ZEUGMA BIOLOGICAL SCIENCE

ZEUGMA
BIOLOGICAL SCIENCE

2024
v:5 n:3 p:10-21

SECRET TINY TALK COMMENTARY OF FUNGI: YEAST AND MOLD AS FORZANDO CANDIDIASIS DISEASE '*Candida albicans*'

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ABSTRACT

The Quorum Sensing System (QS) an interbacterial communication system, which causes disease by triggering virulence, is now accepted and proven. The most important of this cellular communication network are signaling molecules. The general name of the signaling molecule mentioned here is Quorum Sensing Molecules (QSMs); specifically, the most famous molecule is *N*-Acyl Homoserine Lactones (AHLs). This sophisticated mode of cell-to-cell signalling, known as QS, was first discovered in marin bacteria as *Vibrio fischeri*. While investigating many research questions, *V. fischeri* was studied and sampled as a QS model organism. However, awareness of communication in this bacteria has raised the question of whether other tiny creatures in the microorganism world use QS system. Recent studies have proven that yeast and molds also communicate with each other using QS system. Molds and yeast, which are mycological organisms, use QS system, but the details are not yet known. In this manuscript, we review the information available to date on these processes in yeast and mold. We disscussed the diverse chemical 'languages' used by yeast and mold, their possible cross-talk and interkingdom interactions with other organisms. Cosmopalitan *Candida albicans* is a common cause of mucosal infections. In certain groups of immunocompromised patients it also causes life-threatening bloodstream infections that are disseminated to internal organs. It is a polymorphic fungus, being able to grow in yeast, hyphal and pseudohyphal forms. The hyphal form penetrates epithelia and endothelia, causing tissue damage and allowing access to the bloodstream. We discuss the role of QS in fungal colonisation pathogenesis. This review describes of the network of signal transduction pathways that monitors environmental cues to activate a programme of hypha-specific gene transcription, and the molecular processes that drive the highly polarized growth of hyphae.

Keywords: Yeast and mold, Quorum sensing system (QS), N-Acyl Homoserine Lacton (AHLs), Quorum sensing molecules (QSMs), *Candida albicans*, Fungal diseases

ÖZET

Virulansı tetikleyerek hastalığa neden olan bakterilerarası bir iletişim sistemi olan Quorum Sensing System (QS, Çevreyi Algılama Sistemi) artık kabul görmüş ve kanıtlanmıştır. Bu hücresel iletişim ağının en önemlileri sinyal molekülleridir. Burada bahsedilen sinyal molekülünün genel adı Quorum Sensing Molecules (QSMs, Çevreyi Algılama Sistemi Molekülleri); özellikle en ünlü molekül *N*-Asil Homoserin Laktonlardır (AHLs). QS olarak bilinen bu karmaşık hücreden hücreye sinyalleşme modu, ilk olarak deniz bakterilerinde *Vibrio fischeri* olarak keşfedildi. Birçok araştırma sorusunu araştırırken *V. fischeri*, QS model organizması olarak incelenmiş ve örneklenmiştir. Ancak bu bakterideki iletişimin farkına varılması, mikroorganizma dünyasındaki diğer minik canlıların QS sistemini kullanıp kullanmadığı sorusunu gündeme getirmiştir. Son yıllarda yapılan araştırmalar, maya ve küflerin

