Super Glue Production by Dermatophytes: Review

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ABSTRACT: Dermatophytosis can be caused on by the invasion and infection of keratinized tissues in people and animals via a group of filamentous fungus known as dermatophytes. About a quarter of the world's population is affected by it which is one of the most prevalent superficial fungal diseases. Some of these fungi have the capacity to develop complex 3-D biofilm structures, or "biofilm," which are distinguished by the creation of extracellular polymeric molecules and a heightened drug resistance. The assessment of biofilm now relies on a variety of different methods, which frequently results in various evaluations of the microbial strains' capacity to create biofilms.

It has only recently been discovered the architecture and growth features of dermatophytic biofilms (Trichophyton spp., Microsporum spp.). Additionally, the structural complexity and lack of research on filamentous fungal biofilms make therapy challenging. Therefore, there is a demand for newer antifungals or methods for treating resistant dermatophytosis to offer an efficient, original, and safe substitute to current treatments. Therefore, this review highlighted on the significance, characterization and evaluation of biofilm that produced from dermatophytes.

KEY WORDS: Antifungal therapy, Biofilm, Dermatophytes, virulence factors.

INTRODUCTION

Trichophyton spp., Microsporum spp., and Epidermophyton spp. are three genera of Dermatophytes which are filamentous keratinophilic and keratinolytic fungi that are highly related to one another and have evolved to colonize and invade the keratinized tissues of both animals and people [1]. Dermatophytes can be categorized ecologically as geophilic, zoophilic, or anthropophilic depending on where they get their keratin from. Additionally, the majority of human infections are caused by anthropophilic species, and dermatophytes are the most prevalent aetiological agents of superficial mycoses [2].

According to estimates, dermatophytes afflict 25% of the world's population, with 30–70% of people acting as carriers who do not show any clinical symptoms [3]. In response to environmental changes, fungi may develop a variety of adaption mechanisms. A promising antifungal target is the fungal cell wall, which allows fungi to interact dynamically with their surroundings. Additionally, the pathogen's structural integrity, which is actively modified in response to stress conditions, is necessary for adhesion, signaling, and colonization [4].

Numerous instances of antifungal resistance have also been recorded, in addition to time-consuming and expensive therapies [5]. Skin peeling, a drop in humidity, a rise in skin pH, an increase in body temperature, and fatty acids are among the host's main defense mechanisms. Fungi, on the other hand, create adaptable responses to get around these difficulties [6]. In order to tolerate or resist the effects of antifungals, fungi set off a number of mechanisms including overexpression of drug efflux pumps, detoxification of enzymes, and modification of drug targets [7].

According to Brilhantea et al. (2019)[8], the development of a fungal biofilm makes treatment more challenging because it produces an extracellular polymeric matrix, which functions as a physical barrier to inhibit the entry of antifungal drugs and promotes the growth of cells that are resistant to antimicrobials. Additionally, biofilm development enhances the production of efflux pumps and the secretion of proteins that result in filamentation while decreasing the contact between fungi and the human immune system (Wang et al. 2021)[9].

The existence of biofilm is thought to be a significant contributing element to the chronic dermatophytic infection's resistance to traditional antifungal regimens.[10] In addition, giving critically ill patients excessive doses of antifungals frequently results in other complications. The rise of biofilm-based infections signals the need for biofilm-specific medications as well as fresh approaches to finding more effective therapeutic targets [11].
Significance of Biofilms in Dermatophytes

It has been demonstrated over the past few decades that many fungus have the capacity to produce biofilms, much like how bacteria do. Microbial colonies that are attached to biotic or abiotic surfaces and embedded in an exopolymeric matrix produce biofilms. By offering protection against environmental stresses, the host immune system, and antimicrobial substances, this structure improves the conditions for fungal survival both in the environment and within the host, facilitating host colonization and infection. Based on these features, the capacity of fungi to build biofilms is seen as a crucial component of their pathogenicity [2], and although the majority of research on fungal biofilms has focused on yeasts, it is known that filamentous and dimorphic fungus may also produce similar structures [12,13]

Burkhart et al.[14] initially described the potential of dermatophytes to form biofilm in vivo in dermatophytoma in conjunction with tinea unguium. Due to their strong adhesion to the nail plate and capacity to build biofilms, living fungi like hyphae and arthroconidia present in dermatophytoma instances make them resistant to conventional treatments and more challenging to surgically remove. Few research have examined the treatment failures of dermatophytosis, continuing the original report [15,16] The principal virulence mechanism in human nail infections caused by dermatophytes, which promotes chronicity and clinical relapses of infection, is thought to be biofilm development [17].

