates that clove extract have strong and promising effect on *Candida* isolates.

Key words: *Candida albicans, oral fungal infection, Gharyan, clove extract*.

1-INTRODUCTION

The microbiome, a complex collection of microbes that live in our bodies, has coexisted with humans for a very long time and developed symbiotic connections that are crucial to our health. These microbes, which can be commensal, symbiotic, or pathogenic, provide a number of advantages, including avoiding the colonization of pathogens, supplying antioxidants, reducing inflammation, and preserving the health of the digestive system (Kilian *et al*., 2016).With around more than 700 bacterial species, fungi, viruses, and protozoa, the mouth cavity is the second most diverse microbial environment after the gut. With its numerous surfaces on teeth and soft tissues, this special niche harbors a variety of microbial communities that are important to the human body's metabolism, immune system, and physiology (Deo and Deshmukh., 2019). This thesis focused on the mycological world within the human oral cavity, considering the oral environment warm, humid, and nutrient rich provides an ideal habitat for various microorganisms. Fungal colonization begins shortly after birth and this process progress with age (Azevedo *et al.,* 2020). The fungal component of the human microbial ecosystem, or mycobiome, is vital for maintaining homeostasis. Its composition is influenced by endogenous and external factors such as diet, age, sex, and the use of antibiotics or antifungals, the oral cavity, respiratory tract, gastrointestinal tract, urogenital tract, and skin are all homes to the human mycobiome (Belvoncikova *et al*., 2022). The predominant fungal species in the oral cavity is *Candida* species, particularly *Candida albicans*, followed by *Cladosporium*, *Aureobasidium*, and *Saccharomycetes*, with *Aspergillus*, *Fusarium*, and *Cryptococcus* being pathogenic species (Ghannoum *et al*., 2010).

Oral fungal infections, also referred to as oral candidiasis, are the focus of this study. The oral mucosa is the main target of this opportunistic fungal disease. Additionally, under normal circumstances, *Candida* spp. can persist as a normal oral flora without causing illness; nevertheless, when the oral environment changes, opportunistic infections occur, resulting in overgrowth and clinical symptoms. Poor oral hygiene, malnourishment, diets high in carbohydrates, immunocompromised conditions, diabetes mellitus, pregnancy, xerostomia, usage of immunosuppressive drugs, and antibiotic abuse are among the risk factors for oral candidiasis (Lu., 2021). Although thrush can sometimes affect other body areas like skin, vagina, and nails, or in extreme circumstances, it can spread throughout the body; fungal infections usually appear in the oral maxillofacial region. Fungal infections of the oral mucosa are frequently diagnostic in clinical settings, either as primary infections or indications of systemic dissemination. A physical examination is essential for diagnosis, particularly in patients with weakened immune systems. Erythema, ulceration, burning, pseudomembranous white plaques, discomfort, changed taste, and pain are common symptoms of oral candidiasis that can make eating challenging. Samples from the infection site are required for confirmation because clinical diagnosis alone is frequently insufficient. Direct microscopic inspection can help with diagnosis, although it is not conclusive. These techniques work in tandem, with histopathology analysis offering a more reliable diagnosis. Isolates must be cultivated on selective media before being detected using chromogenic agar for a precise identification (Bose and Brizuela., 2024).

The limited number of antifungal drugs compared to antibacterial treatments is due to the biological similarities between fungi and their eukaryotic organisms, making it difficult to describe safe and broad-spectrum agents. Therefore, treatment efficacy, tolerability, and resistance remain significant constraints in managing fungal infections. Current treatments for invasive mycoses include Amphotericin B(Am B), Miconazole, Nystatin, and Itraconazole, with newer additions like Caspofungin, Micafungin, Ravuconazole, Posaconazole, and Voriconazole expanding the therapeutic arsenal(Carrillo-Munoz *et al*., 2006). Because of its limited gastrointestinal absorption and absence of reabsorption by skin or mucosa, Nystatin is a good and easily compounded drug for candidiasis. It is specifically intended for oral delivery. It needs to be stored in a cool, dark place because it becomes unstable in hot, humid, and light environments (Sklenár *et al*., 2013). For serious fungal infections, Amphotericin B (Am B), a conventional polyene macrolide, is essential. Although binding plasma membrane ergosterol is associated to its lethality, new research indicates that its fungicidal activity also includes vacuole disruption. However, its therapeutic usage was limited by the emergence of drug-resistant strains and side effects (Ogita *et al*., 2012).

Essential oils and botanical extracts have gained popularity as strong antifungal substitutes in recent years. Given the drawbacks of traditional antifungal medications, including side effects and resistance development, these natural substances present encouraging therapy options. The effectiveness of several plant-derived chemicals against fungal infections, particularly those that cause oral candidiasis, is still being investigated. (Kaur *et al.,* 2021).

AIMS OF THE STUDY

This study aimed for several goals to study incidence and prevalence of oral fungal infections in Gharyan area:

1. Study the prevalence of oral fungal infection in Gharyan area.
2. Isolation and identification of pathogenic and opportunistic fungal species.
3. Study of risk factors that increase the incidence of infection.
4. Study the effect of some therapeutic antifungals, experiment the effect of Clove plant extract and its oil on fungal isolates.

2-LITERATURE REVIEWS

In such a context, collecting and evaluating the epidemiological and clinical data on oral fungal infections that are currently available from regional and population specific research as well as from the worldwide literature becomes crucial in such a setting. Key trends in oral fungal pathogen diversity, virulence factors, risk factors, diagnostic problems, and changing treatment modalities are highlighted in this chapter by synthesizing research findings from throughout the globe and from similar habitats. Particular attention is paid to analyzing these findings in the context of Gharyan healthcare reality, providing a basis for creating prevention and treatment plans that are more efficient and locally relevant.

Study conducted by **(**Ali *et al*., 2021**)** aimed to identify the *Candida* species responsible for oral thrush in infants in El-Zintan, Libya, and to investigate the relationship between infection rates, age, and feeding practices. The researchers collected oral swabs from 102 infants ranging in age from one day to one year. The samples were cultured on Sabouraud Dextrose Agar (SDA), and *Candida* species were identified using a combination of methods, including CHROM-agar *Candida*, microscopic examination (Gram stain, germ tube test, and chlamydospore formation), and sugar fermentation tests. The study found an overall *Candida* colonization rate of 69.6% among the infants. *Candida albicans* was the most frequently isolated species, accounting for 40.84% of cases. This was followed by *C. tropicalis* (21.21%), *C. glabrata* (18.30%), *C. krusei* (9.85%), *C. dubliniensis* (8.45%), and *C. parapsilosis* (1.40%). The highest incidence of infection (84.8%) was observed in the youngest age group (1-2 months old), with the rate progressively decreasing as age increased. The study demonstrated a significant association between feeding type and infection. Infants who were exclusively breastfed had the lowest rate of infection (61%), compared to those on mixed (80%) or artificial (65%) feeding. The authors concluded that *C. albicans* is the primary causative agent of oral thrush in infants in the Zintan region. Crucially, the study provides strong evidence that breastfeeding has a protective effect against *Candida* colonization in the oral cavity of infants. This local study is particularly relevant as it provides a baseline epidemiological profile of oral candidiasis in infants from a neighboring Libyan city, offering a valuable comparative context for research conducted in the Gharyan area.

Study conducted in Libya by (Ramadan *et al*., 2025) investigated the incidence of fungal species among Libyan individuals. Their cross-sectional study collected oral swabs from a representative sample of the Libyan population to identify *Candida* species and other fungi colonizing the oral cavity. The results indicated that *Candida albicans* was the most common species, consistent with global trends, followed by non-*albicans* species such as *Candida glabrata* and *Candida tropicalis*. The overall oral *Candida* spp. carriage rate was notably high, reflecting significant fungal colonization within the population. The study identified key risk factors influencing carriage rates, including poor oral hygiene, smoking, chronic diseases such as diabetes, and immunosuppressive conditions. It also noted variations in fungal prevalence linked to age and but not linked to gender. These findings provide crucial baseline data for understanding the oral fungal ecology in Libya, including the Gharyan area. The high prevalence of *Candida* spp. carriage highlights the need for focused public health strategies and clinical interventions to manage oral fungal infections, especially in vulnerable groups. This study supports the relevance of local epidemiological data in tailoring prevention and treatment protocols for oral candidiasis in Libya.

Study by (Xiao *et al*., 2019). Examined the relationship between *Candida* spp. carriage and dental health in pregnant women from low income backgrounds in the US. 82 participants were enrolled in their study, including 34 non- pregnant and 48 pregnant women. Researchers performed a thorough oral examination in addition to gathering demographic data, medical history, and oral hygiene status. *Streptococcus mutans* and *Candida* species were detected in saliva, plaque, and swab samples by both independent and culture-dependent techniques. About 79.1% of pregnant women had one or more untreated carious teeth compared to 47.1% of not pregnant women. The average number of carious teeth was 3.9 among pregnant and 3.1 among not pregnant women. Difference not demonstrated to be statistically significant. Severity of the caries was associated with race, plaque scores, and salivary levels of *Candida albicans*. *C. albicans* was the most common *Candida* spp. type, found in 56% of saliva and 40% of plaque samples of pregnant women. Hypertension, numbers of decayed teeth, and salivary *S. mutans* levels were also related to higher oral carriage of *Candida* spp. The study revealed a high prevalence of untreated dental caries and oral *Candida* spp. colonization in socioeconomically disadvantaged pregnant women. The results highlight the significance of intensified prenatal oral health care to treat tooth decay and reduce *Candida* spp. colonization among this population(Xiao *et al*., 2019).

Buranarom *et al*., (2020) studied the relationship between Hyposalivation and its effect on oral health and it is prone to *Candida* spp. colonization in old aged individuals. According to the study, the likelihood of oral *Candida* spp. colonization rose when saliva flow decreased, a condition known as hyposalivation. On the other hand, older individuals poor dental health further increased the likelihood of fungal colonization. According to the study, saliva is essential for regulating fungal growth and preserving the equilibrium of oral microbes. These results highlight the importance of hyposalivation as a risk factor for oral fungal infections, particularly in susceptible groups. This insight is relevant for research on oral fungal infection incidence in the Gharyan, as similar risk factors may affect local elderly populations.

To evaluate oral *Candida* spp. carriage in smokers and tobacco users, (Alaizari and Al-Anazi., 2020) carried out a comprehensive review and meta-analysis. To ascertain the connection between tobacco use and the incidence of *Candida* species in the oral cavity, the study aggregated data from several observational studies. According to the findings, oral *Candida* spp. colonization rates were considerably greater in smokers and tobacco users than in nonsmokers. Tobacco induced alterations in the oral environment, including decreased salivary flow, altered mucosal immunology, and increased epithelium keratinization, that reason for the increased carriage. These changes all support the growth and persistence of fungi. Although non-*Candida albicans* species (NCA) were also commonly isolated, *C. albicans* was the most common species found. The review emphasized that tobacco use is a major risk factor for oral fungal colonization and infection, contributing to higher incidence rates of oral candidiasis in this population. These findings have direct implications for oral health strategies aimed at reducing fungal infection risks, especially in communities with high tobacco consumption.

To find the relation (Martorano-Fernandes *et al*., 2020), through a systematic review and meta-analysis, examined the relationship between oral candidiasis and denture stomatitis among diabetic patients, a group well known for their compromised immunity. Their findings highlighted that diabetic denture wearers were significantly more susceptible to *Candida* spp. infections. Contributing factors included hyperglycemia, xerostomia, impaired neutrophil function, and the biofilm-retaining nature of dentures. The study emphasized the critical role of glycemic control and proper denture hygiene. These findings carry important implications for Gharyan, where diabetes is prevalent, and access to dental care is intermittent, reinforcing the need for integrated public health campaigns focusing on diabetic oral care, fungal screening, and prosthetic maintenance.

Al-Amad *et al*., (2021) conducted a cross-sectional study in the United Arab Emirates to investigate the people carriage oral *Candida* spp. and its relationship with dental carious lesions in adults without any symptoms. The study revealed that a significant proportion of healthy adults harbored *Candida* species in their oral cavity without showing symptoms. Furthermore, the presence of oral *Candida* spp. was associated with an increased risk of dental caries. The research emphasized that oral *Candida* spp. colonization can serve as a reservoir for infection and may contribute to oral health complications even in the absence of overt symptoms. These findings underscore the importance of considering asymptomatic oral fungal carriage when assessing the risk and incidence of oral fungal infections, which is relevant for studies investigating oral fungal infections in the Gharyan area.

In their response to previous reflections on fungal infections in the context of the COVID-19 pandemic (Santosh *et al*., 2021) again emphasized the greater precedence of early diagnosis and multidisciplinary management of oral mycotic infections, particularly in SARS-CoV-2 infection. They emphasized that interaction between COVID-19-immunosuppression, increased hospitalization, and widespread corticosteroid treatment significantly increased susceptibility to opportunistic fungal pathogens such as *Candida albicans* and Mucor species. Authors urged practitioners to be extremely wary of oral mycoses in COVID-19 patients, especially those who present with painful ulcers, pseudomembranous plaques, or aseptic mucosal inflammation of unclear origin. They also cautioned that COVID-19-acquired mycoses may not only become more virulent but also more challenging to treat by virtue of concomitant immune impairment and reduced availability of antifungal diagnostic testing in under siege healthcare systems. This is particularly pertinent to medical facilities such as Gharyan, where post viral opportunistic infections might worsen due to a lack of health infrastructure and delayed diagnosis. (Santosh *et al*.,2021) justification for including patient counseling, common oral fungal evaluation, and cautious antifungal prescribing in COVID-19 clinical treatment instructions highlights the significance of systemic readiness for combating such secondary infections during current and upcoming pandemics.

A comparative study carried out by (Shaimaa *et al*., 2021) to investigate the risk of oral fungal infection in pregnant and non pregnant women. The research examined whether pregnancy related physiological changes contribute to higher rates of *Candida* spp. colonization. Two groups were studied pregnant women and age matched nonpregnant controls. Oral swabs collected, then cultured, and analyzed for the presence of *Candida* species. Results showed that *Candida* spp. colonization was significantly higher in pregnant women, especially during the second and third trimesters. The increased prevalence was linked to hormonal fluctuations, changes in salivary pH and composition, and altered immune responses during pregnancy. *Candida albicans* was the dominant species, but non-*albicans* species, including *C. glabrata* and *C. tropicalis*, identified also. The study concluded that pregnancy is a risk factor for increased *Candida* spp. colonization, which can lead to oral candidiasis if not addressed. The authors suggested regular oral health checkups during pregnancy, early identification of fungal presence, and preventive strategies to reduce the risk of infection(Shaimaa *et al*., 2021).

While in a retrospective study conducted by (Molkenthin *et al*., 2021) focused on the prevalence of *Candida dubliniensis* in oral lichen planus (OLP) patients and its association with corticosteroid therapy. Their retrospective study revealed that immunocompromised individuals, including those on topical steroids were more frequently colonized by *C. dubliniensis*, non-*Candida albicans* (NCA) species with resistance traits. This finding indicates a shift from *C. albicans* dominance and urges the adoption of species-specific diagnostics and tailored antifungal strategies in OLP treatment. Such diagnostic improvements are crucial to enhancing therapeutic results in environments like Gharyan, where experimental treatments are the norm.

Rezazadeh *et al*., (2022) examined *Candida* spp. colonization in oral lichen planus (OLP) lesions with varying degrees of dysplasia. The study found higher colonization rates in dysplastic lesions, with isolates including *C. albicans*, *C. glabrata*, and *C. tropicalis*. Since epithelial dysplasia carries malignant potential, chronic colonization by virulent fungal species may influence disease progression. The authors advocate for mycological screening in dysplastic OLP to ensure early detection and treatment, which could prevent progression to oral malignancy. For health centers in Gharyan, integrating routine fungal assessments in oral pathology protocols could fill diagnostic gaps and enhance preventive care.

For examination the incidence and prevalence of *Candida* species from patients in Slovakia hospital, and susceptibility of oral *Candida* spp. to different antifungal study conducted by (Černáková *et al*., 2022) aimed to identify the distribution of *Candida* species in oral samples and assess their resistance patterns to guide effective treatment. The results showed that *Candida albicans* was the most frequently isolated species, followed by non-*albicans* species such as, *C. tropicalis*, *C. glabrata*, and *C. krusei*. The occurrence of non-*Candida albicans* was significant, indicating a shift in the epidemiology of oral candidiasis toward species with higher antifungal resistance potential. Antifungal susceptibility testing revealed that most *C. albicans* isolates remained susceptible to commonly used azoles like Fluconazole, although some resistance was detected. Non-*albicans* species exhibited higher resistance rates, particularly against itraconazole and Fluconazole. Echinocandins, such as Caspofungin, generally maintained good activity against most isolates. The study concluded that monitoring species distribution and resistance profiles is essential for selecting effective antifungal therapies. The increasing prevalence of resistant non-*Candida albicans* underscores the need for precise laboratory identification and susceptibility testing in hospital settings to reduce treatment failures and improve patient care.

Expanding upon oral fungal infections in immunologically vulnerable groups, (Rodriguez-Archilla and Fernandez-Torralbo., 2022). Conducted a meta-analysis comparing *Candida* spp. colonization between oral lichen planus (OLP) patients and healthy individuals. Their results confirmed a significantly higher rate of *Candida* spp. colonization in OLP patients, especially those undergoing corticosteroid therapies. Though *Candida albicans* was predominant, non-*Candida albicans* (NCA) species like *C. glabrata* and *C. tropicalis* were also prevalent. These findings underscored the importance of species-level diagnosis and personalized antifungal management. Given that corticosteroids can promote fungal overgrowth, routine mycological screening in OLP patients is essential especially in healthcare environments like Gharyan, where indiscriminate corticosteroid use and lack of advanced diagnostics may elevate the risk of undetected fungal colonization.

(Tripathi *et al*., 2022) who demonstrated that elevated iron levels significantly enhance *C. albicans* colonization, biofilm formation, and virulence, explored environmental and nutritional influences. Iron overload also impairs immune clearance and supports fungal dissemination to the gastrointestinal tract. These findings underline the relevance of systemic nutrition in fungal pathogenesis. In Gharyan area, where dietary imbalances and iron-deficiency or overload states may be common due to nutritional gaps, public health strategies that address iron regulation may help mitigate oral fungal disease burden.

Pinto-Almazán *et al*., (2022) conducted a cross-sectional investigation on asymptomatic preschoolers in Mexico and discovered a significant correlation between greater frequencies of *Candida albicans* colonization and malnutrition. Children with inadequate nutrition had fungal reservoirs that could lead to disease in the future, even in the absence of clinical symptoms. This conclusion is particularly relevant in Gharyan area, where unrecognized fungal carriage may be facilitated by pediatric malnutrition and inadequate access to treatment. Long-term infection risks may be decreased by incorporating nutritional review and oral fungal screening into school health programs.