https://doi.org/10.55549/zbs.1483208

de QS sistemini kullanarak birbirleriyle iletişim kurduğunu kanıtlamıştır. Mikolojik organizmalardan küf ve mayalar QS sistemini kullanıyor ancak detayları henüz bilinmiyor. Bu yazıda maya ve kűfteki bu süreçlere ilişkin bugüne kadar mevcut olan bilgileri gözden geçiriyoruz. Maya ve küf tarafından kullanılan çeşitli kimyasal 'dilleri', bunların diğer organizmalarla olası karşılıklı konuşmalarını ve krallıklar arası etkileşimlerini tartıştık. Cosmopalitan *Candida albicans*, mukozal enfeksiyonların yaygın bir nedenidir. Bağışıklık sistemi baskılanmış belirli hasta gruplarında, iç organlara yayılan, yaşamı tehdit eden kan dolaşımı enfeksiyonlarınada neden olmaktadır. Maya, hif ve psödohifal formlarda büyüyebilen polimorfik bir mantardır. Hifal form epitel ve endotele nüfuz ederek doku hasarına neden olur ve kan dolaşımına erişime izin verir. QS'nin mantar kolonizasyon patogenezindeki rolünü tartışıyoruz. Bu inceleme, hifaya özgü bir gen transkripsiyon programını aktive etmek için çevresel ipuçlarını izleyen sinyal iletim yolları ağını ve hifaların oldukça polarize büyümesini yönlendiren moleküler süreçleri açıklamaktadır.

Anahtar Kelimeler: Maya ve küf, Çevreyi algılama sistemi (QS), *N*-Asil Homoserin Lakton (AHLs), Çevreyi algılama sistemi molekülleri (QSMs), *Candida albicans*, Mantar hastalıkları

INTRODUCTION

It has been understood that even bacteria that are seedless and do not have complex organelles, which we call "primitive", can detect the number of bacteria in their population and regulate their gene expression by talking to others! Twentieth century observed a huge paradigm shift in the field of micro sociobiology, which moved from social intelligence of microbes (Sharma et al., 2020).

Bacteria communicate with each other with the signal molecules they produce, and when they realize that they have reached the absolute majority they want, they cause disease in the host by synthesizing critical genes. This signaling system between bacteria is called the Quorum Sensing System (QS) (Jin et al., 2024). The signal molecules used in this system are most commonly known as Quorum Sensing Molecules (QSMs). QSMs are the small chemical molecules, which establish the mode of communication among microbes. These molecules are crucial for determining the decisions of cells, which is a density-dependent process (Sharma et al., 2020).

In addition to their many important benefits in nature and human life, some fungi cause diseases in plants, animals and humans. Particularly dimorphic fungi have great adaptability; It has been understood that they can cause major changes in their own structure, the content of their cell walls, their metabolism, enzyme systems and proliferation patterns when they settle in the host. On the other hand, in a situation where natural resistance is sufficiently reduced, many different types of fungi that cause mycosis also show that "probably all fungi can be considered potentially pathogenic", thanks to their ability to adapt to conditions and widespread (Yücel, 1999).

The American Conference of Governmental Industrial Hygienists (ACGIH) reported that mold density below 100 CFU/m^3 in indoor air is acceptable. The Health and Welfare Department in Canada states that a mold density of 50 CFU/m^3 is acceptable for only one type of mold, unacceptable for a pathogenic mold, a mold density of 150 CFU/m^3 is normal for mixed species, and up to 500 CFU/m^3 is acceptable for *Cladosporium* reported (Fabian et al. 2005).

In classifying fungi, their macroscopic and microscopic morphologies, mycelial features, spore, sporulation and sporangium shapes, life cycles, reproduction styles and other important characters are taken into consideration. According to various sources, there are 250,000-1,500,000 species of fungi in nature, but 150-300 species are pathogenic to humans. More than 110,000 fungal species have been identified so far (more than 30,000 of which belong to the *Basidiomycetes*, more than 30,000 to the *Deuteromycetes*, and more than 30,000 to the *Ascomycetes* classes), and the characters of some of them have not yet been fully elucidated (Zhang et al., 2023).

https://doi.org/10.55549/zbs.1483208

Molds; They are defined as "multicellular fungi that form mycelium", and yeasts are defined as "single-celled structures that generally do not form mycelium". Yeast and mold determination is based on preventing the growth of bacteria on food and isolating and counting yeast and mold (Singh, 2023). Some yeasts and molds; While they are useful in the production of foods such as cheese, beer and wine, they often play a role in the spoilage of foods. Yeast and molds are microorganisms that can easily grow in very wide pH ranges. They grow easily in the storage range of 10–35 ºC, at a water activity of 0.85 and above, and in environments with high salt and sugar concentrations.