Characterizations of Biofilm

A colony of microorganisms creates tight structures called biofilms in which they are immersed in an extracellular matrix made of polymeric materials such proteins, extracellular nucleic acids, membrane vesicles, and polysaccharides.[18] Fungal cells called conidia initially attach to biotic and abiotic surfaces in order to form a biofilm. After being produced, the hyphal fragments, individual conidia, and mycelia enclose themselves in an extracellular matrix that strengthens the resulting biofilm [19]. The benefits of establishing a biofilm for an organism include environmental protection, resistance to physical and chemical stress, metabolic cooperation, and community-based gene expression regulation. Contributory factors include nutrients, quorum-sensing molecules, and surface contact [20] These defenses safeguard microbial pathogens from the immune system of the host and outside influences. Additionally, the development of biofilms led to the potential development of antimicrobial agent resistance, which raises significant issues for the treatment of microbial infections that require up to 100 times the amount of antimicrobials than planktonic cells do[21-23].

Steps of Biofilm formation:

According to Gonzalez-Ramrez et al. (2016)[24], there are four stages in the creation of a biofilm.
1) The first stage of biofilm formation, adhesion, occurs within the first four hours after cell aggregation and ECM production. During this stage, contact between the conidia and the surface as well as between conidia was formed. ECM structures were also visible, and conidial early co-aggregation was present. ECM tightens its bond with the cell in order to accelerate the growth of a fungal colony. The first surface attachment is influenced by a range of environmental parameters, including as the flow of the surrounding media (urine, blood, saliva, and mucus), pH, temperature, osmolarity, bacteria, the presence of antimicrobial agents, and host immunological components.[25].
2) Reproduction Conidia into hyphae with the development of the biofilm was a phase that needed 8–12 hours. Conidia developed in a variety of branching hyphae before anastomosis started. The effective cell accumulation created cellular organization (micro-colonies). Biofilm development requires 16 to 20 hours, during which time the hyphae grew and formed networks. Initially, channel perforation was observed while the ECM was squeezed and stretched between the hyphae. Last but not least, the isolate strain showed aberrant fungal structures resembling micro-hyphae with tiny.
3) A 24-hour period of biofilm growth. this stage entails The processes of mycelia creation, development, and propagation were more pronounced and involved hypha-hypha adhesion, condensed hyphal layering networks, and the performance of channels, a widespread formation of ECM, and high structural arrangement.
4) Cell separation and newly formed conidia were observed as a result of cell dispersion, which was predominantly noticed during the 24-hour mark of biofilm formation.

On the other hand, Costa-Orlandi et al., (2017)[26] described the steps of biofilm formation in six phases as following:

(I) Propagule adsorption, which involves spores, hyphal fragments, or sporangia coming into contact with a surface. (II) Active adhesion, in which spores produce adhesins throughout germination and other reproductive processes. (II) Active adhesion, in which
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understanding the spatial structure of the biofilm and its associated functions [35], despite the fact that SEM is the favored technique for seeing the three-dimensional biofilm structure. The biofilm roughness coefficient, its total biomass, average thickness, and surface-to-volume ratio can all be measured using image analysis [34].

CONCLUSION
The majority of fungal infections that result in dermatophytosis in people and other vertebrates are caused by dermatophytes. Treatment failures are frequently linked to biofilm formation. Biofilms are extremely resistant to most clinically used antimicrobials, requiring inhibitory concentrations 100 times higher than those required to stop planktonic cells from growing. Also, Over any other method of proliferation, biofilm offers fungi a number of advantages. Therefore, biofilms represent a growing issue in the context of human health. There are several ways to analyze the development of microbial biofilms, which most of them rely on automatic readers. Additional descriptors for fungi that produce biofilms may be added in future studies. Additional descriptors for fungi that produce biofilms may be added in future studies. Additional descriptors for fungi that produce biofilms may be added in future studies.

REFERENCES