Preventative and therapeutic strategies for oral fungal infections have advanced markedly, particularly with respect to vulnerable and high-risk populations. A prime example is the study by(Al-Matary *et al*., 2022), who conducted a systematic review and meta-analysis assessing oral Nystatin prophylaxis in very low birth weight (VLBW) neonates. Their findings demonstrated that early prophylactic use of Nystatin significantly reduced fungal colonization and the incidence of invasive fungal infections in these infants. Given the immunological immaturity and clinical fragility of this group, the researchers stressed early antifungal intervention as a vital preventative measure. This strategy is highly applicable in Gharyan, where neonatal care infrastructure is under developed and resource constraints elevate the need for affordable and effective interventions. Implementing cost effective, evidence based treatments like Nystatin could markedly enhance neonatal health outcomes.

In order, to further characterize immunocompromised populations, (Al-Qadami *et al*., 2022) looked at the relationship between the mouth gut microbiome axis and the causation of oral mucositis in cancer patients following chemotherapy and radiation therapy. The study found unmistakable evidence that the pathophysiology of oral mucositis, which includes ulceration, pain, and heightened susceptibility to secondary infections like candidiasis, is significantly influenced by the dysbiosis of the oral and gut microbial communities. The authors pointed out that not just the oral and the gut microbiota are disrupted by cancer therapy but both of them play pivotal roles in mucosal immunity and inflammation as well. Their article detailed how commensal loss and opportunistic overgrowth by pathogens like *Candida albicans* enhance mucosal barrier impairment, prolong healing, and create risks of infection. This has therapeutic importance in regions like Gharyan, where advanced cancer management in the form of microbiome based diagnosis or supportive oral therapy may be unavailable. The research also added credibility to the application of microbiome altering treatments like probiotics or fecal microbiota transplantation as a potential adjunctive treatment for mucositis control and prevention of fungal infection in oncology patients. These findings also point to the significance of incorporating oral health monitoring and fungal hazard management into oncology protocols in low resource environments(Al- Qadami *et al*., 2022).

Niu *et al*., (2023) conducted a cross-sectional investigation into oral and gut fungal dysbiosis in patients with metabolic dysfunction-associated fatty liver disease (MAFLD). Their analysis revealed a markedly elevated fungal burden in this population, with *C. albicans* dominating both oral and intestinal niches. This over representation of *C. albicans* was positively correlated with biomarkers of systemic inflammation, including elevated C-reactive protein (CRP) and pro-inflammatory cytokines, and was also associated with more severe hepatic steatosis and fibrosis scores. The authors suggested that fungal dysbiosis might play a bidirectional role both reflecting underlying metabolic disturbance and actively contributing to disease progression through translocation of fungal antigens and metabolites that exacerbate systemic inflammation. For contexts such as Gharyan, where metabolic syndromes and non-communicable diseases are increasingly prevalent, these findings strengthen the case for integrating oral fungal assessment into chronic disease management frameworks. Such integration could enable early identification of at risk individuals and the implementation of targeted interventions to reduce systemic inflammatory load.

To highlight population and age-specific variations, (Alves *et al*.,2023) conducted a cross regional comparative study involving participants from Eastern Europe and South America to investigate the biofilm forming capabilities of *Candida* species. While *C. albicans* remained the most frequently isolated species, the study also documented substantial biofilm production among non- *Candida albicans* (NCA) species, including *C. glabrata* and *C. tropicalis*. Notably, the biofilms formed by NCA species exhibited structural heterogeneity and demonstrated comparable resistance profiles to those of *C. albicans*, indicating their emerging clinical relevance. A significant observation from the study was that adults developed more complex, multilayered and mature biofilm architectures than children did. The authors attributed these differences to age-associated factors such as diminished immune responsiveness, reduced salivary flow, variations in oral hygiene practices, and shifts in the oral microbiota composition over time. Furthermore, antifungal susceptibility testing revealed demographic linked variability, with certain regional isolates displaying reduced susceptibility to azole class drugs. This finding underscores the importance of generating localized epidemiological and susceptibility data to guide targeted antifungal therapy, as resistance trends may differ significantly across geographic and demographic groups (Alves *et al*., 2023).

Adding to this understanding, (Alqahtani and Alabeedi., 2023) performed a meta-analysis examining the relationship between corticosteroid therapy and secondary *Candida* spp. infection in patients with oral lichen planus (OLP). Their findings demonstrated a statistically significant association between corticosteroid use both topical and systemic and the onset of oral candidiasis. This presents a clinical paradox: corticosteroids remain the first-line treatment for OLP due to their potent anti-inflammatory properties, yet their immunosuppressive effects facilitate opportunistic fungal overgrowth. The review detailed how corticosteroids can impair mucosal immunity by reducing epithelial barrier function, suppressing neutrophil activity, and altering the local microbiome, all of which create a favorable environment for *Candida* spp. colonization and infection. The authors emphasized the necessity of judicious corticosteroid prescribing, the integration of antifungal prophylaxis when indicated, and the implementation of routine oral microbial surveillance during treatment. These recommendations hold particular significance for Gharyan area where unregulated access to corticosteroids and self-medication practices may increase the risk of undiagnosed and untreated secondary fungal infections.

Jafarzadeh *et al*., (2023) documented a paradigm case report of oropharyngeal *Candida glabrata* infection in a patient having cancer in its mouth which was squamous cell carcinoma following COVID-19. This study highlighting the multi factor susceptibilities that converge on such presentation syndromes. The patient recovered from SARS-CoV-2 infection recently and was undergoing cancer therapy, which further exacerbated elevated immunosuppression and created succulent environments for opportunistic overgrowth of fungi. The article emphasized how corticosteroid therapy, cytotoxic therapy, and post COVID-19 immune dysregulation alter the oral microbiota to allow colonization by NCA species including *C. glabrata* that are prone to be resistant to first line antifungals like fluconazole. The authors were emphasizing *C. glabrata* diagnostic difficulty and therapeutic resistance and the need for species-specific identification and susceptibility testing for optimal treatment. This is a clinical illustration of the synergy of co-occurring risk factors like viral infection, malignancy, and immunosuppression to exacerbate oral fungal infections. In regions like Gharyan, where post-COVID monitoring access and oncologic care access are perhaps suboptimal, these observations urge practitioners to remain more vigilant for NCA species and employ multidisciplinary surveillance regimens to prevent delay in diagnosis and imprudent treatment (Jafarzadeh *et al*., 2023).

In a related context, (Abuhajar *et al*., 2023) reviewed chronic atrophic candidiasis more commonly known as denture stomatitis which predominantly affects elderly denture wearers. The multifactorial nature of this condition includes continuous denture use, poor hygiene, mucosal trauma, and systemic factors such as diabetes and immunosuppression. A central contributor to the persistence of infection is the ability of *Candida albicans* to form biofilms on prosthetic surfaces, making eradication difficult and recurrence common. Also highlighted treatment modalities such as topical antifungals, improved denture hygiene, scheduled denture removal, and systemic risk factor management. The inclusion of patient education as a preventive tool was deemed essential. For Gharyan, where traditional prosthetics are common and access to dental care is sporadic, these recommendations align well with the need for community-centered health strategies.

Furthering this discourse(Ma *et al*., 2024) provided a meta-analysis reinforcing the association between *C. albicans* and OLP. Their findings showed that colonization not only coexists with OLP but also may exacerbate it through persistent mucosal inflammation and impaired lesion healing. The authors emphasized that early identification and treatment of fungal super infections could enhance treatment efficacy and prevent potential malignant transformations in erosive OLP. In resource limited clinics like those in Gharyan, where diagnostic delays are common, the integration of routine fungal screening in OLP management protocols could yield significant clinical benefits.

Study conducted in Iran by (Erfaninejad *et al*., 2024) aimed to study on HIV-positive Iranian patients, analyzing phenotypic and genotypic profiles of *C. albicans* isolates from oral lesions. The researchers reported high biofilm production, partial resistance to itraconazole, and strong sensitivity to fluconazole. Their findings emphasized the importance of strain-level identification and antifungal susceptibility testing, especially for high-risk, immunocompromised patients. For Gharyan, where HIV care infrastructure is expanding, these insights advocate for introducing fungal screening and susceptibility testing into oral healthcare services for immune-suppressed individuals.

About Alzheimer disease(Golipoor *et al*., 2024) added to this by evaluating fungal colonization in Alzheimer's disease (AD) patients. Their study reported elevated *Candida* spp. loads, abnormal resistance profiles, and enzymatic shifts in AD patients compared to controls. Factors such as impaired oral hygiene, cognitive decline, and polypharmacy contributed to this colonization. The authors advocated for regular oral fungal screening and development of antifungal strategies tailored to neurologically impaired populations. This approach is highly applicable to Gharyan aging demographic, where geriatric oral healthcare remains underdeveloped.

On other hand, to investigation about the susceptibility of uncommon *Candida* spp. that isolated from people addicted on the drugs, (Ghojoghi *et al*., 2024). The study highlighted that substance abuse can increase the risk of oral fungal infections due to compromised immunity, poor oral hygiene, and coexisting systemic health problems. The researchers isolated multiple *Candida* species, with most prevalent species was *Candida albicans,* followed by non-*albicans* species such as *C. glabrata*, *C. tropicalis*, and finally C. *krusei*. Some rare yeast species were also detected, reflecting the diversity of fungal pathogens in this high-risk population. Antifungal susceptibility testing revealed variable resistance patterns. While most *C. albicans* isolates remained susceptible to common antifungal agents like Fluconazole, resistance was more frequent among non-*albicans* species, particularly *C. glabrata* and *C. krusei*. Resistance to Itraconazole and Ketoconazole was also reported in some isolates, raising concerns about treatment efficacy in recurrent or persistent infections. The findings emphasize the importance of species level identification and antifungal susceptibility testing before initiating therapy, especially in drug abusing populations where non-*albicans* species and resistant strains are more prevalent. The authors recommend targeted antifungal therapy combined with management of underlying risk factors, including substance abuse treatment, to achieve better clinical outcomes and reduce recurrence rates (Ghojoghi *et al*., 2024).

Meta-analysis conducted to evaluate occurrence and distribution of *Candida* spp. among people complain from HIV by (Musinguzi *et al*., 2024). This people suffer from oropharyngeal and oral candidiasis. The study synthesized data from multiple African countries in the context of the universal test and treat (UTT) policy for HIV management, which has increased early diagnosis and treatment of HIV.

The analysis revealed a high prevalence of oral candidiasis among PLHIV, with an estimated pooled prevalence rate of approximately 48%. *Candida albicans* was the most frequently isolated species, followed by non-*Candida albicans* species, such as *Candida glabrata* and *Candida tropicalis*, which are increasingly recognized for their clinical importance due to varying antifungal resistance profiles. The study highlighted that despite the UTT policy improving HIV outcomes, oral candidiasis remains a common opportunistic infection in PLHIV, reflecting ongoing immune suppression and fungal colonization challenges. The presence of diverse *Candida* species underscores the need for accurate species identification to guide effective antifungal therapy, as some non-*albicans* species exhibit resistance to commonly used antifungal drugs (Musinguzi *et al*., 2024).

These findings are particularly relevant to understanding oral fungal infection dynamics in immunocompromised populations in African regions, including Libya and the Gharyan area. They emphasize the importance of monitoring *Candida* species distribution and resistance patterns to improve management strategies for oral fungal infections among vulnerable groups. This systematic review provides a valuable framework for assessing the incidence and clinical management of oral candidiasis within your study context.

In order to determine the prevalence and systemic correlations of angular cheilitis among Libyan patients who complain of type two diabetes mellitus, (El-Kakalli *et al*., 2024) carried out an extensive cross-sectional study. At order to detect angular cheilitis, an extensive clinical investigation was conducted on a representative sample of diabetic patients who were receiving treatment at Libyan healthcare institutions. With rates above 35%, the results indicated a markedly a high incidence of angular cheilitis in this population. This condition is primarily linked to fungal infections, particularly *Candida* species, which colonize and infect the oral mucosa. The study further explored systemic factors contributing to the development of angular cheilitis. Poor glycemic control emerged as a major risk factor, with patients exhibiting higher HbA1c levels showing increased susceptibility to oral fungal infections. Immune system impairment associated with diabetes was also identified as a key contributor, reducing the body ability to control *Candida* spp. colonization and infection. Additional factors such as nutritional deficiencies and local factors including saliva reduction were noted to exacerbate the condition.

In the context of Libya, this study highlights the close connection between diabetes and oral fungal infections. These results raise the possibility that diabetics in Libya, particularly in locations like Gharyan, may be more susceptible to oral fungal diseases such angular cheilitis, given the country's rising diabetes incidence. In order to lessen the burden of oral fungal infections in susceptible groups, the study emphasizes the necessity of integrated oral healthcare measures in diabetic management programs, such as routine oral screens and antifungal medications. This thorough data highlights systemic health determinants that affect infection rates and outcomes, supporting this study focus on the incidence of oral fungal infections in the Gharyan area.

A study conducted by(Ciurea *et al*., 2020) provided a comprehensive analysis of *Candida* spp. virulence mechanisms, emphasizing key features such as host tissue adhesion, phenotypic switching, biofilm formation, and the secretion of hydrolytic enzymes, including proteases and phospholipases. These attributes are particularly problematic in immunocompromised hosts, where immune surveillance is decreased, leading to more severe and recurrent infections. Importantly, (Ciurea *et al*.,2020) also noted the rising clinical significance of non-*Candida albicans* (NCAs) species, which exhibit greater resistance to conventional antifungal treatments and are more difficult to eradicate. This insight is critically relevant for regions such as Gharyan, where advanced laboratory infrastructure may be lacking, and empirical treatment is frequently practiced. The integration of fungal virulence profiling into clinical protocols could substantially improve outcomes through targeted therapy. The pathogenesis and virulence of *Candida* species, particularly *Candida albicans*, form a cornerstone of understanding the clinical manifestation, progression, and resilience of oral fungal infections. These organisms have developed an array of survival and pathogenic strategies, allowing them to exist as benign commensals in healthy hosts and transition into invasive pathogens under favorable host or environmental conditions.

To describe oral candidiasis as an opportunistic infection mainly caused by *Candida albicans*, although non-*albicans* species also contribute to the disease. (Vila *et al*., 2020) conducted to *Candida* spp. normally exists as a harmless commensal organism in the oral cavity. However, under certain conditions such as immune-suppression, uncontrolled diabetes, prolonged antibiotic use, denture wearing, and poor oral hygiene, it can shift to a pathogenic form capable of causing infection. The pathogenesis involves a transition from the yeast to the hyphal form, which enables tissue invasion. Biofilm formation on oral surfaces provides the organism with protection against antifungal agents and host immune responses. Additionally, *Candida* spp. secretes hydrolytic enzymes that damage epithelial cells and promote further colonization and persistence in the oral cavity. Risk factors include HIV/AIDS, cancer chemotherapy, organ transplantation, endocrine disorders such as diabetes mellitus, and xerostomia. These conditions compromise the host immune system or alter the oral environment, creating favorable conditions for fungal growth. Clinically, oral candidiasis may present in several forms, including pseudo-membranous candidiasis (thrush), erythematous candidiasis, angular cheilitis, and chronic hyperplastic candidiasis. Management requires identifying and addressing the underlying risk factors. Mild cases, treated with topical antifungal agents such as Nystatin or Clotrimazole, while severe or recurrent cases often require systemic antifungals like Fluconazole or Itraconazole. Good denture hygiene and regular oral care are also essential to prevent recurrence. Recurrent or persistent oral candidiasis can indicate the presence of systemic disease, highlighting the need to investigate underlying health conditions alongside antifungal treatment.

By examination how pathogenic *Candida* species can evade the host immune system, study conducted by (Singh *et al*., 2020), focusing on mechanisms that allow these fungi to avoid destruction by the complement system, a key component of innate immunity. The complement system acts as a first line of defense by marking pathogens for elimination and directly lysing microbial cells. The study detailed several evasion strategies employed by *Candida* species, including: Binding and inactivating complement regulatory proteins to prevent complement activation, Producing proteases that degrade complement components, Altering cell surface structures to avoid recognition and opsonization. Finally, forming biofilms that protect fungal cells from immune attack. These mechanisms enable *Candida* spp. to persist and cause infection, even in immunocompetent hosts. The research underscores the complexity of host pathogen interactions and explains why *Candida* spp. infections can be difficult to eradicate. Understanding these immune evasion tactics is essential for developing more effective treatments and preventive measures for oral fungal infections(Singh *et al*., 2020). This knowledge is valuable for this study on oral fungal infection incidence in the Gharyan area, providing insight into why infections may persist or recur despite immune defenses and antifungal therapy.

Extending this understanding, (Lopes and Lionakis., 2021) provided a comprehensive review of *Candida albicans* pathogenesis, with particular emphasis on its adaptive strategies during mucosal infections. The authors described in detail the yeast to hyphal morphological switch, a hallmark virulence factor that enables *C. albicans* to transition from a harmless commensal to an invasive pathogen. This morphological plasticity is regulated by environmental cues such as pH, temperature, CO_2 concentration, and nutrient availability. The hyphal form is associated with enhanced tissue penetration, secretion of hydrolytic enzymes such as secreted aspartyl proteinases (SAPs) and phospholipases, and activation of host inflammatory pathways. Another central focus was biofilm formation, which the authors characterized as a multi-stage process beginning with initial adhesion to host tissues or abiotic surfaces, followed by microcolony formation, extracellular matrix production, and eventual maturation. Mature *Candida* spp. biofilms not only exhibit heightened resistance to commonly used antifungal agents, often requiring concentrations many times higher than planktonic cells for inhibition, but also serve as reservoirs for recurrent infection. (Lopes and Lionakis., 2021) highlighted that the dense extracellular matrix physically impedes antifungal penetration and can sequester immune effectors, thereby reducing clearance efficiency. The review further examined host pathogen interactions, particularly the role of innate immunity in controlling mucosal *Candida* spp. infections. Neutrophils were described as the primary effect or cells against *C. albicans*, capable of deploying oxidative bursts, releasing antimicrobial peptides, and forming neutrophil extracellular traps (NETs).

In healthy individuals, these defenses typically maintain fungal populations at commensal levels. However, in immune- compromised populations such as patients with diabetes mellitus, cancer undergoing chemotherapy, HIV/AIDS, or advanced age neutrophil function is often impaired, either quantitatively or qualitatively, resulting in reduced fungal clearance and persistent infection.