Yeast and molds can cause structural defects, gas formation, bitter taste and bad odor in food, and they also cause food poisoning due to the toxic substances they secrete.

Aspergillus, Cladosporium and *Penicillium* are ascomycetes, 1st row: *Aspergillus spp.*, 2nd row: *Cladosporium spp.* and 3rd *Penicillium spp.* Species belonging to these three genera have high functional plasticity, are well adapted to spread in large numbers and long distances, therefore they are considered cosmopolitan, and can be found in the soil, textiles, paints, seeds, indoor environments, in the air, or as symbionts of plant and human and animal pathogens (Manoharachary et al., 2016).

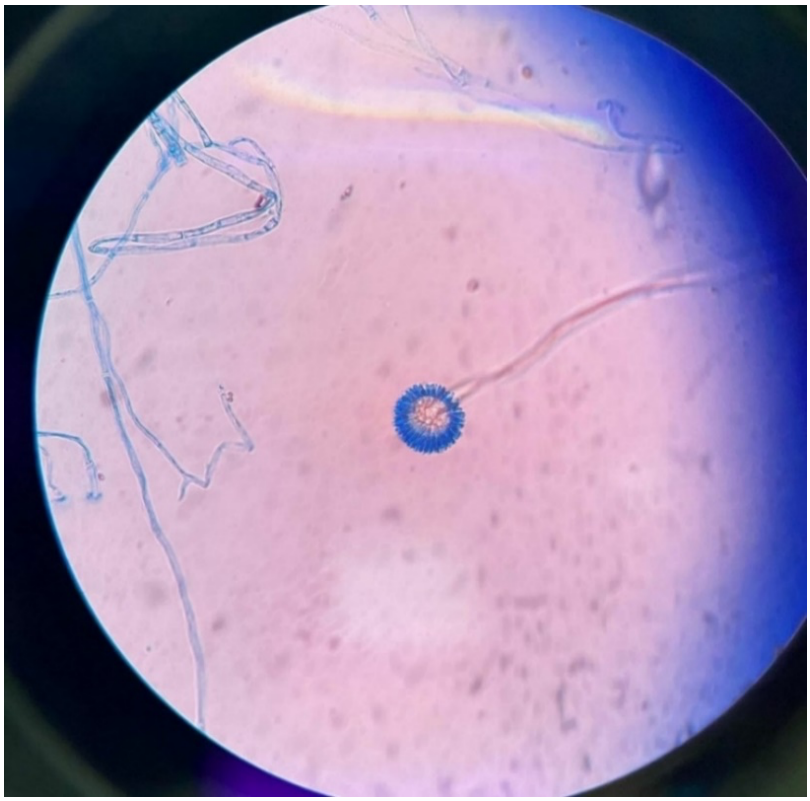

Figure 1. *Aspergillus spp.* Aspergillus P. Micheli ex Haller, (1768).

YEAST

Yeast cells have a round, oval and cylindrical appearance and are single-celled. Its dimensions vary between 2-10x3-16 µm, depending on the species and culture conditions. They reproduce by budding or splitting in half. Budding occurs from one or more points of a yeast cell, the matured structure breaks away from the parent cell and a daughter cell is formed. The daughter cell is called blastoconidia. In true yeast hyphae, the cell walls are parallel to each other. In the pseudohyphae, a concave structure is seen close to the budding area. Some yeasts reproduce by both budding and division. The cells formed in this way are called arthroconidia (Cutler and Hazen, 2020).

