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Effects of Nonthermal Plasma on Fungi: Uses and Fungal Reactions

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Introduction

Understanding the impact of nonthermal plasma (NTP) treatment on fungi or other microorganisms is motivated by the complex interactions between the components of plasma and the unique and complex processes that the plasma induces in the fungal cells. NTP is used to devitalize and disinfect a variety of surfaces and liquids in medical, agriculture, and food processing. The use of NTP in biotechnology for managing antifungal resistance and fungus breeding may become more widespread. Recent advances in the use of various NTP device types in antifungal treatment were recently reviewed in a number of outstanding studies, however few articles went into great detail on the molecular pathways induced by NTP. We currently struggle with a lack of understanding of molecular mechanisms and have some issues . This study seeks to provide readers with the most recent knowledge on NTP formulations and designs, direct and indirect uses, and molecular mechanisms used by fungi in response to NTP because plasma has received substantial interest in antifungal treatment in recent years [1].

There are various chapters in the review. The NTP systems utilised in treating fungi, plasma production and composition, and biological processes that plasma in fungal cells might activate are all introduced in Section 2. Additionally, it provides an overview of the plasma's physiologically active reactive species and their impacts on fungus. A summary of plasma's uses in medicine, agriculture, food preservation, biotechnology, and cultural object protection is given in Section 3. Free electrons and ions in a quasi-neutral system called plasma act in concert [2].

Discussion

This behaviour is evident in the plasma response to applied external electromagnetic fields and departures from neutrality as well as in the plasma's capacity to sustain a wide range of waveforms and oscillations. Ionization, which creates a particular number of positive ions and free electrons, produces plasma. If quasi-neutrality holds true, the number density of electrons, denoted by the symbol ne, is about equal to the ion density, denoted by the symbol ni, and is referred to as the plasma density. The standard unit of plasma density is cm3. At atmospheric pressure, the plasma density can range from 109 to 1019 cm3, which corresponds to an ionisation level of 1010 to 1. Depending on how it was created, plasma. It can reach a temperature of up to 10^6 K. NTP is generated by an electric discharge when the generated ions reach a temperature close to the environment (maximum 340 K), which predestines NTP for use in many applications. NTP is often referred to as nonequilibrium plasma because it is not in thermodynamic equilibrium. Nonequilibrium plasma is characterized by the temperature of electrons ranging from a few eV to 10 eV, while the temperature of heavy particles varies from room temperature to a level comparable to the electron temperature but usually lower [3-5]. NTP is easily formed in the air at atmospheric pressure using various discharges. In addition to air, plasma can also be created in other gases such as nitrogen, oxygen, argon, or carbon dioxide. The most commonly used electric discharges are corona discharge, dielectric barrier discharge, and plasma. A corona discharge can be seen as a bright glow in Figure 1A. The active region of corona and plasma formation takes place close to sharp electrodes like thin wires, spikes, or edges in a highly non-uniform electric field with high intensities. A typical electrode geometry is point-to-plate geometry, which consists of a strongly curved electrode positioned as a counterpart to a flat electrode [6].

Conclusion

The pointed electrode might have a negative or positive potential when corona discharges are operated in direct current or pulsed mode. The utilisation of corona discharges is widespread in industry. Numerous studies looked into ways to increase protein secretion and spore germination without causing mutations. In a study by Farasat et al., the impact of NTP on recombinant phytase production in the yeast Pichia pastoris, as well as the composition and structure of the phytase enzyme, were assessed. After being in contact with plasma, either directly or indirectly, the yeast produced more recombinant phytase. When plasma was used to treat a commercial phytase solution with NTP, the enzyme activity increased by up to 125%. It was also demonstrated that this protein's secondary structure remained preserved following exposure to plasma, although the tertiary structure underwent a small modification. Two plasma discharges were used by Veerana et al. to treat A. oryzae cells, specifically a micro dielectric barrier discharge (MDBD) in nitrogen. The diversity of filamentous fungi, their capacity to construct intricate structures, and the development of hundreds of different cell types that react differently to plasma therapy present us with numerous difficulties when working with them. On the one hand, by lowering antifungal medications, NTP could aid in the fight against the establishment of novel infections and antifungal-resistant strains. On the other hand, when the extensive use of NTP is envisaged, one should be concerned about the creation and potential spread of genetically modified strains. We must deal with issues beyond only technical ones in the future. Additionally, those knowledge gaps on the molecular processes underlying fungal interactions with plasma reactive species must be filled.

Acknowledgement

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Conflict of Interest

None.

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