Ojah *et al*., (2021) investigated the antifungal potential of various natural and commercial agents against *Candida* spp. biofilms formed on denture base materials. The study addressed the persistent problem of denture stomatitis, which is frequently associated with biofilm forming *Candida* species, particularly *Candida albicans*. In this in vitro experimental design, denture acrylic specimens were inoculated with *Candida* spp. strains and subsequently treated with Triphala, neem (*Azadirachta indica*), Aloe vera (*Aloe barbadensis*), and a commercially available denture cleanser. Biofilm inhibition and reduction were measured using quantitative microbiological techniques. The findings revealed that Triphala and Aloe vera exhibited the highest antifungal efficacy among the tested natural agents, achieving significant reductions in viable *Candida* spp. counts. Neem also demonstrated antifungal activity but to a lesser extent. The commercial denture cleanser showed strong biofilm removal ability; however, the authors cautioned about its potential adverse effects on denture material integrity with prolonged use. Triphala effectiveness was attributed to its high tannin and polyphenol content, which can disrupt fungal cell walls, while Aloe vera's bioactivity was linked to its anthraquinones and saponins that interfere with fungal adhesion and growth. The authors highlighted the relevance of these findings for communities where conventional antifungal agents may be costly or inaccessible. In particular, the cultural familiarity and local availability of Triphala and Aloe vera make them viable candidates for integration into daily denture hygiene protocols (Ojah *et al*., (2021). In the context of Gharyan area, where traditional medicine is still widely practiced and advanced prosthodontics care may be limited, adopting such natural antifungal approaches could improve oral health outcomes for denture wearers. The study underscores the potential for developing low cost, herbal based antifungal regimens that are both effective and culturally acceptable, aligning with global interest in alternative and complementary oral healthcare solutions.

Similarly, (Talapko *et al*., 2021) reinforced the critical importance of understanding *C. albicans* virulence by detailing several key mechanisms that facilitate its pathogenicity in the oral environment. Their review highlighted the pathogen capacity to adhere to epithelial cells via specialized surface adhesions, a feature that allows initial colonization and persistence within the host. Additionally, *C. albicans* displays remarkable morphological plasticity, notably the ability to transition between yeast, pseudohyphal, and hyphal forms. This phenotypic switching enhances tissue invasion, promotes biofilm formation, and contributes to immune system evasion each of which increases the organism resilience against host defenses and pharmacological interventions.

Importantly, (Talapko *et al*.,2021) emphasized the growing concern of antifungal resistance, particularly among isolates derived from biofilms, which exhibit significantly reduced susceptibility to commonly used antifungals such as fluconazole. This resistance trend is especially problematic in healthcare systems that lack advanced diagnostic capabilities, where empirical treatment based on general clinical suspicion remains the norm. In under resourced settings like Gharyan, the combination of limited laboratory support and unrestricted antifungal use may contribute to the proliferation of resistant strains. The authors called for regionally tailored antifungal stewardship programs that promote evidence based prescribing practices, along with investment in early and species-specific diagnostic tools. These measures are crucial to minimizing delays in effective treatment and curbing the escalation of drug resistance in vulnerable populations.

Ponde *et al*., (2021) addressed another layer of diagnostic and therapeutic challenge through their detailed review of *Candida albicans* biofilm formation and its polymicrobial interactions in the oral cavity. Biofilms are a critical virulence factor, enabling fungal cells to adhere to mucosal surfaces and prosthetic devices while evading host immunity and antifungal agents. These biofilms embed the fungal community in a protective extracellular matrix, significantly reducing treatment efficacy. Furthermore, *C. albicans* frequently coexists with bacterial species such as

Streptococcus mutans and *Staphylococcus aureus* in these biofilms, creating polymicrobial environments that complicate both diagnosis and treatment.

In a related investigation, (Pasman *et al*., 2022) examined the inter-kingdom interactions between *S. aureus* and *C. albicans* in oropharyngeal candidiasis (OPC). Their findings demonstrated that *C. albicans* modulates the host immune response by secreting pro-inflammatory cytokines, thereby promoting mucosal colonization and invasion by *S. aureus*. This synergistic interaction exacerbates infection severity and challenges treatment efficacy. The study highlights the importance of considering the polymicrobial nature of oral infections, which often involve dynamic interplay between fungal and bacterial species. Understanding these interactions is crucial, particularly in settings like Gharyan, where diagnostic resources are limited and broad-spectrum treatments are difficult to implement. (Pasman *et al*.,2022) proposed targeting immune mechanisms involved in such interactions as a novel therapeutic strategy, suggesting that immunomodulatory therapies could disrupt the synergistic cycle between fungi and bacteria. These insights support the development of more refined treatment protocols and preventive strategies based on microbial ecology and host immunity.

The mechanism through *C. albicans* invades the oral cavity and develops into an infection was examined by (Patel., 2022). According to the review, *Candida albicans* is a common commensal species that is present in healthy oral flora. However, when the host immune system is weakened or the equilibrium of the oral microbiome is upset, it can turn pathogenic. Attachment to oral epithelial cells, which is facilitated by host surface receptors and fungal adhesions, marks the start of colonization. After adhering, *Candida albicans* can create intricate communities called biofilms, which shield the fungus from harsh environments and antifungal medications. The transition from yeast to hyphal form is critical for tissue invasion and infection development. Factors contributing to infection include immune-suppression, antibiotic use, xerostomia, poor oral hygiene, and systemic diseases such as diabetes. The review detailed clinical manifestations of oral candidiasis, including pseudomembranous, erythematous, and chronic hyperplastic forms, each with distinct presentations and implications. (Patel., 2022)emphasized that early detection and intervention are essential to prevent progression from colonization to active infection. Treatment strategies include topical and systemic antifungals, alongside managing underlying risk factors. This understanding is crucial for addressing oral fungal infections in populations like those in the Gharyan area, where similar predisposing factors may influence infection rates and severity.

In an applied clinical context (Hussein *et al*., 2023) conducted a comprehensive analysis of the oral microbiota in Egyptian patients presenting with varying periodontal health statuses, including healthy individuals, those with gingivitis, and patients suffering from periodontitis. The study identified ten fungal and nine bacterial species across the collected samples. Notably, *Candida tropicalis* exhibited significant diversity among the three groups, indicating its potential role in periodontal disease progression. The researchers also assessed the antifungal efficacy of commonly used oral hygiene products. Paradontax tooth paste, Hexitol mouth wash, and clove oil demonstrated substantial antimicrobial activity against the tested fungal and bacterial strains. Although clove oil required higher minimum inhibitory concentrations (MICs) compared to Paradontax and Hexitol, it was recommended as an effective antifungal and antibacterial agent due to its natural origin and minimal side effects(Hussein *et al*., 2023). These findings underscore the importance of incorporating antifungal susceptibility testing into routine oral care practices. Such measures are particularly crucial in under resourced settings like Gharyan area, where diagnostic resources may be limited, and empirical treatments are common. Tailoring oral hygiene protocols based on regional microbial profiles and resistance patterns can enhance treatment efficacy and mitigate the development of drug resistant strains.

Pushing the boundaries of antifungal therapeutic research, (Song *et al*., 2023) investigated a class of diaryl chalcogenide compounds that target key virulence mechanisms of *C. albicans* including hyphal morphogenesis, surface adhesion, and biofilm maturation without exerting fungicidal activity. This anti-virulence approach aims to disarm the pathogen rather than eradicate it outright, thereby reducing selective pressure for resistance and minimizing disruption to the commensal microbiota. The study demonstrated that these compounds significantly impaired biofilm biomass and hyphal development in vitro and attenuated pathogenicity in murine infection models, all while exhibiting minimal cytotoxicity to mammalian cells. This therapeutic paradigm has particular relevance for Gharyan, where antifungal resistance to azole drugs is increasingly reported and where access to novel systemic antifungals remains limited. By offering a mechanism of action distinct from conventional fungistatic or fungicidal drugs, anti-virulence agents could represent a cost-effective and resistance-resilient addition to the local antifungal arsenal.

Ajetunmobi *et al*., (2023) provided a broad overview of antifungal treatment progression, highlighting the specific difficulties posed by biofilm-associated infections. Their review showed how biofilms reduce antifungal efficacy and protect fungal cells from immune clearance. Traditional antifungals like Fluconazole perform poorly against biofilm forming *Candida* species. Newer strategies, including combination therapy, biofilm disruptive agents, and antifungal coated devices, show greater potential. Additionally, novel approaches such as nanoparticle delivery, phytochemicals, and tailored synthetic compounds were emphasized for their ability to penetrate and disrupt biofilms. For Gharyan area, where biofilm related infections are likely underdiagnosed, this review calls for aggressive therapeutic planning and further research into localized antifungal resistance and biofilm characteristics.

Broadening the discussion to include a systems biology perspective (Defta *et al*., 2024) examined the role of the oral mycobiome in both health and disease. Historically, research has focused predominantly on the bacterial component of the oral microbiome, but recent advances in next-generation sequencing have brought the fungal community or Mycobiota into focus. (Defta *et al*.,2024) reported that oral microbial dysbiosis involving fungi is implicated in numerous conditions, from localized infections like caries and periodontitis to systemic illnesses such as cancer and autoimmune diseases. Their work emphasized that fungi are not passive inhabitants but active participants in shaping the oral ecological balance. The recognition of mycobiotic profiles as indicators of oral and systemic health supports a paradigm shift toward precision medicine. This is particularly valuable for Gharyan, where access to high-tech diagnostics may be limited, but where such insights could guide cost-effective, tailored interventions.

The complexity of diagnosing oral fungal infections continues to grow due to evolving pathogen profiles, overlapping symptomatology, and increasing resistance among fungal strains. (Shi *et al*., 2024) documented two rare cases of superficial fungal infections caused by non-*Candida albicans* species, which presented with unusual greenish-black pigmentation at the infection site. This unexpected clinical manifestation prompted a deeper diagnostic investigation, revealing NCA strains that were resistant to standard antifungal treatments typically used for *Candida albicans*. These findings underscore the limitations of relying solely on classical diagnostic criteria and highlight the growing need for clinicians to recognize atypical infection presentations.

NCA species such as *C. glabrata* and *C. tropicalis* often exhibit distinct virulence profiles, form robust biofilms, and demonstrate increased resistance to commonly prescribed antifungal medications. (Shi *et al*., 2024) emphasized the importance of advanced diagnostic approaches, including molecular assays and species-level culture techniques, to accurately classify these organisms and guide effective treatment. This recommendation holds particular weight for area like Gharyan, where diagnostic infrastructure may be minimal and empirical therapy is widely practiced. Ensuring diagnostic accuracy in such settings is crucial to avoid misclassification and treatment failure.

Adding further nuance, (Mousa *et al*., 2025) conducted an in-depth investigation into the acidogenic and fluoride resistant properties of *Candida albicans* and several non-*Candida albicans*(NCA) species, including *C. tropicalis*, *C. parapsilosis*, *C. maltosa*, and *C. glabrata*. Their study revealed that these organisms are capable of producing acids under both aerobic and anaerobic conditions, contributing to their cariogenic potential. Notably, despite the fluoride sensitivity of their enolase enzyme, the overall growth and acid production of these species remained largely unaffected even at fluoride concentrations as high as 80 mM, with the exception of *C. glabrata*.

These findings raise concerns about the efficacy of current dental hygiene protocols that rely heavily on fluoride for caries prevention. The ability of *Candida* species to thrive in acidic environments and resist fluoride suggests that standard fluoride based interventions may not be sufficient to control fungal colonization, particularly in individuals with poor oral hygiene or diets high in fermentable carbohydrates. This is especially pertinent for area like Gharyan, where fluoride exposure may be routine, but fungal surveillance and advanced diagnostic capabilities are limited (Mousa *et al*., 2025)

(Mousa *et al*.,2025) recommend exploring alternative antifungal agents that specifically target acid resistance mechanisms or operate independently of fluoride based interventions. Such strategies could include the development of novel therapeutics aimed at disrupting the unique metabolic pathways of *Candida* species or enhancing the host immune response to these pathogens. Implementing these approaches in under-resourced settings like Gharyan could significantly improve the management of oral fungal infections and reduce the prevalence of dental caries associated with *Candida* species.

Understanding the risk factors and epidemiological dynamics of oral fungal infections is crucial for effective disease control and management. Oral candidiasis is a multifactorial condition, influenced not only by microbial factors but also by host immunity, systemic health, nutrition, pharmacologic exposures, and demographic patterns. A wide body of literature has explored these variables, offering insights into how specific populations, clinical practices, and regional characteristics such as those in Gharyan area shape the prevalence, severity, and outcomes of fungal oral infections.

Henschel *et al*., (2021) reported a 25-year retrospective study of oral clinical features of systemic mycoses in an endemic region of Brazil, presenting a sense of the clinical challenge and diagnostic challenge such a condition poses. They reported cases of a referral unit and determined that oral lesions often were the first or only manifestation of systemic mycoses, that is, paracoccidioidomycosis, histoplasmosis, and candidiasis. The ulcers were typically tender ulcers, granulomatous lesions, in addition, pseudomembranous plaques, despite these were typically misdiagnosed as neoplastic or inflammatory processes, and the patients were accordingly delayed or inappropriately managed. Surprisingly, most of the infected patients had underlying comorbidities like HIV/AIDS and were immunocompromised or worked occupationally with exposure to fungal reservoirs (i.e., farmers). These are life- affecting findings for health systems in resource limited settings like Gharyan area, where high technology diagnosis is not available and oral fungal lesions go unnoticed as indicators of systemic infection. The study underscores the need for oral healthcare professionals to be educated on recognizing atypical presentations and having appropriate referral mechanisms for systemic examination. The research also suggests that the inclusion of oral examination within the standard diagnostic workup in suspected systemic fungal infection could enhance early diagnosis and therapeutic success, particularly among high-risk or endemic populations.

Study conducted by (Cannon., 2022) provided a historical and forward-looking perspective in her comprehensive review of oral fungal infection diagnosis and management. The review chronicled the evolution of clinical and laboratory techniques, from early culture based methods to modern molecular diagnostics such as PCR and next-generation sequencing (NGS). These innovations have significantly enhanced the ability to detect and differentiate fungal species, particularly in immunocompromised individuals who are more vulnerable to infection and more likely to harbor resistant strains.

(Cannon.,2022) also addressed the growing issue of antifungal resistance, especially in the context of biofilm formation and long-term antifungal use. Cannon advocated for the integration of alternative therapeutic approaches including the use of herbal compounds and probiotics as complementary or substitute treatments to conventional antifungals. Probiotic strains such as *Lactobacillus* spp. were shown to restore oral microbial balance and prevent fungal colonization, while plant-based remedies offered antifungal and anti-inflammatory benefits with reduced toxicity. These alternative strategies are especially relevant in underserved area like Gharyan, where access to the latest antifungal medications may be restricted. (Cannon., 2022)integrative approach blending molecular diagnostics, traditional therapies, and emerging treatment modalities provides a pragmatic framework for addressing oral fungal infections in resource-limited settings. Her review underscores the necessity of adopting a multidisciplinary model that incorporates both modern technology and culturally acceptable, cost-effective solutions to enhance patient care and treatment outcomes.

As a complement to augmented diagnostic and therapeutic strategies, (Guillouet *et al*., 2022) proposed a clinical decision making tool designed to assist in the diagnosis of oral lesions in pediatric patients. The model employed a decision tree incorporating variables such as lesion morphology, patient age, symptom duration, and the presence of systemic symptoms to differentiate between viral, bacterial, and fungal etiologies. This systematic diagnostic approach enhances clinical accuracy, especially in primary care settings where advanced diagnostics may not be available. *Candida* species were identified as the most prevalent fungal pathogens in immune-compromised children, with angular cheilitis, erythematous patches, and pseudo-membranous plaques among the most common clinical manifestations. The utility of this decision tree is particularly evident in low resource environments like Gharyan area, where limited pediatric oral health services often result in misdiagnosis or neglect. Its integration into community clinics could significantly improve early identification and treatment of pediatric oral fungal infections.

In an atypical clinical scenario, (Habib *et al*., 2023) documented an exceptionally rare case of oral infection caused by *Verticillium* species a genus predominantly recognized as a plant pathogen with very limited precedent in human disease. The patient exhibited persistent, painful oral ulcerations unresponsive to multiple courses of conventional antifungal agents. Standard microbiological cultures repeatedly yielded negative results for *Candida* species, prompting advanced molecular identification techniques, which ultimately confirmed *Verticillium* spp. infection. This case challenges the entrenched assumption that oral mycoses are almost exclusively due to *Candida* spp. and highlights the diagnostic vulnerability in settings with limited laboratory resources. The protracted diagnostic process not only delayed effective therapy but also prolonged patient morbidity, illustrating the real-world consequences of diagnostic narrowness. (Habib *et al*., 2023)advocated for expanding diagnostic capacity to include molecular tools capable of detecting non-canonical fungal pathogens, coupled with clinician education to maintain a broad differential diagnosis in persistent or treatment-refractory oral lesions. In resource constrained environments such as Gharyan area, adopting such protocols could prevent misdiagnosis and improve treatment outcomes.

Presenting D-cateslytin, brand new antifungal peptide, as a potentially effective treatment for *Candida albicans* induced oral infections. Using both in vitro tests and oral cell culture models, the study by (Dartevelle *et al*., 2018) sought to assess the antifungal activity, safety, and mechanism of action of D-cateslytin. The outcomes showed that, even at low micromolar concentrations. D-cateslytin successfully suppressed *Candida albicans* growth. It showed selective toxicity by rupturing fungal cell membranes, which resulted in rapid cell death without endangering mammalian oral cells. Additionally, the peptide prevented the production of biofilms, which decreased the fungus capacity to survive on oral surfaces and withstand therapy. D-Cateslytin showed synergistic effects when combined with existing antifungal drugs, suggesting potential to enhance treatment efficacy and lower required drug doses, which may reduce side effects and drug resistance development. The study highlighted D-Cateslytin stability in the oral environment and low likelihood of inducing fungal resistance, making it a strong candidate for clinical application. Its peptide nature also allows for design modifications to improve pharmacokinetics and delivery. These findings are significant for managing oral candidiasis, especially in regions like Gharyan where antifungal resistance and treatment limitations pose challenges. D-Cateslytin offers a novel therapeutic option that could improve outcomes for patients with oral fungal infections.

With mixing essential oils with itraconazole study by (Kumar *et al*., 2020) added to this body of research by formulating an Itraconazole based topical cream with herbal oil integration. The cream exhibited enhanced antifungal activity and improved drug stability compared to conventional formulations. Through synergistic action between Itraconazole and herbal oils, the cream reduced the potential for systemic toxicity. This innovation aligns with the therapeutic needs of resource-constrained areas like Gharyan, where herbal remedies are more accessible than synthetic drugs.

Building on natural antifungal agents (Didehdar *et al*., 2022) explored the efficacy of Cinnamomum, particularly cinnamaldehyde, in disrupting fungal biofilms and inhibiting cell adhesion. Their findings demonstrated strong antifungal activity, suggesting that cinnamaldehyde could serve as a viable plant based alternative to synthetic antifungals. In culturally traditional contexts like Gharyan, such herbal options are not only cost effective but also socially acceptable, making them suitable for public oral health programs.