https://doi.org/10.55549/zbs.1483208

MOLD

Mold colonies are generally composed of thin, long and transparent microscopic filaments called hyphae. Their lengths are 1-3 cm (or longer) and their diameters are 5-10 µm, depending on the species. Network-like formations consisting of hyphae are called mycelium. When hyphae are examined in three dimensions, their cell walls are tubular structures parallel to each other. In some molds the hyphae are divided by transverse partitions. These transverse divisions in the cells are called septum. Hyphae with a septum are also defined as septate hyphae, and hyphae without a septum are called non-septated (senocytic) hyphae. Some of the hyphae within the same colony extend into the substrates on which they live to provide nutrition. In general, they are also called vegetative hyphae because they provide nutrition. Another part remains outside (aerial hyphae). Among the hyphae of this last type, some take part in reproduction and accordingly, special organizations are formed (reproductive hyphae, fertile hyphae) (Geris et al., 2023).

Hyalohyphomycetes species (*Aspergillus flavus, A. fumigatus, A. niger*), *Zygomycetes* species (*Rhizopus, Mucor, Absidia*), *Fusarium* species and other molds (*Pseudallescheria, Alternaria, Cladosporium*) whose spores are common in nature are the species that can most frequently cause disease. When they find sufficient moisture, heat and nutrients, they can grow very quickly and invade environment. It directly threatens health when number of conidial fungi suspended in 1 m^3 of inhaled atmospheric air reaches 10^6 (Rainer et al., 2000).

QS SYSTEM AND MOLECULES OF SYSTEM IN YEAST AND MOLD

In fungi, intraspecies communication regulates vital biological processes such as mating, growth, morphological switching and virulence expression. Those are controlled by messengers, which include alcohols, small peptides (pheromones), lipids (oxylipins), small molecules (acetaldehydes) and volatile compounds (CO_2) (Affeldt et al. 2012).

Although the QS mechanism is generally thought to occur in bacteria, in recent years it has been observed that this mechanism is also observed in molds and yeasts. However, the characteristics of the QS seen in molds and yeasts and the signaling molecules involved in this mechanism have not yet been clearly defined (Barriuso et al., 2018). For molds, the QS mechanism is not specific and its diversity is quite high (Padder et al., 2018). The QS mechanism in *Aspergillus* species is thought to regulate population-dependent behaviors such as the formation of secondary metabolites and morphogenesis, which is changing cell structure according to environmental conditions (Barriuso et al., 2018). Although it is known that the signaling molecule that provides this mechanism is oxylipins, information about how oxylipins are perceived and transmitted is limited (Affeldt et al., 2012). Oxylipins have the structure of 3,7,11-trimethyldodeca-2,6,10-trien-1-ol and are known as farnesol (Bacon et al., 2017). In their study in 2012, Affeldt et al. stated that *Aspergillu flavus* cultures use oxylipins as signaling molecules in the QS. The QS is based on stimulating the GprC and GprD genes of oxylipins, and by stimulating these genes, aflatoxin synthesis of *A. flavus* is stopped. Yeasts and molds in which the farnesol signaling molecule functions include *Penicillium sclerotiorum, Histoplasma capsulatum, Ceratocystis ulmi, Saccharomyces cerevisiae, Crytococcus neoformans, Ustilago maydis, Penicillium spp., Fusarium spp., Pleurotus spp., Leptomitus spp., Achlya spp., Saprolegnia spp.* can be counted (Bacon et al., 2017, Raina et al., 2010). According to some observations, the QS mechanism in *S. cerevisiae* yeasts occurs through aromatic alcohols derived from amino acids. It is thought that proliferating yeasts control the biofilm and virulence effect by producing tryptophan and phenylethyl alcohol (Barriuso et al., 2018). It is theorized that this mechanism occurs in *S. cerevisiae* yeasts when ARO9 and ARO10 key genes are stimulated by high cell density and tryptophan and phenylethyl alcohol are produced and used as signal molecules (Chen and Fink, 2006). Slime Molding or Slime Molds are unicellular organisms characterized by fruiting bodies

