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Microbial Toxin Production: Opportunists and True Pathogens

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Abstract

A toxin is a poisonous substance produced within living cells or organisms. Toxins can be small molecules, peptides, or proteins that are capable of causing disease on contact with or absorption by body tissues interacting with biological macromolecules such as enzymes or cellular receptors. Microbial toxins include toxins produced by micro-organisms, including bacteria and fungi. Microbial toxins promote infection and disease by directly damaging host tissues and by disabling the immune system.

Keywords: Microbial toxin; Protein; Tissues

Introduction

Bacterial toxin

Bacteria generate toxins which can be classified as either exotoxins or endotoxins. Exotoxins are generated and actively secreted; endotoxins remain part of the bacteria. Usually, an endotoxin is part of the bacterial outer membrane, and it is not released until the bacterium is killed by the immune system.

Fungal toxins

Aflatoxin: First identified in the late 1950s, the toxin was named aflatoxin from *Aspergillus Flavus* (+ toxin), the fungal species from which aflatoxin was isolated. There are several named aflatoxins, including B1 (the toxin contains a visible blue spot) and G1 (contains a grayish spot). Aflatoxin B1 is approximately three times more toxic than aflatoxin G1.

The aflatoxins are primarily produced by *A. flavus* and *A. parasiticus*, although aflatoxins are also produced by other fungi. Aflatoxins are extremely toxic and their target organ is the liver. Aflatoxin B1 is considered when ingested to be the most potent naturally-occurring heptacarcinogen (liver carcinogen). Due to the level of toxicity and carcinogenicity, the action level for total aflatoxins in food destined for humans or lactating dairy mammals was set at 20 ppb shortly after it was identified in 1957; this number has been dropped to 1 ppb today. The average person consumes 0.002 ppb of aflatoxin daily (mostly through corn products) – this number is 10 times higher, or 0.02 ppb in the Southeastern U.S. 400 ppb of aflatoxin is lethal to humans, while 50 ppb will kill a horse. Aflatoxins have been proposed as the cause of the mysterious disappearance of civilizations in the American Southwest and South America prior to the appearance of Europeans.

Sterigmatocystin: This mycotoxin is produced by *Aspergillus veriscolor* and some strains of *A. flavus* and *A. parasiticus*. Sterigmatocystin is considered to be a biosynthetic precursor of aflatoxin, and like aflatoxin, it contains the bis-dihydrofurofuran ring and is therefore a carcinogen with the target organ being the liver.

Ochratoxin: This mycotoxin is produced by both *Aspergillus ocraceus* and *Penicillium viridicatum*. Ochratoxin A (OA) combines with aflatoxin to make it more toxic, and has been shown to be a human carcinogen. Ochratoxin formation is favored by cold temperatures of below 50 F and has been found growing on cheesecake. Pigs store Ochratoxin A in edible tissue, and the USDA is currently establishing action limits for Ochratoxin in swine feed and tissues. The target organ for Ochratoxin A seems to be the kidney, followed by the liver. Ochratoxin B is non-toxic.

Alternariols: This mycotoxin is produced by Alternaria species, which is one of the most common fungal spores encountered as it can grow on cement, wallpaper, tile grout and a variety of foods.

Tricothecenes: These are very toxic chemicals produced by Fusarium, Trichoderma, Stachybotyrs and other less common fungi. The tricothecenes are divided into four classes: T-1, T-2, T-3 and T-4. The T-1 mycotoxin is both rare and extremely toxic; the other three classes are most often encountered. The first of these is T-2, which has a history dating back to 1912 in Russia, where it was associated with alimentary toxic aleukia (ATA). T-2 is so toxic that contact with crystalline T-2 causes cellular death, blistering and necrosis at the contact site. Bacterial infection of the wounds usually leads to death, and for this reason, ATA is believed to be the cause of the fall of ancient Athens. According to declassified documents, T-2 mycotoxin is the only one known to have been implemented as a biological weapon. The toxin is highly heat stable and resistant to UV light destabilization, two very important characteristics when considering an agent for biological warfare.

Diacetoxyscirpenol (DAS): Also known as anguidine, this is a less toxic type of tricothecene known as T-3 and produced by Fusarium. Its significance lies in its ability to react with other toxins to make them more potent.

Deoxynivalenol (DON): The least toxic tricothecene and known as a T-4, DON is the most easily detected tricothecene. Since all four

classes of tricothecene are usually found together, DON is considered a sentinel for the presence of other, more potent tricothecenes.

Zearalenone: This potent mycotoxin is produced by Fusarium and is associated with testicular atrophy and enhanced mammary development in boys and uterine prolapse in girls. Many countries already have set action levels for zearalenone.

Fumonisin B1: This mycotoxin is produced by *Fusarium moniliforme*. Fumonisin is the subject of tremendous study as it suspected to be a carcinogen.

Conclusion

The potentiality of a microbe to produce toxin is known as toxigenesis. It also determines the pathogenicity of the microbe to cause disease in a susceptible host. Chemically, the toxins are categorized into lipopolysaccharides, which are associated with the cell wall of Gram-negative bacteria, and proteins, which are released from bacterial cells.