In order to employ clove extracts as material additions in active food wrapping and contemporary food systems(Gengatharan and Abd-Rahim., 2023) carried out a brief review. The study demonstrated clove extracts potent antibacterial qualities, especially their ability to effectively combat fungi like *Candida* spp. Bioactive substances like Eugenol, which prevent the growth of fungi and the production of biofilms, are included in these extracts. According to the review, by avoiding microbiological contamination, the use of clove extracts in packing materials can increase the shelf life of food. The investigation of natural plant-based medicines for the treatment of oral fungal infections was supported by this antifungal potential. The findings are relevant for developing alternative or complementary treatments for oral fungal infections in the Gharyan area, emphasizing safer, natural antifungal options.

A thorough analysis of human oropharyngeal candidiasis (OPC), including its etiology, clinical manifestations, and available treatments, was presented by (Qadir *et al*., 2023). According to the review, *Candida albicans* is the main cause of OPC, while non-*albicans* species are also becoming more and more implicated, particularly in individuals with impaired immune systems. The authors listed risk factors that promote fungal overgrowth and infection, including immunosuppression, the use of antibiotics, diabetes, and poor oral hygiene. In addition, they explained the pathogenesis, emphasizing how *Candida* species cling to and infiltrate the oral mucosa, circumvent host immunity, and create biofilms that make therapy more difficult.

(Qadir *et al*., 2023)regarding management, the review discussed antifungal therapies including topical agents like Nystatin and Clotrimazole, as well as systemic azoles such as Fluconazole. It emphasized challenges such as antifungal resistance and the need for alternative treatments, including natural compounds and improved drug delivery systems. This review offers valuable insights into the etiology and management of oral fungal infections relevant to your study in the Gharyan area. Understanding these factors is critical to developing effective prevention and treatment strategies tailored to local patient populations.

Pandey *et al*., (2023) this study aimed to highlighted on antifungal effect of clove essential oil. That nanoemulsified clove oil enhances the stability, bio-availability, and efficacy of its active components, particularly Eugenol, which is the main compound responsible for antifungal activity. Studies summarized in the review demonstrated that clove oil nanoemulsions effectively inhibit the growth of *Candida* species, including *Candida albicans,* by disrupting fungal cell membranes and interfering with key metabolic processes. The nanoemulsion formulation also improved penetration and sustained release, increasing antifungal effectiveness compared to conventional extracts. The review suggested that clove oil nanoemulsions hold promise as alternative or adjunct antifungal agents, especially in treating oral fungal infections where drug resistance and side effects limit current therapies. These findings indicating potential for developing locally sourced, natural antifungal treatments with improved efficacy that can used in Gharyan area.

The study by (Aldabaan *et al*., 2024) aimed to identify the biological activities of nanoparticles synthesized from Indian Clove *Syzygium aromaticum*. The research evaluated antimicrobial, anticancer, antidiabetic, and antioxidant properties of these nanoparticles. Findings demonstrated strong antimicrobial activity against a range of pathogens, including fungal species. The silver nanoparticles showed potential as an effective antifungal agent, suggesting a possible alternative or complementary approach to managing fungal infections. This study provides a scientific basis for exploring plant-based antifungal therapies, which could be relevant to controlling oral fungal infections in regions like the Gharyan area. Incorporating such natural antifungal agents could enhance treatment strategies and reduce resistance associated with conventional antifungal drugs.

The examination of inhibitory effects on the growth of *Candida albicans* by using different concentration of clove extracts study conducted by (Qassim *et al*., 2024). Used laboratory assays to test various concentrations of clove extracts against *Candida albicans* strains isolated from clinical samples. The results showed that clove extracts significantly inhibited *Candida albicans* growth in a dose-dependent manner. The antifungal activity was attributed to bioactive compounds such as Eugenol, which disrupt fungal cell membranes and inhibit enzyme activity essential for fungal survival. The study suggested that clove extracts could serve as effective natural antifungal agents, potentially useful in preventing or managing oral candidiasis. These findings support the exploration of clove-based treatments as alternative or complementary therapies, especially in areas where resistance to conventional antifungal drugs is rising.

Exploring alternative, probiotic based therapies, (Vazquez-Munoz *et al*., 2024) evaluated the antifungal properties of *Lactobacillus johnsonii* strain MT4 an oral isolate obtained from murine models. Their research demonstrated that MT4 could colonize the oral mucosa and exert antifungal effects via chitinase production, disrupting *Candida albicans* cell walls. In vivo, oral inoculation with MT4 curtailed *Enterococcus* overgrowth and mucosal damage induced by *Candida* spp. infection. These findings highlight the therapeutic relevance of probiotics in regulating oral microbiota and curbing fungal colonization. Such strategies could be particularly useful in Gharyan, where natural and cost-effective treatment alternatives are highly needed.

Focusing on preventive strategies for denture wearers, (Memon *et al*., 2024) compared the antifungal effects of chitosan and aloe vera. Both agents inhibited *Candida* spp. adhesion and biofilm formation on denture lining materials, but chitosan proved significantly more effective. Given its biocompatibility and antifungal efficacy, chitosan represents a promising alternative to chemical disinfectants, which may damage denture materials or mucosal tissues. For elderly populations in Gharyan, this natural agent could play a crucial role in routine oral care.

Further advancing delivery systems, (Gamil *et al*., 2024) conducted a randomized controlled trial comparing standard miconazole gel to a chitosan nanoparticle-loaded version in diabetic patients. The nanoparticle gel showed superior efficacy in reducing *Candida* spp. load and improving symptoms. Chitosan nanoparticles enhance drug absorption, sustain release, and maintain mucoadhesion, making them ideal for patients with chronic infections, such as those with diabetes. These results advocate for integrating nanotechnology into antifungal care, especially in settings where therapeutic efficacy is often compromised by economic and logistical barriers.

Addressing antifungal resistance, (Faustova *et al*., 2024) evaluated the susceptibility of nineteen *C. albicans* clinical isolates to common antifungal drugs. Using a standardized double dilution method, they found Fluconazole to be least effective, while Micafungin and Posaconazole showed the strongest antifungal activity. The findings underscore the importance of updating resistance profiles and moving away from empirical therapy toward susceptibility guided treatment. In area like Gharyan, where diagnostic resources are limited, this shift is critical for improving treatment efficacy. (Faustova *et al*.,2024) also employed cluster analysis to further explore variability in antifungal responses among maxillofacial inflammation patients. The study highlighted drug response heterogeneity, reinforcing the need for individualized antifungal strategies based on laboratory diagnostics. The authors advocated for integrating fungal sensitivity testing into standard care a step essential for optimizing treatment in clinical contexts where empirical approaches dominate due to resource constraints.

Similarly (Devi *et al*., 2024) conducted a demographic survey highlighting high oral fungal infection rates among middle aged and elderly individuals with comorbidities such as cancer and diabetes. The study emphasized the risks posed by compromised immunity, late diagnosis, and insufficient initial treatment, all of which can lead to complications such as ulceration and systemic dissemination. These findings hold special relevance for Gharyan, where care for chronic diseases is often fragmented and oral fungal complications remain under recognized. Integrating oral fungal surveillance into routine care for diabetic and immunocompromised patients could provide a low-cost yet effective strategy for improving public health outcomes.

Complementing these findings, (Stoopler *et al*., 2024) offered a clinical review emphasizing early detection and management of oral fungal infections. They highlighted how secondary conditions like denture stomatitis and angular cheilitis may signal deeper systemic vulnerabilities, such as immunosuppression in patients with HIV, cancer, or diabetes. Their work underscored the role of oral examinations as diagnostic touch points for broader health assessments an approach particularly valuable in Gharyan, where primary care providers may be the only point of contact for at-risk individuals.

A recent study by (Martin *et al*., 2024), examined the occurrence of invasive fungal infections (IFIs) in adults and young patients with acute lymphoblastic leukemia who supposing into chemotherapy. The research found a low overall risk of IFIs in this population but identified *Candida* species as the most common fungal pathogens. Diagnosis relied on clinical evaluation and microbiological cultures, while treatment involved timely antifungal therapy based on clinical suspicion and culture results. Although the study focused on a specific group of immunocompromised patients, its findings highlight the importance of monitoring fungal infections in vulnerable populations. These insights provide a valuable reference for understanding the occurrence and management of oral fungal infections in the Gharyan area, particularly regarding pathogen profiles and treatment approaches.

A cross-sectional study in Saudi Arabia is specific in Al-Baha region (Alzahrani *et al*., 2024) conducted study to assess oral fungal colonization between 148 disabled and non-disabled individuals and identify associated causative factors. The study employed concentrated oral rinse and culture on Sabouraud Dextrose Agar (SDA) with chloramphenicol, alongside WHO based oral examinations and questionnaires covering medical history and oral hygiene habits. Findings revealed asymptomatic colonization in approximately 38% of participants no visible lesions were detected despite *Candida* spp. presence. *Candida albicans* emerged as the most prevalent species (61%), followed by *C. glabrata* (14%), *C. dubliniensis* (10%), *C. krusei* (9%), *C. tropicalis* (4%), finally, *C. parapsilosis* (2%). Statistically significant risk factors for higher *Candida* spp. density and presence included diabetes, smoking, poor plaque control, and gingival health(p= 0.001, 0.001, 0.01, and 0.01, respectively). Disability status, in contrast, showed no significant effect on *Candida* spp. colonization. The study underscores the role of systemic and oral hygiene factors in facilitating oral fungal carriage, even in absence of symptoms, and provides strong comparative framework for analyzing oral fungal risk in contexts like Gharyan area.

Comparative study in vitro to assess the effect of cinnamon and clove essential oils against oral *Candida albicans*, by (Bouslama *et al*., 2024). Antifungal activity against *Candida albicans* isolated from oral samples. They tested four volumes 0.25µL, 0.5µL, 1µL, and 2µL using a microdilution method to establish minimum inhibitory concentrations(MICs). The results demonstrated dose-dependent antifungal efficacy, with both essential oils inhibiting fungal growth. The MICs provided a clear measure of the lowest concentration required to prevent growth. Complementing this, other research revealed that cinnamon leaf and clove bud essential oils contain high levels of Eugenol (approximately 73–75%), with additional minor components like β-caryophyllene, eugenyl acetate, and α-humulene. These oils exhibited MICs of 600–1000µg/mL depending on the *C. albicans* strain and showed additive or synergistic interactions when combined. They effectively inhibited mycelial growth and the yeast-to-hypha transition, both critical virulence factors of *C. albicans*. Further in vitro studies showed that clove oil affects *C. albicans* even at sub-inhibitory concentrations, altering enzymatic activity and protein expression linked to pathogenicity, without inducing chromosomal rearrangements. Together, these findings underscore the potent antifungal and anti-virulence properties of cinnamon and clove essential oils. They support the potential for using natural, plant based agents to manage oral fungal infections.

Golestannejad *et al*., (2024) research study from at Sayed Al-Shohada Hospital in Isfahan, Iran, compared the effectiveness of Aamphotericin B, and Nystatin against *Candida* spp. that were isolated from patients undergoing radiation therapy. By utilizing the restriction of PCR fragment length polymorphism, the fungal isolates were identified. The researchers used the recommendations provided by the Clinical and Laboratory Standards Institute to determine the minimal fungicidal levels(MFCs) and minimum inhibitory concentrations (MICs). Only 71.4% of the *Candida albicans* isolates were responsive to Amphotericin B prior to radiation, whereas all isolates were totally sensitive to Nystatin. Sensitivity to Amphotericin B decreased somewhat to 75% after the start of radiation therapy, but sensitivity to Nystatin stayed at 100%.According to the study findings, Nystatin Outperformed Amphotericin B, in terms of antifungal effectiveness againstoral

Candida species both prior to and during radiation treatment.

Alfaifi *et al*., (2024) further explored SARS-CoV-2's role in disrupting the oral microbiome. Their study showed increased colonization of *Candida albicans* in COVID-19 patients, a finding they linked to virus-related immunosuppression and microbial dysbiosis. This underscores the need for oral fungal monitoring as part of broader infectious disease control efforts particularly in resource-constrained regions like Gharyan, where systemic infections may exacerbate pre-existing healthcare challenges.

In a similar approach, Rajão *et al*., (2025) studied *Limosilactobacillus reuteri* AJCR4 and its capacity to inhibit *Candida* spp. biofilms. Biofilms contribute to fungal resilience by protecting organisms from antifungal agents and immune responses. *L. reuteri* successfully suppressed *Candida* spp. growth and biofilm development, representing a safe, probiotic-based adjunct to antifungal regimens. These findings hold promise for sustainable oral health interventions in low-resource settings like Gharyan, where prophylactic and non-toxic therapies are crucial.

Naji *et al*., (2025) study the comparative effect between antifungal effect of azoles and oak extract on some *Candida* spp. isolated from young patients. The study compared the efficacy of the oak bark extract with standard azole antifungal agents commonly used in clinical treatment. Laboratory tests demonstrated that the Quercus robur bark extract exhibited significant antifungal activity, effectively inhibiting the growth of both *Candida albicans* and *Candida glabrata* strains. The extract showed comparable or, in some cases, superior antifungal effects to azole drugs, which are often limited by emerging fungal resistance. The researchers suggested that bioactive compounds in the oak bark, such as tannins and phenolic, contributed to its antifungal properties.

This study highlights the potential of plant-based natural products as alternative or complementary therapies in managing oral candidiasis, particularly in pediatric patients. Given the rising concern about antifungal resistance, such natural extracts could play a crucial role in expanding treatment options (Naji *et al*., 2025).

3- MATERIALS AND METHODS

3.1. Clinical examination and specimen's collection:

Prior to collecting samples, an official authorization letter was obtained from the academy, permitting sample collection from patients at the Poly Clinics center in Gharyan area. An additional letter was provided to facilitate visits to schools within this area. To maintain scientific integrity and ethical standards informed consent was obtained from each patient before sample collection. Each participants signed a consent from authorizing the collection of oral samples.

3.1.1. Clinical examination:

As this study focused on oral fungal infections, clinical examination was primarily centered on the oral cavity. Prior to sample collection, informed consent was obtained from each patient, which was documented on a clinical chart. The oral cavity of every patient was thoroughly examined using disposable dental instruments to identify any signs of fungal infection or ulcers on the soft tissue. Additionally, personal details were collected, including age, gender, and contact information. Information regarding medical conditions (e.g., diabetes, high blood pressure), pregnancy status, smoking habits, recent antibiotic use, presence of dental prostheses, dental problems, and educational level was also obtained.

Figure (1): Female with 46 years old, from Gharyan, diagnosed with candidiasis caused by *Candida albicans*.

3.1.2. Samples collection:

Sample collection was initiated on February 2nd, 2025, and concluded on April 20th, 2025. A total of 140 cases were included in this study, with each patient being assigned a serial number. Samples were collected from individuals aged 2 to 78 years, comprising 62 males and 78 females. Specimens were obtained from the oral cavity of patients attending the clinic for medical treatment. Samples were extracted from several oral regions, including the tooth, soft tissues, and, if present, dental prostheses and dental pockets. Sterile swabs were used, and a precautionary protocol was followed to avoid contamination. Collected samples were stored in a chilled, sterile container. Subsequently, the gathered samples were transferred to the fungi laboratory at the Faculty of Medical Technology, Alriyaina, University of Zintan, for further mycological analysis.

For each patient, three sterile swabs were utilized. One swab was designated for Gram stain and cotton blue stain, which were prepared for direct microscopic examination. The remaining two swabs were used for cultivation on Petri dishes containing suitable nutrient media. Sabouraud Dextrose Agar (SDA), supplemented with chloramphenicol, was employed to limit fungal colonies and inhibit bacterial development, thereby facilitating the isolation of slow-growing fungi. Additionally, cycloheximide was incorporated to selectively cultivate pathogenic species.

3.1.3. Exclusion criteria:

Individuals and patients who had recently taken antimicrobial drugs (antibiotics) within the past month were excluded from the study.

3.2. Mycological examination and culturing of specimens:

3.2.1. Isolation media:

Sabouraud Dextrose Agar (SDA) medium was used for the isolation of general fungal mycobiota and opportunistic species. The SDA medium (Liofilchem, Italy) was composed of 10% peptone, 40% dextrose, and 10% agar per liter of distilled water. This medium was supplemented with 5%

cycloheximide for the isolation of pathogenic fungal species and with 250 mg of chloramphenicol to suppress bacterial growth and restrict fungal colonies, which facilitated the isolation of slow-growing fungi. Subsequently, 65 grams of the SDA were suspended in one liter of sterile distilled water, mixed, and heated with frequent agitation, then boiled for a few minutes to completely dissolve the medium. The nutrient medium was sterilized in an autoclave at 121°C for 15 minutes. After cooling, it was distributed into sterilized plates. Once the medium hardened, smears were placed on the agar medium, and plates were incubated at 37°C for 24 hours, with a maximum duration of 14 days. Growing fungal colonies were then stored in slant tubes containing SDA medium and chloramphenicol, which were refrigerated at 4°C for further studies.

Figure (2): Some materials and instruments used in laboratory work.

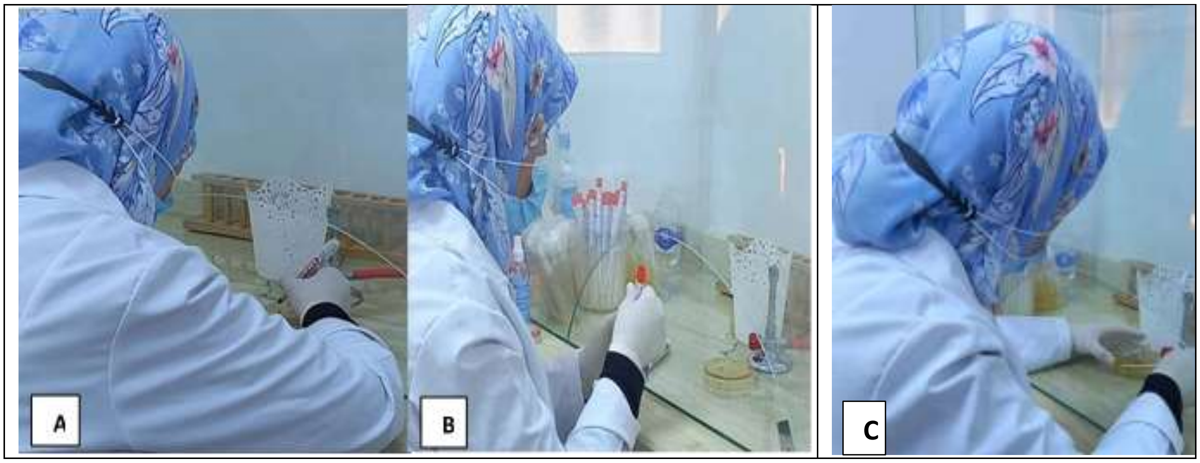


Figure (3): A. Date and serial number written on Petri dishes.
B. Samples prepared for streaking onto the media.
C. Samples collected from patients streaked onto the media.