https://doi.org/10.55549/zbs.1483208

that may be formed through aggregation or fusion; Slime Molds contribute to the decomposition of dead vegetation. Evelyn Keller and Lee Segel, scientist who developedthe first models fort he Dynamics of a type of slime mold (*Dictyostelium discoideum*), laid the foundation for what was perhaps the first example of what was later called an 'emergent system' and showed that slime mold cells could trigger aggregation without following a leader, altering the amounts of information and matter they released individually. Thus slime mold cells may offer a fascinating example of other forms of aggregation derived from more-than-human systems. These beings can teach us other ways of understanding life, intelligence, and the relationships between biology and the environment. They are companion species to think about thenew ecologies of the future (Cull, 2013).

CANDIDIASIS DISEASE AND QSM-QS SYSTEM OF *C. albicans*

Although there are 200 different species belonging to the *Candida* genus, the source of 75% of Candidal infections is *C. albicans*, which is responsible for opportunistic, persistent infections that develop oral and vaginal in humans. According to Odds, there is a direct relationship between adhesion and the ability of *C. albicans* to colonize and cause disease (Odds, 1988).

One of the most interesting features of the *C. albicans* genome is the presence of structural changes such as chromosome length polymorphisms (narrowing or widening of sequence repeats), reciprocal translocations, chromosomal disappearances (deletions) and triplets (trisomies) in certain chromosomes to create genetic diversity. Since these karyotypic changes lead to phenotypic changes, they provide an adaptation strategy to this organism. Once the analysis of the *C. albicans* genome is completed, the mechanism of these changes will be better understood. The *C. albicans* genome is being sequenced at the Stanford DNA Sequencing and Technology Center. Funds for this project come from by the US National Institute of Dental and Craniofacial Research and the Burroughs-Wellcome Fund is provided. A pilot sequencing project is also funded by Beowulf Genomics and is being conducted at the Sanger Center.

In recent years, it has been reported that QS regulations exist in fungi like bacteria and affect the community-based behaviors of fungi such as biofilm formation and pathogenesis. The most intensive studies on this subject are on *C. albicans* (Hogan, 2006). *C. albicans* is an important opportunistic pathogen, dimorphic fungus that has a QS system. The process of transformation of budded yeast into a polarized filament is important in causing disease. It has been shown that when cell density increases in *C. albicans* culture suspensions in the stationary phase, the hyphal form is suppressed by a water-soluble factor, and this suppression also occurs in Candida tropicalis suspensions, but is not observed in other species (Hazen and Cutler 1979). In addition, it has been reported that many QS molecules such as tyrosol, farnesol and volatile play a role in the QS mechanism in *Candida albicans* yeast, which is an important pathogen in humans (Padder et al., 2018). In their study in 2001, Hornby et al. stated that farnesol activated the virulence effect of *C. albicans* at high cell density, but farnesol was not detected in tissues taken from patients in clinical findings. They stated that this indicates the possibility of farnesol as a signaling molecule that only initiates the QS mechanism (Hornby et al., 2001). In addition, the function of tyrosol in the QS mechanism seen in *C. albicans* is thought to be that it comes into play when farnesol is in limited abundance and acts as a signaling molecule like farnesol (Kruppa, 2008). If farnesol is produced in excessive amounts, the QS mechanism is suppressed and Volatile comes into play and takes over the function of the signaling molecule. This mechanism of volatile, like other signaling molecules, has not been fully explained (Schmidt et al., 2015).

In some cases, QS molecules may also take part in interspecies interactions outside the same microbial community. For example, the morphology of *C. albicans* is affected in the presence of *Pseudomonas aeruginosa* in the environment. It has been shown that the "3-oxo-C12 homoserine

https://doi.org/10.55549/zbs.1483208

lactone" molecule released by this bacterium suppresses hyphal development without affecting the fungal reproduction rate (Nag, 2024). QS signals can also have an antibiotic effect against the host or the micro-organism they compete with. Although *Aspergillus nidulans* does not produce a measurable amount of QS molecules, it does undergo apoptosis in the presence of farnesol.