3.3. Identification of fungal cultures:

3.3.1. Macro-microscopic features of fungal colonies:

3.3.1.1. Macroscopic feature on SDA:

Phenotypic identification of fungi the morphological identification of the isolated fungal genera and species was based on macroscopic and microscopic features. The following references were used for fungal identification: Frey *et al*., (1979); Clayton and Midgley (1985); Kwon-Chung and Bennett (1992); Crissey *et al.*, (1995); de-Hoog *et al.* (2000); Larone (2002); and Ellis *et al.*,(2007).(figure:4)

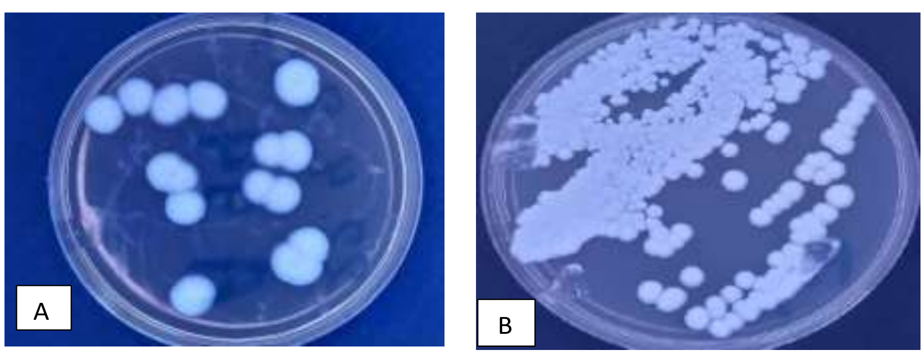


Figure (4): A, B, Petri dishes contain growth colonies of *Candida* spp. on Sabouraud dextrose agar (SDA), seven-day-old colonies at 37°C.

3.3.1.2. Microscopic feature under light microscope:

A smear of the growing colonies was prepared, producing two slides. These were stained with cotton blue and Gram stain, and then examined under a light microscope(figure:5).

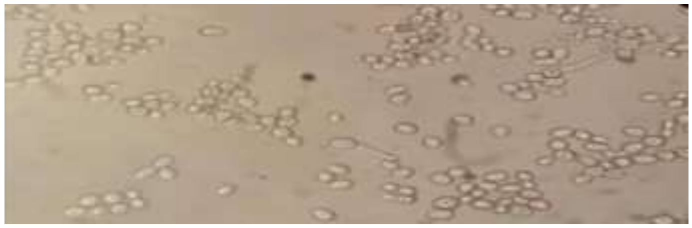


Figure (5): Examination under light Microscope (Muhammed and aljader., 2021).

3.3.2. Growth on specific media (chrome agar media):

Chrome-agar is selective medium that allow the rapid isolation of yeasts from mixed cultures and rapidly identify of *Candida* spp. Growth on Chrome-agar *Candida* spp. medium (Chrome-agar Company. Liofilchem. Italy): It comprised per\liter; peptone (10.0g), agar (15.0g), chloramphenicol (0.5g), and Chromogenic mix. (25.2g), pH 6.1±0.2. This medium was prepared according to the manufacturer's instructions, does not require autoclaving and was dispensed into Petri plates after cooling. A culture media utilized for rapidly identify many common *Candida* species (Pfaller *et al*, 1996). Chemical colorimetric reaction on agar that allows distinction between *C. albicans*, *C. glabrata*, *C. krusei*, *C. tropicalis*, and other non- *Candida albicans* species. The medically important *Candida* species appear as different colored colonies due to differential uptake of these chromogenic compounds. After incubation at 37ºC for 24–48 hours *C. albicans* produces green colonies, while *C. tropicalis* produces blue colonies, *C. glabrata* produces dark pink colonies, and *C. parapsilosis* produces cream to pale pink colonies, *C. Krusei* produce pink colure with pale edge. Chrome-agar can be helpful in detecting the presence of mixed cultures, as well as providing a preliminary species identification (figure: 6).

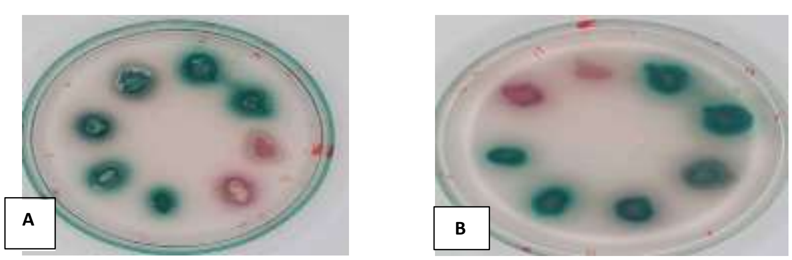


Figure (6):A.B. *Candida* species identified by using Chrome-agar media.

3.4. Preservation of fungi on agar slants:

Test tubes with a 15mL capacity were used to prepare and distribute Sabouraud dextrose agar (SDA). The fungal strains that needed to be preserved were inoculated in the agar slants and sterilized at 121°C for 20 minutes before being incubated at 37°C for 7 days. The developed fungal slants were then kept in a frigid at 4°C for preservation (Smith and Onions., 1994).

3.5. Susceptibility of fungi to some antifungal agents:

Fungal susceptibility was evaluated using the disc diffusion method or with the microdilution reference method to determine the minimum inhibitory concentration (MIC). Fungal susceptibility to Amphotericin B (20 µm), Nystatin (100 IU), and Miconazole (10 µm) (Liofilchem, Italy) was assessed. Yeast growth was performed on Mueller Hinton Agar (MHA) M173-G500, which was composed of (g/L): Beef infusion (300), Casein acid hydrolysate (17), Starch (1.50), and Agar (17), with a final pH of 7.3 ± 0.2 (at 25°C). Plates containing autoclaved MHA (M173) supplemented with 2% Glucose and 0.5 µg/mL Methylene Blue Dye Medium were prepared. The medium thickness in the plates was approximately four mm. A fungal cell smear was streaked over the entire agar surface using sterile disposable cotton swabs. The inoculum was allowed to dry for 5-15 minutes with the lid in place. Discs loaded with the test antifungal agents were then placed with centers at least 24 mm apart. This procedure was performed in triplicate for every species. Plates were incubated at 37°C within 15 minutes after disc application. Cultures were examined after 24-48 hours for yeasts and 1-2 weeks for filamentous fungi, after which zones of inhibition were measured in mm (Diogo *et al*., 2010).

3.6. Susceptibility of fungi to clove oil:

Eugenol oil (manufactured by DHARMA research, made in USA.www. DHARMA RESEARCHE.com), commonly used in dentistry, was tested for its efficacy on isolated fungal species. After preparing sterile glass Petri dishes containing Mueller Hinton agar, holes with a suitable diameter (10 mm) were made using a sterile cork borer. Fifty microliters (50 µL) of oil were added into these holes. This procedure was triplicated with each fungal isolate species. The Petri dishes were then incubated at 36-37°C for 24-48 hours.

3.7. Susceptibility of fungi to plant extract:

Clove extract was employed in this study. Clove buds were first cleansed and then dried before being ground very finely. Fifty grams (50 g) of ground cloves were measured with 500 mL of 96% alcohol (ethanol). This experiment was repeated with the same measurements but using sterile distilled water as a different solvent. The mixtures were then placed in a shaker container for 48 hours in a dark environment. Filtration was the next step; to ensure thorough filtering, the extract was filtered using sterile gauze and filter paper three times (round disk filter paper, diameter 185 mm, Tema International - Italy). To separate the extract from the ethanol and water solvents, the filtered solution was placed in a rotary evaporator (figure:7), with the device adjusted to efficiently separate the mixture(Qassim *et al*., 2024). To obtain the clove extract in powder form, a dry oven was used at 40 ± 2°C (figure:8). A low temperature was maintained to avoid the destruction of active ingredients.

Figure (7): Separation of the clove extract from its solvent using a rotary evaporator.

After drying the clove extract, different concentrations (100%, 50%, and 25%) were prepared from both the alcoholic and aqueous clove extracts.

Holes were made using a sterile cork borer in sterile glass Petri plates containing Mueller Hinton agar (MHA), with three holes of 10 mm diameter in each plate. The media were streaked with sterile swabs containing smears of fungal isolates, and the procedure was triplicated for every fungal species. Each hole was filled with 50 µL of extract. Distinct concentrations of 25%, 50%, and 100% of both alcoholic and aqueous clove extract were created. Subsequently, the Petri dishes were incubated at 36-37°C for 24-48 hours in an incubator.

Figure (8): Drying the clove extract in a hot oven at 40 ± 2℃.

Figure (9): Final clove extract in powder form.

3.8. Statistical Analysis:

All statistical analyses were conducted using SPSS (statistical packages for social sciences) Statistics version 27. Descriptive statistics, including means and standard deviations, were used to summarize quantitative variables, while frequencies and percentages were reported for categorical variables. The distribution of *Candida* species and treatment efficacy across groups was assessed using one-way analysis of variance (ANOVA), followed by post hoc comparisons Tukey Honestly Significant Difference(HSD) to identify statistically significant differences among groups, with significance set at $p < 0.05$. Associations between categorical demographic and health variables and oral fungal infection status were evaluated using the Chi-square test of independence. Prior to conducting ANOVA, assumptions of normality and homogeneity of variance were checked and not violated. Superscripts in tables were used to denote significant, pairwise differences between means where applicable.

The mean and standard deviation (SD) of the tentative study performed in triplicate were used to express all data. Analysis of the statistical significance was conducted according to Stahle and Wold (1989).

3.9. Ethical aspects:

Each patient completed the data sheet and gave their consent before samples were taken from their mouth cavities. In addition, a serial number was assigned to every patient. Additionally, each patient's privacy was protected.

4- THE RESULTS AND DISCUSSION

The current study was designed to investigate the incidence of oral fungal infections in the Gharyan area, identify pathogenic and opportunistic species, determine risk factors for these infections, and evaluate the efficacy of commonly used antifungal agents. Furthermore, the antifungal effects of alcoholic and aqueous clove extracts against the isolated fungal species were explored. The results of this study are presented in this chapter. A significant discussion of the findings is presented, based on a detailed analysis of the data, which addresses the achievement of each of the study's objectives.

Firstly, Table(1) presents the results of Chi-square analyses assessing the association between various demographic and health-related variables and oral fungal infection status. The majority of variables showed no statistically significant association with infection presence, suggesting comparable distributions between positive and negatives cases.

Table (1): Demographic and Health Variables in Relation to Oral Fungal Infection.

Variable	**Result**				**Chi square**	**P value**
	Positive		**Negative**			
	Count	**%**	**Count**	**%**		
Age						
< 20	22	32.8	31	42.4	**1.474**	**0.688**
20-39	16	23.9	16	21.9		
40-59	24	35.8	21	28.8		
>=60	5	7.5	5	6.8		
Gender						
Male	28	41.8	32	43.8	**0.005**	**0.942**
Female	39	58.2	41	56.2		
Diabetes mellitus						
Yes	3	4.5	3	4.1	**0.012**	**0.914**
No	64	95.5	70	95.9		
Blood pressure						
Yes	7	10.4	3	4.1	**2.116**	**0.146**
No	60	89.6	70	95.9		
Pregnant						
Yes	4	6.0	0	0.0	**4.486**	**0.034**
No	63	94.0	73	100.0		
Smoke						
Yes	4	6.0	7	9.6	**0.632**	**0.427**
No	63	94.0	66	90.4		
Dental procedure						
Yes	18	26.9	14	19.2	**1.171**	**0.279**
No	49	73.1	59	80.8		
Oral hygiene						
Bad	32	44.8	34	46.6	**1.951**	**0.377**
Fair	26	38.8	23	31.5		
Good	9	13.4	16	21.9		
Cancer						
Yes	4	6.0	2	2.7	**0.889**	**0.346**
No	63	94.0	71	97.3		

Regarding the incidence of oral fungal infections in the Gharyan area, 67 out of 140 cases (47.8%) were positive for candidiasis, distributed across both males and females and different age groups, while 73 cases (52.1%) did not have candidiasis, as shown in(Figure:10).

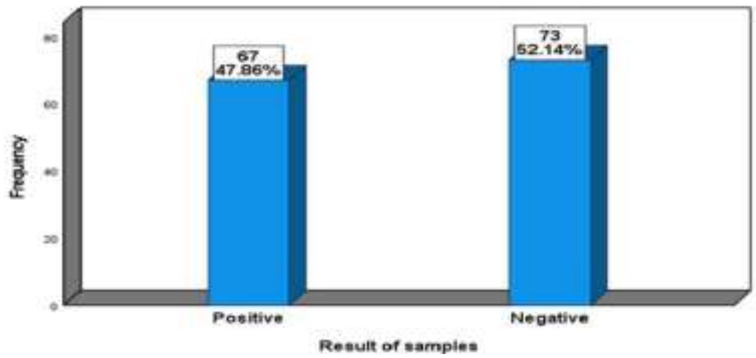


Figure (10): Positive as well as negative cases.

Starting with age variable was not significantly associated with infection status, $\chi^2 = 1.47$, $p = 0.688$, indicating similar age distributions among infected and non-infected participants. The below graph displays the candidiasis distribution among different age(figure:11).

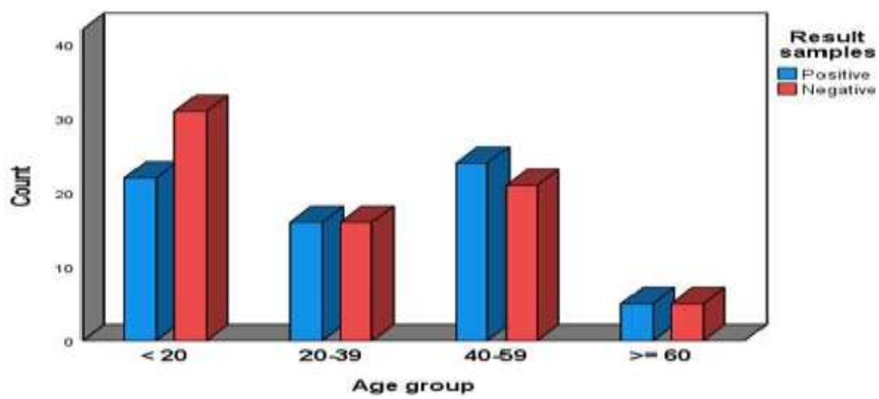


Figure (11): Positive and negative cases in relation to age.

The results were similar age distribution between infected and non-infected cases. Probably due to the samples were taken randomly, because there is no bias for specific age, or because small of sample size. This result was aligning with the previous local study in Benghazi researched by (Ramadan *et al.*, 2025)which indicated there is no relation between specific age and *Candida* spp. carriage isolated, for example, where the most peak of *Candida albicans* was among age group 20-49 years old, while *C. dubliniensis* more prevalent among 20-29 age group. On the other hand, the current result was not consistent with the study conducted by (Rosario *et al*., 2024: and Cadavid *et al*., 2025). Where (Rosario *et al*, 2024) indicated in those studies, old patients among 60-100 years old, more susceptible to infection, which among 172 old patients there are 36.6% have *Candida* infection, especially when interfere with other factors such as: diabetic or wearing denture. While (Cadavid *et al*.,2025), in their studies concluded the fungal infection in oral cavity more frequent in old patient ≥40 years, this study included 240 case admitted to hospital, 77 of them having oral candidiasis, 79.2% approximately 61case ≥40 year, especially those need to oral treatment or wear dental prosthesis, or have weak immune response lead to more prone to infection.

Likewise, gender variable did not show a significant association, $\chi^2 = 0.005$, $p = 0.942$, as showed in (figure:12).

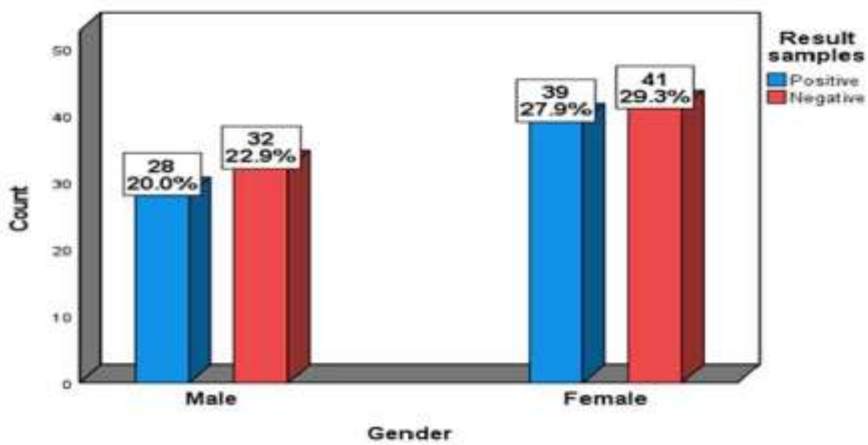


Figure (12): Positive and negative cases in related to gender.

In related to gender, infection rates were nearly identical between males (41.8%) and females (58.2%). This result was in consistent with study conducted by (Alrayyes *et al*., 2019) which concluded the oral fungal infections (OFI) were not statistical significant related to gender, from 104 cases there were 79 approximately (76%) male and 25 approximately (24%) Female have infection. Infection rates were approximately nearly between both gender, unless interfere with other causative factors such as oral hygiene or other condition that interaction together to cause infection.

Regarding health conditions, no significant association was found for diabetes mellitus, $\chi^2 = 0.012$, $p = 0.914$, although diabetes mellitus considered as prime risk

Factor and the main causative for OFI as conducted by many studies. One of them, local study in Musrata, Libya, conducted by (Esmaio *et al*., 2017), this local study isolated 13 species of *Candida* spp. from diabetic patients with type two diabetes mellitus. Among 170 patients have type two diabetes mellitus there were 182 *Candida* spp. have been identified with different frequencies, such as *C. albicans*, *C. glabrata*, *C. tropicalis*, *C. dubliniensis*, *C. humicola*, *C. krusei*, *C. tropicalis*, and *C. kefyr* etc... Diabetic patient is more prone to infection due to high sugar level in saliva that enhance proliferation of *Candida* spp. xerostomia and other disturbance with high sugar level. Consequently, this result is not consistent with current study which displays no significant association for diabetes mellitus, perhaps this due to small number of diabetic patient in current study, or the samples which were randomly taken without any bias for any variables. Next graph (Figure:13) displays distribution of *Candida* infection among diabetic and non-diabetic patient.

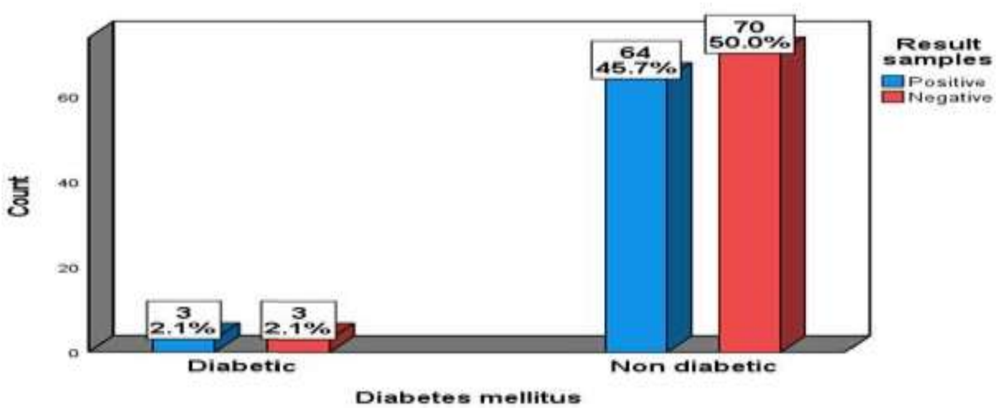


Figure (13): Incidence of candidiasis in both diabetic and non-diabetic patient.

Likewise for next health conditions as blood pressure, in current study blood pressure was not significantly related to oral fungal infection, $\chi^2 = 2.116$, $p = 0.146$, as showed in figure(14) that displays distribution of infection in related to blood pressure.

Probably due to small number of participants having blood pressure in this study, from ten patients have high blood pressure, seven of them suffering from candidiasis, while 3 of them are not infected. This result is not consistent with study conducted by (Rosario *et al*., 2024) which conducted to identify risk factors that lead to colonization of *Candida* spp.

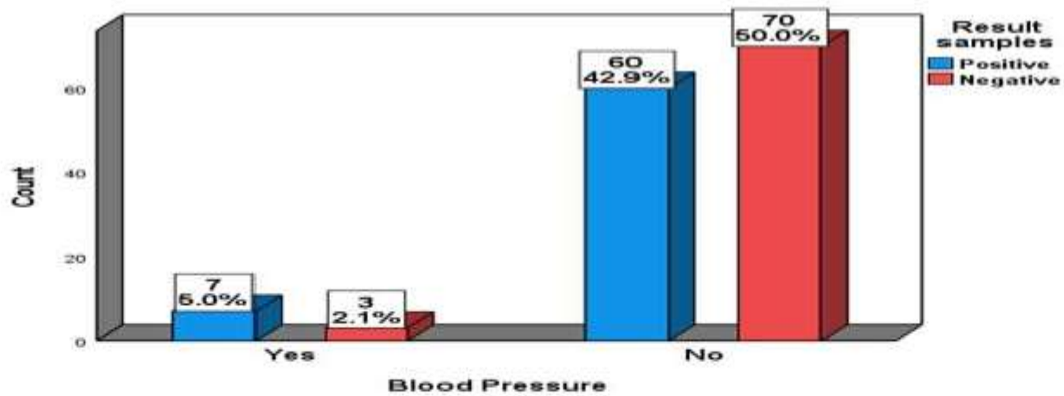


Figure (14): Incidences of candidiasis in related to blood pressure.

(Rosario *et al*., 2024) displayed significant relation between patients with blood pressure with relation to other factors, p = 0.049 such as, patients wearing dental prostheses, having oral sensitivity for this appliances or having oral injury. These cases became more prone to infections due to vascular disease which caused less of blood supply to tissue leading to loss of teeth. Therefore there was need to use dental prostheses that colonized easily by different oral microorganisms.

Similarly with other health condition as cancer. In current study cancer variable was not significantly related to infection χ^2 = 0.889, p = 0.346, perhaps due to small number of patient of this category who included in this study i.e. six of 140 case suffering from cancer. Four of six cancer patients have candidiasis, this results is not consistent with results concluded in study conducted by (Singh and Singh., 2020; Kermani *et al*., 2021). (Singh and Singh., 2020) concluded the chance to oral mucosal infection became from 30-60%with people subjected to chemotherapy or radiotherapy, especially in head and neck cancer. Because radiation therapy interferes with normal cycle of epithelial cell, leads to oral injury. And this will be followed easily colonized by oral microbiota, leading to a shift in balance between oral microbiota causing the patients more prone to infection. In study conducted in Iran by (Kermani *et al.*, 2021) indicated that people who suffer from cancer, especially head and neck cancer, have high chance for oral fungal infection, the results were among 59 cases have head and neck cancer there were 36 cases approximately(61.01%) were positive to candidiasis. The effect of radiation and chemotherapy on oral soft tissue, caused injury in oral soft tissue, making it more susceptible to invasion by fungi and bacteria. Chemotherapy and radiotherapy lead to change of *Candida* spp. from normal flora to pathogenic species as well.

The following graph (figure: 15) displays current results samples of fungal infection with relation to cancer.

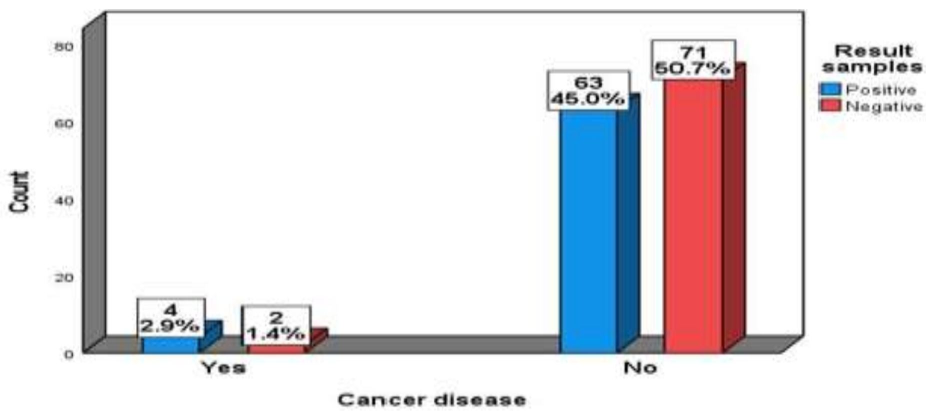


Figure (15): Fungal infection related to cancer patients.

Similarly in smoking status was not significantly related to oral fungal infection in current study, $\chi^2 = 0.632$, $p = 0.427$. Perhaps the count of smoker people In this study was small which after statistical analysis displays no statistical significance. This number of participants were taken randomly without any bias. Although, many studies contradicted with this result, such as: (Shrestha *et al*., 2021; Patel., 2022). Study conducted by (Shrestha *et al.*, 2021) indicated the incidence of *Candida* spp. was significantly related to smoking in which 22 approximately (44%) in smoker individual and 26 approximately (52%) among chewing smoker tobacco users. Smoker ones more susceptible to candidiasis due to adverse effect of smoking on epithelial layer, and the presence of nicotine that decreases salivary secretion. This leads to more proliferation of *Candida* spp. which causes colonization and formation infection. Other study conducted by (Patel., 2022)indicated the smoker individual especially who has unhealthy condition was more prone to infection, because of smoking leads to change and alteration in oral microbiota, and smoking lead to decrease salivary flow that enable *Candida* spp. to colonize and form thick biofilm. Especially when there was interference with other factors such as: poor oral hygiene or badly decayed tooth. The following graph (figure: 16) shows incidence of fungal infection in current study between smoker and non-smoker.

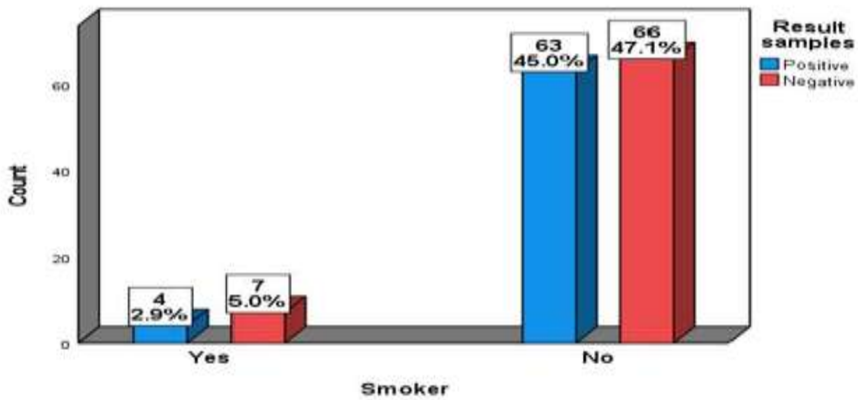


Figure (16): Incidence of fungal infection in smoker and non-smoker cases.

The only variable that showed a statistically significant association was pregnancy, $\chi^2 = 4.486$, $p = 0.034$. All pregnant women in the sample were found among the infected group (6.0% of positive cases), with none appearing in the non- infected group. The small sample size may limit generalizability, but this result suggests a potential vulnerability to oral fungal infections during pregnancy. In addition, the pregnant women might be risk factor for candidiasis. This result suggests a potential vulnerability to form oral fungal infections during pregnancy period. The results of current study contradicted with the results conducted by (Shaimaa *et al*., 2021), which conducted by taking 30 samples from non-pregnant women. In addition, to 30 other oral samples from pregnant women. (Shaimaa *et al*., 2021), study resulted, after cultivated and analyzed, there was no significance in relation to pregnancy, this study concluded the presence of *Candida* spp. was similar between pregnant and non-pregnant and to stabilize of infection requiring synergic between other factors such as poor oral hygiene. On the other hand, this result aligning with study of (Fujiwara *et al*., 2015), which indicated changing in the oral microbiota during pregnancy due to physiological changes and hormonal disturbances. Also, this study had significant relation with increase of *Candida* spp. proliferation, especially in the middle and late trimester of pregnant . Hormones changed and increased estrogen and growth hormone, leading to more proliferation of *Candida* spp. which enhanced colonization and causing infections. The following graph (figure: 17) displays incidence of candidiasis among pregnant and non-pregnant women.

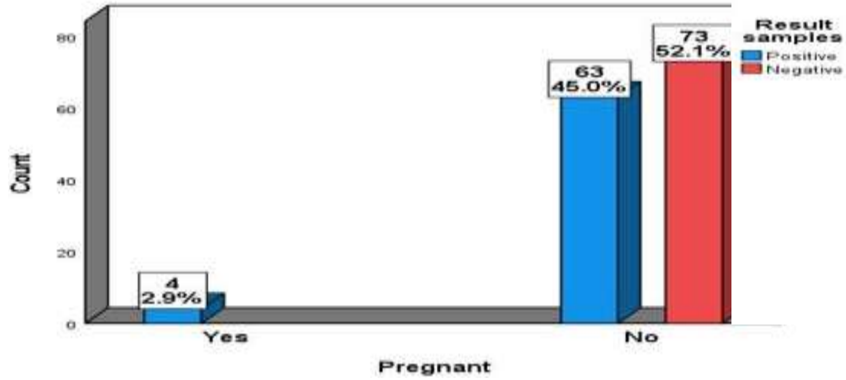


Figure (17): Prevalence of infection in pregnant and non- pregnant female.

In relation to oral cavity status and dental procedure, neither dental procedures nor oral hygiene status was significantly associated with infection in this analysis, despite observed differences in distribution. For example, bad oral hygiene was reported in 44.8% of infected cases versus 46.6% of non-infected cases, χ^2 = 1.951, p= 0.377, a showed in below graphs (figure: 18, 19).

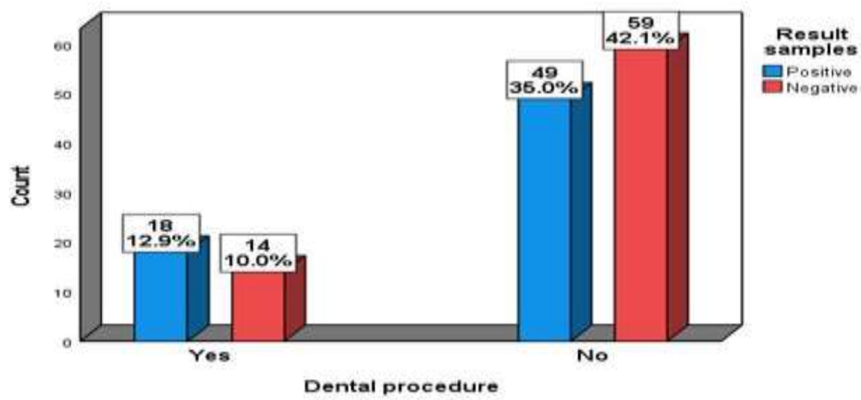


Figure (18): Positive and negative results in related to dental procedure.

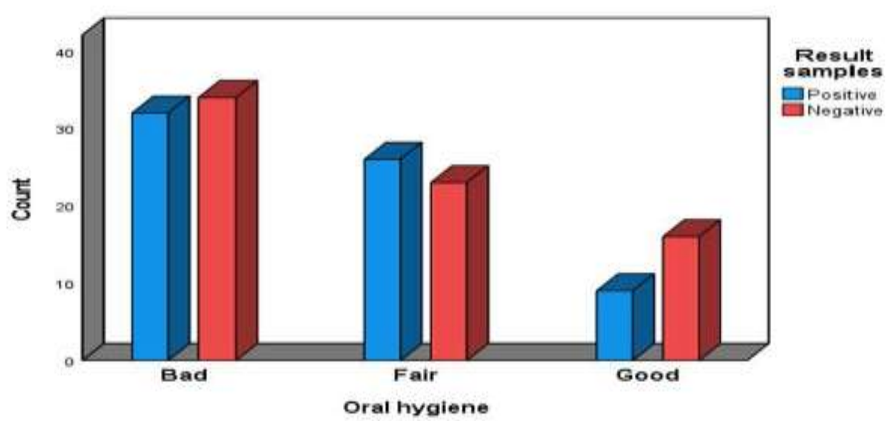


Figure (19): Results in regarding to oral hygiene status.

The current results were not consistent with below studies, perhaps due to small sample size and taking samples without any bias for any variables. Although, bad oral hygiene considered as an excellent niche for colonization, which formed biofilms by oral microorganisms and increased the chance to accelerate the infection as mentioned by many studies (Redfern *et al*., 2022; Ramadan *et al*., 2025; Cadavid *et al*., 2025). The study by (Redfern *et al*, 2022) focused and indicated that patient has dental procedure, excessive dental plaque, badly decayed teeth, or poorly hygiene more susceptible to candidiasis. This was because of the ability of *Candida* spp. to adhere and form biofilm that enabled them to colonize and form the infection. The study conducted by (Ramadan *et al*, 2025) indicated there was relation between *Candida* spp. carriage and patients who have dental procedure, which provided surfaces of dental appliances. The latter provide good attachment surface and increased chance to colonization and formation biofilm. In addition, the other study conducted by (Cadavid *et al*, 2025) showed relation among patients with dental prostheses and those who older than 40 years, who were subjected to high degrees of infection, (Cadavid *et al*, 2025) diagnosed 42.9% approximately(33/77) of cases which wearing dental prostheses with oral candidiasis due to decrease in oral care maintenance, inadequate dental prostheses care and surface texture of acrylic dental prostheses. This provided a good environment to adhering microorganisms leading to increasing in chance of infection.

Overall, in current study, except for pregnancy, none of the demographic or health variables showed statistically significant differences in infection rates between groups.

In regarding to distribution and incidence of oral fungal infections in Gharyan area next table (2) displays the distribution and incidence of *Candida* spp. that have been collected from patients.

Table (2): Incidence and Distribution of Oral Fungal Infections (OFIs).

***Candida* spp.**	**Count**	**%**	**Chi square**	**P value**
C. albicans	57	85.0	**177.552**	**< 0.001**
C. glabrata	4	6.0		
C. krusei	2	3.0		
C. parapsilosis	2	3.0		
C. tropicalis	2	3.0		
Total	67	100.0		

After identifying the samples that had growth, the responsible for oral fungal infection was *Candida* with different species. By using chrome-agar which used to identify the *Candida* spp. and the results as showed in table (2) the most frequent was *Candida albicans*.

The results presented in (Table 2) indicated a significant variation in the distribution of *Candida* species among oral fungal infections in the Gharyan area. The most frequently isolated species was *Candida albicans*, accounting for (85.0%, n = 57) of all cases. This was followed by *C. glabrata* (6.0%, n = 4), C. *krusei* (3.0%, n = 2), C. *parapsilosis* (3.0%, n = 2), and *C. tropicalis* (3.0%, n = 2). A chi-square test showed a statistically significant difference in the frequency distribution among these species, $\chi^2 = 177.55$, $p < 0.001$, suggesting that the predominance of *C. albicans* was not due to random variation. This distribution pattern highlighted a unique local epidemiological profile that may inform targeted prevention and treatment strategies. This result, aligning with study conducted by (Cadavid *et al*., 2025), indicated the most frequent and incidence was *C. albicans* 92.1% of cases, followed by *C. tropicalis*, and *C. parapsilosis* with different percentage. Besides, in this study, these was a relation between *Candida* spp. infection and prevalence of *Candida* spp. especially, among immunosuppressive patient, old aged and those who had oral prostheses. In addition, this result aligning with study conducted by (Černáková *et al*., 2022) which resulted that there was incidence of the *Candida* strains with different percentages. Moreover, most frequent spices was *C. albicans* 61.9%, followed by *C. krusei* (14.3%), *C. valida* (9.5%), and *C. glabrata*, *C. tropicalis*, and *C. intermedia* (4.8% for each species) and *C. albicans* was most frequent. In related to *Candida* spp. that caused infection in oral cavity due to presence of *Candida* spp. as normal flora in oral cavity. It can be converted to pathogenic when oral environment changed and cause opportunistic infection. In addition to virulent factors that enabled them to establish infection, while other species such as *C. krusei*, *C. parapsilosis*, *C. glabrata*, and *C. tropicalis* representing much lower proportions. The occurrence of non-*Candida albicans* was significant, indicating a shift in the epidemiology of oral candidiasis toward species with higher antifungal resistance potential. Also due to some of NCA had more resistance to antibiotics and overgrowth due to abuse of drugs or prolonged use that leading to unbalanced of oral microorganisms especially in recent years among immunosuppressive patients that increased chance to infection formation.

Following graph (Figure: 20) displays different *Candida* spp. and its occurrence in current study in Gharyan area.

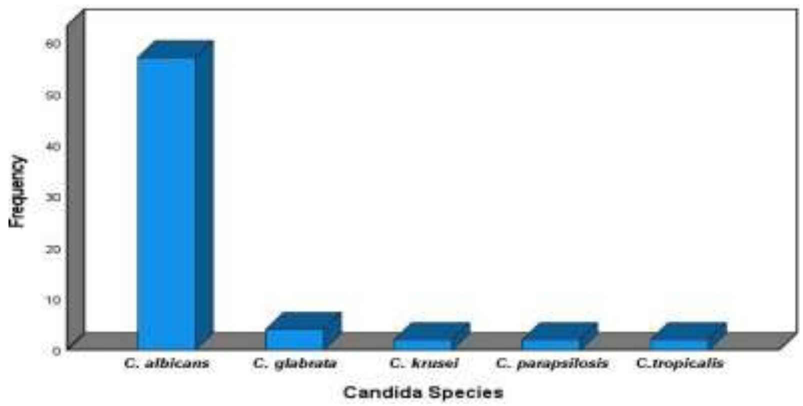


Figure (20): Graph displays occurrence of *Candida* spp**.**

Table (3): Comparison of mean values and standard deviation of *Candida* spp. inhibition.