This suggests that farnesol provides an advantage to *C. albicans* in its competition with *Aspergillus*. A similar inhibitory effect was also observed on S51 *Fusarium graminearum* (Kischkel et al., 2020). Farnesol can stop the reproduction of *S. cerevisiae* within 30 minutes by inducing reactive oxygen intermediates formed in mitochondria and inhibiting a signaling pathway. Farnesol also takes part in the bacterial-fungal interaction and increases the sensitivity of both $Gram^-$ and $Gram^+$ bacteria to antibiotics. It has been shown that farnesol disrupts the membrane integrity of *Staphylococcus aureus* at concentrations of 50-200 μM. Additionally, it has been shown that subinhibitory concentrations of some antifungal drugs increase *C. albicans* by stimulating farnesol production (Hogan 2006).

DISCUSSION

The first case recorded in the Western literature regarding the worsening of asthma due to exposure to mold was a case of asthma that entered a wine cellar where mold was fermenting and entered a severe attack in 1726 by Sir John Floyer. In 1873, Charles Blackley, a physician from Manchester, inhaled fungi from straw and stated the relationship between *Chaetomium elatum* and *Penicillium glaucum* and asthma attacks. In 1924, it was reported that asthma was common in humid regions in the Netherlands and that using filtered air was relieving (Denning et al., 2006). In 1924, Van Leeuwen stated that there was a seasonal relationship between mold spores in the atmosphere and asthma attacks (Hiram and Bush, 2001).

Candida albicans, also known as candida fungus, is a type of fungus that lives in the body and is a fungal infection caused by the overgrowth of yeast as a result of the disruption of the balance of healthy bacteria and yeast. The places most commonly affected by Candida fungus are the mouth, intestines and vagina. Candida fungi, which also cause infections in internal organs such as the kidneys, heart or brain, are seen with symptoms such as severe pain, diarrhea and mouth sores. Medicines containing antifungal ingredients are used in the treatment of candida fungus, allowing the infection to be cleared (Fanosh et al., 2024).

In 1969, Lingappa et al. In a study conducted on seven-day cultures of *C. albicans* in liquid Sabouraud medium, they showed that two products inhibited the growth of *C. albicans*: Phenyl ethyl alcohol and tryptophol. Although these molecules inhibited the growth of *C. albicans* at concentrations of 160 and 250 μM, Hazen et al.'s study showed that these molecules were not necessary for the inhibition of the germination tube. The same researchers showed that a molecule called "morphogenic autoregulatory substance" (MARS) is abundantly present in tissue cultures of *C. albicans* and that while it does not affect reproduction of non-germinating cells, it suppresses germination in germinating cells, and that ions such as cobalt, calcium and nickel are effective in directing the effect of this compound (Lingappa et al., 1969).

In 2001, two independent groups identified a molecule found in *C. albicans* supernatants that suppressed hyphal development: "Farnesol" (Oh et al., 2001; Weber et al., 2010). Farnesol is a signaling molecule that acts on *C. albicans* strains at a concentration of 1-50 μM and can suppress micelle formation despite the presence of substances that trigger hypha formation such as bovine serum albumin or proline N-acetyl glucosamine in the medium. However, high concentrations (10-250 μM) are needed to suppress hypha formation. In addition to suppressing hypha formation, it also protects the cell against hydrogen peroxide. These properties provided by Farnesol seem to be a good way for the fungus to escape from host defenses.

https://doi.org/10.55549/zbs.1483208

The second QS molecule produced by *C. albicans* is "tyrosol", a tyrosine derivative. “Tyrosol”, unlike farnesol, increases hypha formation. Thus, *C. albicans* can keep its morphogenesis under control with the help of farnesol and “tyrosol”. Two QS molecules identified in *Saccharomyces cerevisiae*, phenyl ethanol and tryptophol, are also produced by *C. albicans* and increase the formation of pseudohyphae when "Tyrosol" is not effective (Egbe et al., 2015).