***Candida* spp.**	**N**	**Mean ±SD**	**F value**	**P value**
C. albicans	**18**	**38.35[a] ±25.44**	**277.305**	**< 0.001**
C. glabrata	**18**	**48.40[b] ±29.467**		
C. krusei	**18**	**24.85[c] ±5.999**		
C. parapsilosis	**18**	**21.46[d] ±11.311**		
C. tropicalis	**18**	**29.59[e] ±7.582**		

Table (3) presented the results of the one-way ANOVA comparing the mean, and SD values of inhibition of *Candida* species in Gharyan area. Results revealed a statistically significant difference among the groups, F = 277.31, $p < 0.001$. Post hoc comparisons indicated that *C. glabrata* (M = 48.40, SD = ± 29.46) showed the highest mean inhibition, followed by *C. albicans* (M = 38.35, SD = ±25.44), *C. tropicalis* (M = 29.59, SD = ±7.58), *C. krusei* (M = 24.85, SD = ±5.99), and *C. parapsilosis* (M = 21.46, SD = ±11.31). These results suggested variability in treatment response or spontaneous regression among different *Candida* species. With *C. parapsilosis* showing the least favorable inhibition, this result in line with the study conducted by (Branco *et al*., 2023), indicated that *C. parapsilosis* have high resistance for treatment and have virulent factors enabling them to form biofilm and adapted easily when environment changed and caused infection, particularly in neonates and immunocompromised patients. In addition, other study conducted by (Husni *et al*., 2023) indicated the excessive use of medication caused changes in microbiota and increased in resistance among different fungal species especially non - *Candida albicans* spp.

Recently clinical and laboratory standard institute recommended to introduce specific minimum inhibitory concentration for each species of *Candida* (Branco *et al*., 2023). Below figure (21) displays mean values and standard deviation among *Candida* spp.

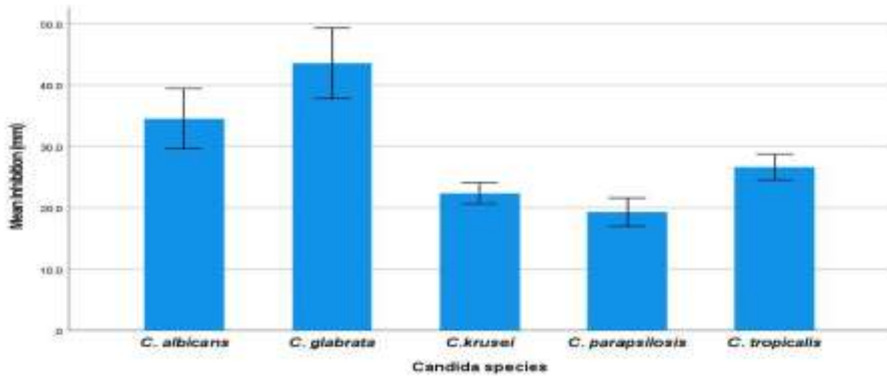


Figure (21): Comparison of mean and SD values of inhibition of *Candida* spp.

`Table (4): Efficacy of antibiotics in inhibiting oral fungal infections.

Antibiotics	N	Mean ±SD	F value	P value
Amphotericin B	**15**	**27.83^{a} ±5.216**	**6.796**	**0.004**
Miconazole	**15**	**22.43^{b} ±6.502**		
Nystatin	**15**	**20.60^{b} ±3.699**		

Table (4) presented the results suggest that Amphotericin B was significantly more effective in reducing oral fungal infections compared to the other two agents. The findings provide important evidence for clinicians when selecting antifungal therapy that supported the use of Amphotericin B as a potentially superior option in this context.

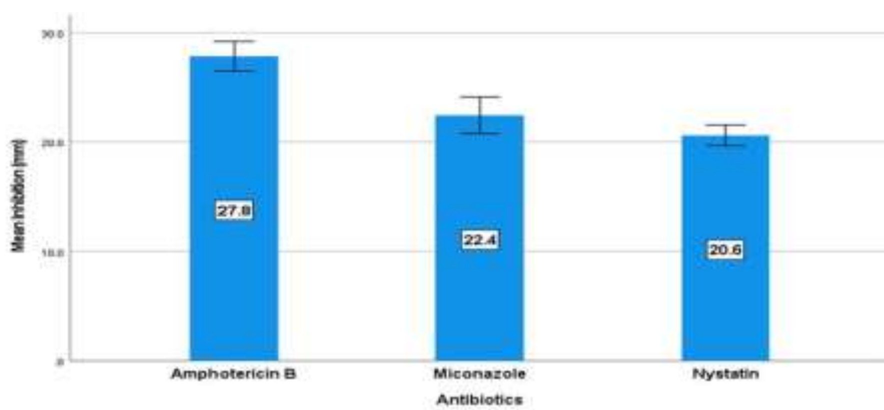


Figure (22): Efficacy of antibiotics against different *Candida* spp.

To discuss the efficiency of antifungal agents subjected on the different *Candida* spp. that isolated in this study, as showed in above graph (figure: 22), there were sensitivity to antibiotics that have been used i.e. Amphotericin B, Miconazole, and Nystatin. The results displayed in Table (4), Amphotericin B was significantly more effective in reducing oral fungal infections compared to the other two antibiotics. Although, miconazole and nystatin also showed efficacy but with different degrees and less effective than of Amphotericin B. This results was not consistent with local study conducted by (Ramadan *et al*., 2025), denoted that the isolated *C. albicans* was resistant to Amphotericin B. approximately 1% of *Candida albicans* had moderate response to Amphotericin B; while other 99% from same species had resistance to this drug and sensitive to other drugs such as: Fluconazole. Probably due to the difference in procedure in taking samples, dose which used in study, or the avoidance use of Amphotericin B which had many side effects. On the other hand, the efficacy of antibiotics are differentiated by different of *Candida* spp. or case from which the samples had been taken. For example: the study conducted by (Golestannejad *et al*., 2024) concluded there was difference in response to antibiotics before and after radiotherapy. *C. albicans,* in Golestannejad study, was sensitive to Nystatin and 71.4% was sensitive to Amphotericin B before radiation therapy, while after radiotherapy all *C .albicans* was 100% sensitive to Nystatin and 75% sensitive to Amphotericin B. See effect of different antibiotics on *Candida* spp. On plates (figure: 25, 28, 31, 34, and 37).

Table (5): Efficacy of Antifungal Agents to reduction Oral Fungal Infections.

Antifungal agents	N	Mean ±SD	F value	P value
Amphotericin B	15	27.83^{a} ±5.216	152.692	< 0.001
Miconazole	15	22.43^{b} ±6.502		
Nystatin	15	20.60^{bd} ±3.699		
Alcoholic clove extract 25%	15	18.27^{d} ±8.610		
Alcoholic clove extract 50%	15	29.37^{a} ±7.005		
Alcoholic clove extract 100%	15	41.40^{e} ±9.832		
Aqueous clove extract 25%	15	35.13^{f} ±26.457		
Aqueous clove extract 50%	15	43.80^{e} ±33.671		
Aqueous clove extract 100%	15	53.93^{g} ±27.82		
Clove oil	15	0.00 ±0.000		

A one-way ANOVA was conducted, displayed in (Table 5), to examine the efficacy of various antifungal agents against oral fungal infections in terms of mean reduction values. The results indicated a statistically significant difference among treatments, F = 152.69, p< 0.001. Post hoc comparisons showed that aqueous clove extract at 100% concentration (M = 53.93, SD = ± 27.82) produced the greatest reduction, followed by aqueous clove extract 50% (M = 43.80, SD = ±33.67), alcoholic clove extract 100% (M = 41.40, SD = ±9.83), aqueous clove extract 25% (M = 35.13, SD = ±26.45), and alcoholic clove extract 50% (M =29.37, SD = ±7.005). Standard antifungal drugs such as Amphotericin B (M = 27.83, SD = ±5.21), Miconazole (M = 22.43, SD = ±6.50), and Nystatin (M = 20.60, SD = ±3.69) showed moderate efficacy but they were generally less effective compared to higher concentrations of clove extracts. These findings suggested in general, the clove extracts may represent a promising natural alternative to conventional antifungal treatments, particularly at 100% concentration. This result aligning with study conducted by (Abdellatif *et al*., 2023), that compared the efficacy of clove extract with Miconazole gel, and that resulted the efficacy of clove extract was more effective compared to commonly medication that may have undesirable side effect. The clove effect showed promised natural product to treat *Candida* infection. Following graph displays different antifungal agents used in current study (figure: 23). In contrast, clove oil (M = 0.00, SD = 0.00) demonstrated no antifungal effect. This result was not in line with study conducted by (Hosseini *et al*., 2024) that showed antifungal had effect when using zinc oxide Eugenol sealer on *C. albicans.* Perhaps due to different in manufactures or because in current study, the researcher used the Eugenol only without mixing with powder in this restoration. See effect of clove extract on different *Candida* spp. on Plates (figure: 26, 27, 29, 30, 32, 33, 35, 36, 38 and 39).

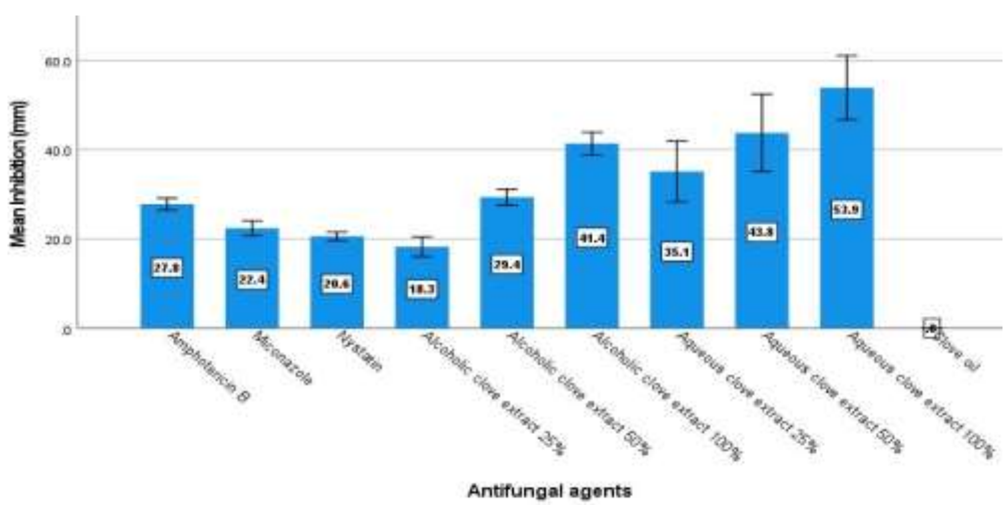


Figure (23): Efficacy of antifungal agents to inhibition of oral fungal infections.

A comparative ANOVA was performed to assess the mean efficacy of antifungal agents and clove extracts against different *Candida* species in reducing oral fungal infections (Table 6, figure 24). The results demonstrated significant variability in antifungal effectiveness across treatments, F (varied by species) = 58.93, $p < 0.001$ for *C. albicans*, with similar patterns observed for the other species.

Table (6): Comparative Analysis of antifungal agents against Different *Candida* Taxa.

Candida spp	Antibiotic	N	Mean ± SD	F value	P value
C. albicans	Amphotericin B	3	26.33±10.611	58.931	< 0.001
	Miconazole	3	18.83±3.055		
	Nystatin	3	24.50±5.408		
	Alcoholic clove extract 25%	3	11.83±0.289		
	Alcoholic clove extract 50%	3	30.39±0.836		
	Alcoholic clove extract 100%	3	44.90±0.985		
	Aqueous clove extract 25%	3	24.67 ±1.528		
	Aqueous clove extract 50%	3	80.33 ±1.528		
	Aqueous clove extract 100%	3	83.33 ±3.055		
C. glabrata	Amphotericin B	3	31.00 ±1.803		
	Miconazole	3	27.67 ±1.607		
	Nystatin	3	20.33 ±1.041		
	Alcoholic clove extract 25%	3	11.83 ±0.289		
	Alcoholic clove extract 50%	3	36.00±10.682		
	Alcoholic clove extract 100%	3	48.75 ±1.982		
	Aqueous clove extract 25%	3	85.33 ±0.577		
	Aqueous clove extract 50%	3	84.67 ±5.508		
	Aqueous clove extract 100%	3	90.00 ±0.000		
C. krusei	Amphotericin B	3	28.33 ±1.041		
	Miconazole	3	31.17 ±0.289		
	Nystatin	3	19.17 ±2.021		
	Alcoholic clove extract 25%	3	23.33 ±0.289		
	Alcoholic clove extract 50%	3	28.72 ±8.238		
	Alcoholic clove extract 100%	3	24.30 ±3.477		
	Aqueous clove extract 25%	3	20.67 ±1.528		
	Aqueous clove extract 50%	3	16.00 ±1.732		
	Aqueous clove extract 100%	3	32.00 ±2.000		
C. parapsilosis	Amphotericin B	3	25.17 ±4.805		
	Miconazole	3	15.00 ±2.000		
	Nystatin	3	19.00 ±5.568		
	Alcoholic clove extract 25%	3	12.00 ±0.500		
	Alcoholic clove extract 50%	3	21.90 ±2.451		
	Alcoholic clove extract 100%	3	43.44 ±8.946		
	Aqueous clove extract 25%	3	15.67 ±4.042		
	Aqueous clove extract 50%	3	7.67 ±1.155		
	Aqueous clove extract 100%	3	33.33 ±1.528		
C. tropicalis	Amphotericin B	3	28.33 ±4.537		
	Miconazole	3	19.50 ±3.041		
	Nystatin	3	20.00 ±0.000		
	Alcoholic clove extract 25%	3	32.33 ±0.289		
	Alcoholic clove extract 50%	3	29.83 ±1.638		
	Alcoholic clove extract 100%	3	45.61 ±2.965		
	Aqueous clove extract 25%	3	29.33 ±1.155		
	Aqueous clove extract 50%	3	30.33 ±1.528		
	Aqueous clove extract 100%	3	31.00 ±3.000		

For *C. albicans*, aqueous clove extract at 100% concentration (M = 83.33, SD = ±3.05) and, aqueous clove extract at 50% (M = 80.33, SD = ±1.52) achieved the highest efficacy far exceeded conventional antifungal drugs such as Amphotericin B (M = 26.33, SD = ±10.61) and Miconazole (M = 18.83, SD = ±3.05). This result consistent with result of (Qassim *et al*., 2024) due to properties of clove extract were attributed to its active compounds, particularly Eugenol, which had been shown to disrupt fungal cell membranes, inhibit biofilm formation and inhibit fungal growth. Similarly, for *C. glabrata*, aqueous clove extract at 100% (M = 90.00, SD = 0.00) showed the greatest reduction when compared to alcoholic clove extract and the effect outperforming by Amphotericin B (M = 31.00, SD = ±1.80) and Nystatin (M = 20.33, SD = ±1.04). In regarding to efficiency of alcoholic extract, this result was not consistent with study conducted by (Mostafa *et al*., 2022) which alcoholic clove extract showed good effect on *C. glabrata*, alcoholic solvent had high efficiency to extract more active ingredients than water solvent.

Likewise for *C. tropicalis*, alcoholic clove extract at 100% (M = 45.61, SD = ±2.96) outperformed both standard antifungals and aqueous clove preparations. As well, in case of *C. parapsilosis*, alcoholic clove extract at 100% concentration (M = 43.44, SD = ±8.94) produced the strongest inhibition, whereas lower aqueous concentrations showed limited efficacy. This result was in line with results of (Mostafa *et al*., 2022) showed good effect as prevent proliferation of *Candida* spp. and had anti- *Candida* effect.

Finally, for *C. krusei*, aqueous clove extract at 100% concentration (M = 32.0, SD = ±2.00) achieved the highest efficacy. However, Miconazole (M = 31.17, SD = ±0.28) and Amphotericin B (M = 28.33, SD = ±1.04) were relatively more effective compared to other concentration of aqueous and alcoholic clove extracts. It Suggested species-specific differences, that confirmed results showed by (Ambe *et al*., 2020). His results highlighted the *C. krusei* had resistance properties more than other strain of non-*Candida albicans* and this strain was responsible for hospital infection and more frequent among HIV patients.

Overall, the findings indicated that aqueous and alcoholic clove extracts, particularly at higher concentrations, exhibit strong antifungal activity against most *Candida* species, and it sometimes surpassed standard antifungal medications. Nonetheless, species-specific variability was evident as *C. krusei* that roughly responded similar to conventional antifungal drugs compared to clove extracts, as shown in figure (24).

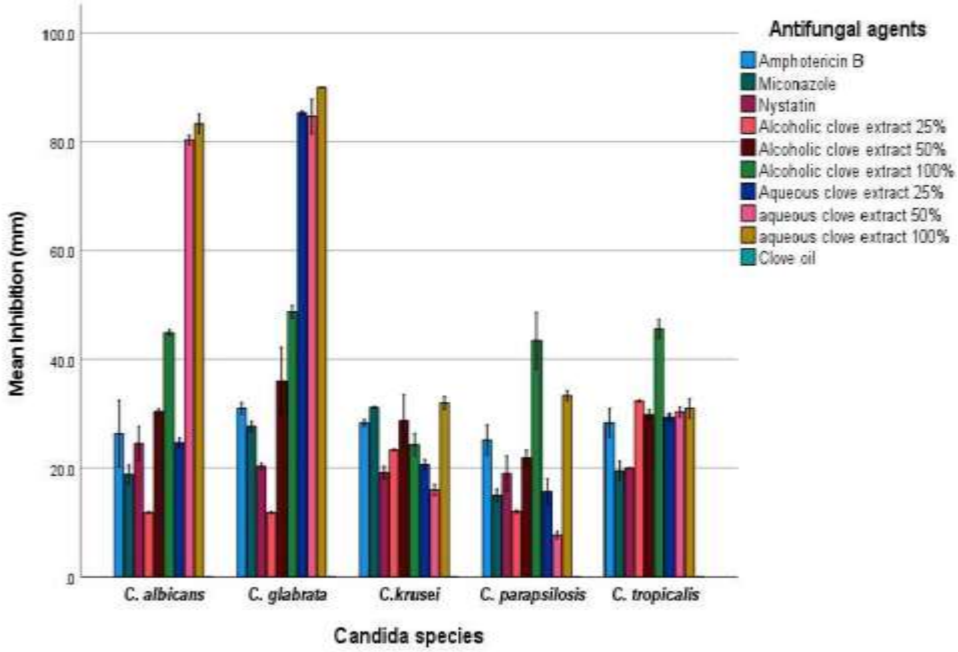


Figure (24): Effect of different antifungal agents against each *Candida* spp.