Numerous studies report that over 80 airborne molds affect respiratory allergy-related health (Owhonka et al., 2024).

C. albicans is dimorphic fungus, and it was first fungus to be reported to have QS, used in control of its yeast cell-to-filamentous growth transition. One QSMs was identified as farnesol, which is excreted continuously during growth of *C. albicans* at levels that are proportional to cell density (Hornby et al. 2001). Pick of farnesol in environmental inhibits of germ tubes when cultures reach high density (Lindsay et al. 2012). Tyrosol, which was subsequently identified as second QSM in *C. albicans*, promotes cell growth and germ tubes at low density (Kruppa 2009).

In *S. cerevisiae*, aromatic alcohols 2-phenylethanol and tryptophol, which are derived from amino acids phenylalanine and tryptophan, serve as QSMs under low-nitrogen conditions (Wuster and Babu 2010). Similar to situation in bacteria, fungal QS can involve different compounds in species-specific signalling networks (De Sordi and Mühlschlegel 2009). Recently examined in *S. cerevisiae*, *Hanseniaspora uvarum, Torulaspora pretoriensis*, *Zygosaccharomyces bailii, Candida zemplinina* and *Dekkera bruxellensis*. Each of these showed species-specific kinetics for the production of 2-phenylethanol, tryptophol and tyrosol, although in *C. zemplinina* and *D. bruxellensis*, none of these QSMs were detected after 28 h of wine fermentation (Zupan et al. 2013).

Tiny molecules QSMs are maintained at low concentrations. The structures of most QSMs have been defined through X-ray crystallography and nuclear magnetic resonance (Wuster and Babu 2007). The effective research of QSMs demands the determination of kinetics of QSM (Avbelj et al., 2016).

A building surrounded by molds is considered sick, and this situation is defined as a sick building. Various types of undesirable clinical conditions may occur in people as a result of living, working in, or staying in a sick building for certain periods of time. Clinical symptoms that occur when a healthy person without any disease inhales indoor atmospheric pollutants are called Sick Building Syndrome (SBS). (London Hazards Centre, 1990). Symptoms of sick building syndrome include headache, eye, nose and throat irritation, dry cough, skin dryness or itching, dizziness, nausea, attention deficit, fatigue, and odor sensitivity (Hosseini et al., 2024). As a result of microbiological contamination of indoor air, extrinsic allergic alveolitis, humidifier fever, asthma, allergic rhinitis, sick building syndrome and infections may occur (Denning et al., 2006).

Molds are the most abundant particles in the air we breathe (Money, 2024). Molds creates adverse effects on human health on the nervous, respiratory, immune, hematological and dermatological systems and multiple organs and causes infections. Allergenic spores, even in small numbers, can enter the body through the eye conjunctiva, skin, respiratory and nasal mucosa and cause disease symptoms such as asthma, allergic rhinitis and conjunctivitis (Fabian et al., 2005.).

Fungal viruses, known as mycoviruses, are ubiquitous in filamentous fungi, including plant, insect, and human pathogenic and beneficial fungi. The infection rates of mycoviruses in different fungal species range from nearly zero to greater than 90 percent. Mycovirus can be transmitted horizontally and vertically through hyphal anastomoses and spores, respectively. In addition, some mycoviruses such as *Cryphonectria hypovirus* 1 (CHV1) and *Sclerotinia*

https://doi.org/10.55549/zbs.1483208

sclerotiorum hypovirulence-associated DNA virus 1 (SsHADV-1) can be hosted and transmitted by plants and insects, respectively (Rigling and Prospero, 2018).

CONCLUSION

Mold diseases symptoms manifest in multiple different ways that need to addressed. In every case, removal from the exposure is critical. We find that diagnosis and appropriate treatment for mycotoxins and other environmental toxicants needs to precede and be concurrent with treatment for other chronic diseases (Kuhn and Ghannoum, 2003).

Colonization does not reach into the deeper tissues, but now becomes an ongoing exposure to allergens, mycotoxins, and biotoxins and will complicate the impact. Even if the environmental source has been removed, exposure continues inside the body (Ammann, 2016).

Even bacteria can sense fungal and oomycetal volatiles and respond with changes in motility (Schmidt et al., 2016).

QS communication system has been included in most of the research today. This system is effective on both bacteria and fungi. *Pseudomonas aeruginosa* in bacteria and *C. albicans* in fungi use QS system to realize their pathogenicity. In simultaneous bacterial and fungal infections, the Quorum Sensing mediators of each microorganism also affect the other. Most of the time, mixed bacterial and fungal infections have gained more importance in both identification and treatment, and the decision of which is at the forefront in infections caused by two different microorganisms at the same time requires more caution (Hogan et al., 2006).

A QSMs is not solely a by-product of fungal catabolism. As vitally data, a QSMs is non-toxic in concentration range that is required to elicit response. Signal network affected by a QSMs is adaptive at level of cell density. Thus QSMs, cells manner in which the cells shouldn't act individually. A purified QSMs can reproduce the biological circumstance at a relevant. So, essential a purified QSMs can evoke biological circumstance at 'real-life'. A QSMs secretes and accumulates in the extracellular environment and is available to other cells. Instruments exist to sense and respond specifically to a QSMs. Winzer et al. (2002) claimed that QSMs should be conducted by specific receptor, while Monds and O'Toole (2008) found as in some cases, cells transfer a QSM and sense it as an intracellular. QSMs generates concerted response once a critical concentration has been reached, i.e. the 'quorum'. Here, QSMs concentration should be proportional to cell density.

In this article we have submitted a broad overview of a novel field of research, QS system in fungi. Over coming years will be able to elucidate whether fungal communication is common to taxonomic groups or is strain specific. In addition, an understanding of the molecular components of QS systems will be required to determine the extent of cross-talk among fungi, to decipher the origin of the fungal 'languages' and to unravel the way fungi communicate with other organisms, such as bacteria. Microbial fungal QS communication can determine will for clinical treatment purposes.

COMMENT

Yeast and mold social signalling the same at the level of mono-cultures as it is during the development of the microbial consortia? In other words, do yeasts 'talk' the same language with each other as that they use with other species in the surrounding microbial community? Yeast and mold communication molecules alphabet really so poor, that is really limited to only few 'letters', or are there also other, as yet unidentified QSMs? Yeast communication limited only to specific of growth cycle, or matter of continuously 'chatter'? Are the effects of QSMs truly stochastic, rather than deterministic? (Systems where we obtain outputs depending on certain inputs, such as a calculator or stereo, are deterministic systems. Systems in which there is a random relationship between input and output based on probability distribution, such as the stock

https://doi.org/10.55549/zbs.1483208

market system and economic systems, are also stochastic systems.) How do yeast and molds know that they have reached absolute majority? Do they count the QSMs molecules they secrete? If so, how do they understand the concept of 'number'? There are articles in the literature that talk about artificial intelligence for bacteria. Is this artificial intelligence also present in fungi? Can yeast and molds make the distinction between whether the molecule they secrete is the molecule they secrete, or whether it is the molecule secreted by an individual other than the fungus? If it can, what is the biological mechanism that manages this and how?

Compliance With Ethical Standards: This article does not contain any studies with human participants or animals performed by any of the authors.

Ethics committee approval: Ethics committee approval is not required for this research.

Financial disclosure: The authors have no financial disclosure to report.

Conflict of interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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