The next figures displays effect the different antifungal agents on *Candida* spp. Firstly, by *C. albicans*, *C. glabrata*, *C. krusei*, *C. parapsilosis*, and *C. tropicalis*, respectively.

A	B	C
		

Figure (25): Effect of Antibiotics, A.Amphotericin B, B. Miconazole and C. Nystatin on *Candida Albicans.*

A	B	C
		

Figure (26): Effect of alcoholic clove extract on *Candida albicans* A. with 100%, B. with 50%, C. with 25%concentration.

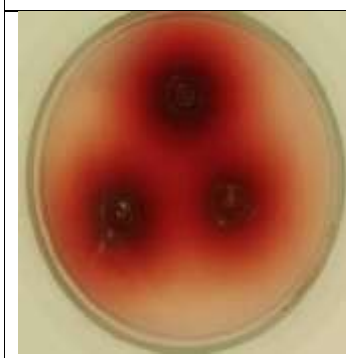
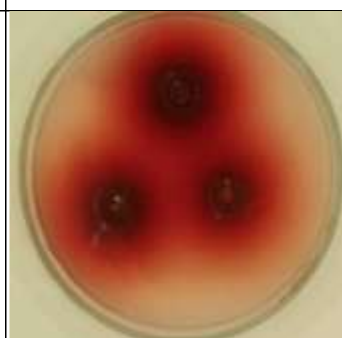
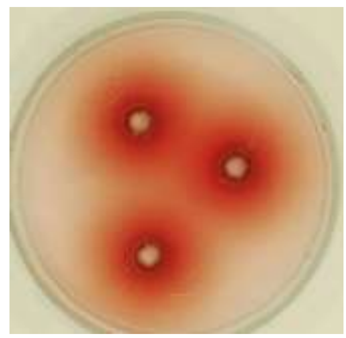
A	B	C
		

Figure (27): Effect of aqueous clove extract on *C. albicans*. A, with 100%. B, with 50% and C, with 25% concentration.

A	B	C
		

Figure (28): Effect of antibiotics on *C. glabrata*. A, Amphotericin B. B, Miconazole. C, Nystatin.

A	B	C
		

Figure (29): Effect of alcoholic clove extract on *C. glabrata* A, with 100%. B, with 50%. C, with 25% concentration.

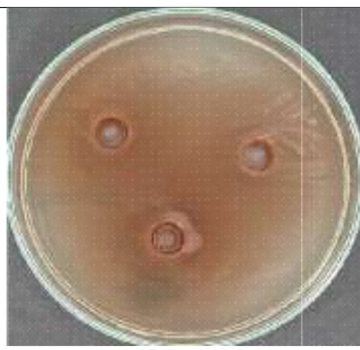
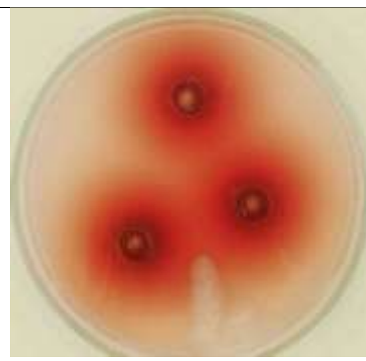
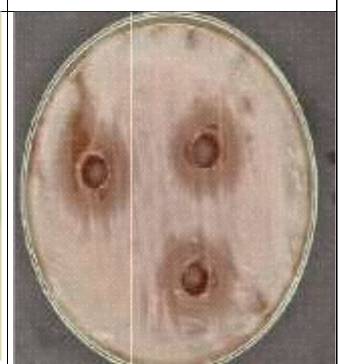
A	B	C
		

Figure (30): Effect of aqueous clove extract on *C. glabrata* A, with 100%. B, 50%. C, with 25% concentration.

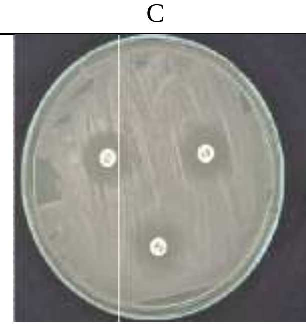
A	B	C
		

Figure (31): Effect of some antibiotics on *C. krusei* that showing inhibition zone. A, Amphotericin B. B, miconazole. C, Nystatin.

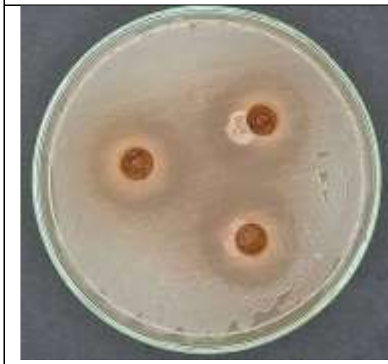
A	B	C
		

Figure (32): Effect of alcoholic clove extract on *C. krusei*, A. with 100%. B, with 50%. C, with 25%concentration.

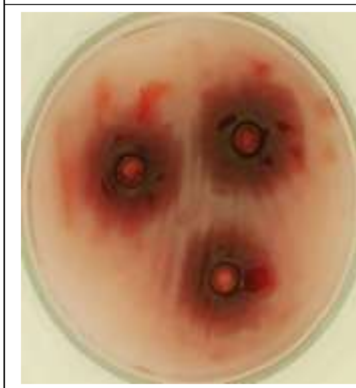
A	B	C
		

Figure (33): Effect of aqueous clove extract on *C. krusei*. A, with 100%. B. with 50%. C, with 25%concentration.

A	B	C
		

Figure (34): Effect of some antibiotics on *C. parapsilosis*. A, amphotericin B. B, miconazole .C, Nystatin.

A	B	C
		

Figure (35): Effect of alcoholic clove extract on *C. parapsilosis*. A, with 100%. B, with 50%. C, with 25% concentration.

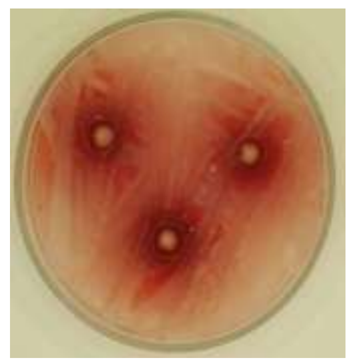
A	B	C
		

Figure (36): Effect of aqueous clove extract on *C. parapsilosis*. A, with 100%. B with 50%. C, with 25%concentration.

A	B	C
		

Figure (37): Effect of some antibiotics on *C. tropicalis*, showing inhibition zone. A, Amphotericin B. B, Miconazole. C, Nystatin.

A	B	C

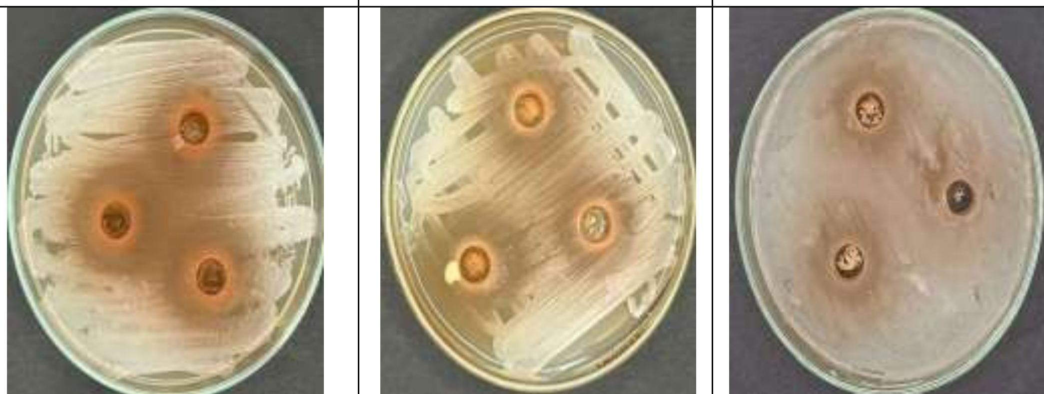


Figure (38): Effect of alcoholic clove extract on *C. tropicalis*. A, with 100%. B, with 50%. C, with 25%concentration.

A	B	C

Figure (39): Effect of aqueous clove extract *C. tropicalis* A, with 100%. B with 50%. C, with 25% concentration.

CONCLUSION

Ultimately, the current study concluded in regarding to oral fungal infection in Gharyan area, find among 140 case there are 67 positive case having candidiasis distributed between both male and female in different ages. most of demographic data and health condition that analyzed in this study was not statistically significance, and not related to oral fungal infection. Except pregnancy was the only demographic or health-related variable significantly associated with higher infection rates. Age variable was not significantly associated with oral fungal infection, indicating close age distributions among infected and non-infected participants. Likewise, gender did not show a significant association, with infection rates being nearly identical between males and females. Similarly, diabetes mellitus, blood pressure, and oral prostheses showed not significantly associated with infection status.

After identifying the samples that had growth, the responsible for oral fungal infection was *Candida* with different species. By using chrome-agar was used to identify the *Candida* spp. the most frequent was *Candida albicans*. These results indicate a significant variation in the distribution of *Candida* species among oral fungal infections in the Gharyan area. The most frequently isolated species was *Candida albicans*, accounting for (85.0%, n = 57) of all cases. This was followed by *Candida glabrata* (6.0%, n = 4), *Candida krusei* (3.0%, n = 2), *Candida parapsilosis* (3.0%, n = 2), and *Candida tropicalis* (3.0%, n = 2). *C. albicans* was most frequent In related to *Candida* spp. that cause infection in Gharyan area, while other species such as *C. krusei*, *C. parapsilosis, C. glabrata*, and *C. tropicalis* representing much lower proportions. Difference in the frequency distribution among these species, suggesting that the predominance of *C. albicans* is not due to random variation. This distribution pattern highlights a unique local epidemiological profile that may inform targeted prevention and treatment strategies.

Traditional antifungal drugs like amphotericin B, and miconazole showed moderate efficacy, with varying effectiveness depending on the fungal strain. Amphotericin B was significantly more effective in reducing oral fungal infections compared to the other two antibiotics. Although, Miconazole and Nystatin also showed efficacy but with different degrees and less effective than of Amphotericin B.

The findings provide important evidence for clinicians when selecting antifungal therapy, supporting the use of Amphotericin B as a potentially superior option in this context.

In regarding to Clove extract, both of aqueous and alcoholic show superior effect on *Candida* spp. except in *C. krusei*, which the effect of traditional antibiotic almost nearly to effect of clove extract suggesting species-specific differences. Overall, the findings indicate that aqueous and alcoholic clove extracts, particularly at higher concentrations, exhibit strong antifungal activity against most *Candida* species, often surpassing standard antifungal medications.

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5. RECOMMENDATION

1. Promote further clinical research into the antifungal properties of clove extract, particularly at high concentrations, given its superior efficacy in this study.
2. Consider integrities clove extract into treatment protocols or as a complementary therapy, especially in populations with resistance to standard antifungals.
3. Raise awareness among pregnant women regarding their increased susceptibility to oral fungal infections and encourage preventive dental care during pregnancy.
4. Implement routine fungal screening in at-risk groups, particularly among pregnant patients and individuals with poor oral hygiene.
5. Encourage species-specific antifungal treatment, since different *Candida* strains respond differently to treatment options.

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7. APPENDICES

Appendix (1): Ethical Approval Letter.

State of Libya
Ministry of Higher Education and Scientific Research
Libyan Authority for Scientific Research
NRCTTD

دولة ليبيا
وزارة التعليم العالي و البحث العلمي
الهيئة الليبية للبحث العلمي
المركز الوطني لأبحاث امراض
المناطق الحارة و العابرة للحدود

الموافق 21 / 8 / 2025 م

الرقم الاشاري / 14

Ethical Approval Letter

Title of the research proposal:

Incidence of oral fungal infections in Gharyan area

Dear: ايمان سالم الفورتي

The Subcommittee for Bio-safety and Bioethics at the National Research Center for Tropical and Transboundary Diseases has reviewed and approved your application form to conduct the above-mentioned research in the meeting held on 14/8/2025. Your approved application was given reference no. NBC: 016.H.25.16

Yours sincerely

Chairman of the subcommittee

صورة منه إلى:
• ملف اللجنة

Alzintan - Libya | +218914307212 | info@nrcttd.edu.ly | www.nrcttd.edu.ly

Appendix (2): Questionnaire and Patient Informed Consent Form for Participation in a Research Study:

أكاديمية الدراسات العليا-فرع غريان

جدول استبياني للمشاركة في البحث العلمي

عنوان البحث: **حدوث العدوات الفطرية الفموية في مدينة غريان**

للباحثة: **إيمان سالم عمر الفورتي**

جدول استبياني لغرض إجراء بحث علمي يوضح البيانات المطلوبة أثناء جمع العينات من المرضى:

الرقم التسلسلي للمريض	العمر	الجنس	مرض السكري	ضغط الدم	الحمل	التدخين	الإجراءات السنية	صحة الفم	السرطان	توقيع المريض

دعوة للمشاركة:

أنت مدعو للمشاركة في دراسة بحثية علمية تهدف إلى معرفة حدوث العدوات الفطرية الفموية في مدينة غريان، يمكنك طلب أي توضيحات إضافية من الباحث دون تحمل أي تكاليف مالية.

حقوق المشارك:

1-يحق لك رفض المشاركة أو الانسحاب في اي وقت.

2-السرية التامة للبيانات الشخصية.

3-يحق لك الحصول على جميع نتائج الفحوصات.

موافقة المشارك:

أقر بأنني قد فهمت جميع جوانب هذه الدراسة، وقد تمت الإجابة على جميع استفساراتي، واوافق طواعية على المشاركة في هذا البحث.
توقيع المشارك: ....

التاريخ:...../....../.......

Appendix (3): Libyan Academic Approval Directed to Polyclinic Center and School:

Ministry of Higher Education
And Scientific Research
The Libyan Academy Gharyan

وزارة التعليم العالي والبحث العلمي
الأكاديمية الليبية
فرع غريان

الإشاري: 1/...
التاريخ:
الموافق: 2024/12/3

السادة: إدارة العيادة المجمعة /غريان

بهذا نفيدكم إدارة الأكاديمية الليبية للدراسات العليا / فرع غريان ، بأن الطالبة/ إيمان سالم الفورتي- رقم القيد (220300572) بمدرسة العلوم الأساسية، قسم علوم الحياة شعبة أحياء الدقيقة، بصدد إعداد رسالة الماجستير بعنوان (حدوث العدوات الفطرية الفموية في مدينة غريان) بحاجة إلى عينات ذات علاقة بإعداد البحث.

تأمل منكم المساعدة في توفير البيانات المتاحة لديكم
ولكم جزيل الشكر سلفا على حسن تعاونكم
والسلام عليكم ورحمة الله وبركاته

أ.د. صلاح الدين النيه جمعة
وكيل الشؤون العلمية بالأكاديمية الليبية للدراسات العليا
فرع غريان

العنوان الرئيسي ،غريان ، خلف معهد الهادي كعبار | المركز الإعلامي للأكاديمية الليبية ، غريان

Ministry of Higher Education
And scientific Research
The Libyan Academy Gharyan

وزارة التعليم العالي والبحث العلمي
الأكاديمية الليبية
فرع غريان

الإشاري: 2025/11/57
التاريخ:
الموافق: 2025/2/13

السيد المحترم : مراقب التربية والتعليم غريان

بهذا نفيدكم إدارة الأكاديمية الليبية للدراسات العليا / فرع غريان ، بأن الطالبة إيمان سالم عمر الفورتي - رقم القيد (220300572) بمدرسة العلوم الأساسية ، قسم علوم الحياة ، شعبة أحياء دقيقة بصدد إعداد رسالة الماجستير بعنوان (حدوث العدوات الفطرية الفموية في مدينة غريان) بحاجة إلى بيانات ذات العلاقة بإعداد البحث .

تأمل منكم المساعدة في توفير البيانات [illegible] لديكم
ولكم جزيل الشكر سلفا على حسن [illegible]
والسلام عليكم ورحمة الله وبركاته

أ.د. هدى [illegible] أبوخريص
المسجل العام بالأكاديمية الليبية للدراسات

العنوان الرئيسي ، غريان ، خلف معهد الهادي كعبار | المركز الاعلامي للأكاديمية الليبية ،غريان

8-المستخلص

الالتهابات الفطرية الفموية أصبحت شائعة الحدوث، خاصة بين الأشخاص ذوي المناعة المنخفضة، هدفت هذه الدراسة إلى دراسة حدوث وانتشار عدوى الفطريات الفموية في منطقة غريان، جمعت 140 عينة فموية بواسطة مسحات معقمة من المرضى، وتم زراعتها والتعرف عليها بواسطة الكروم كانديدا آجار، حيث كانت معدل الاصابة67 حالة موجبة مايعادل(47.9%), والنوع الأكثر شيوعا هي كانديدا البيكانس(85%) ، تليها كانديدا جلابراتا (6%)، بينما كانديدا كروسياي، وكانديدا برابسيلوسيس، كانديدا تروبيكاليس (3% لكل من هذه الأنواع)، أظهرت نتائج التحليل الإحصائي عدم وجود فروق ذات دلالة إحصائية فيما يتعلق بحدوث العدوى(العمر، الجنس، السكري، التدخين، ضغط الدم، السرطان، الإجراءات السنية ونظافة الفم)، باستثناء حالات الحمل.

جميع عزلات كانديدا في هذه الدراسة كانت حساسة للمضادات المستخدمة الامفوتريسين ب، ميكونازول، والنيستاتين بدرجات حساسية متفاوتة بين الأنواع المعزولة، وفيما يتعلق بفعالية مستخلص القرنفل سواء المائي أو الكحولي، فقد أظهر فعالية عالية تفوقت حتى على المضادات الحيوية شائعة الاستخدام بدرجات متفاوتة مع كل نوع من الأنواع المعزولة، تشير الدراسة إلى أن مستخلص القرنفل له تأثير قوي وواعد على أنواع المبيضات المعزولة.

الكلمات الدالة: كانديدا ألبيكانس، الالتهابات الفطرية الفموية ، غريان، مستخلص القرنفل.

دولة ليبيا

الأكاديمية الليبية للدراسات العليا-فرع غريان

مدرسة العلوم الأساسية

قسم علوم الحياة

شعبة علم الأحياء الدقيقة

حدوث العدوات الفطرية الفموية في منطقة غريان

مقدمة من:

إيمان سالم عمر الفورتي

المشرف:

أ.د. محمد أحمد منصور الرياني

كلية الطب -جامعة الزنتان

رسالة مقدمة إلى مدرسة العلوم الأساسية بأكاديمية الدراسات العليا، لاستكمال متطلبات الحصول على درجة الماجستير في علم الأحياء الدقيقة (الفطريات الطبية).

2025