

Mycotoxins, in a prospection in the causes and treatment of metabolic syndrome

Abstract

Metabolic syndrome (MS) and MS-related phenomena are widely distributed. For examples, cardiovascular disease and type 2 diabetes are two common diseases known to occur in MS. Till date, a number of risk factors as well as treatment strategies have been introduced in MS. Mtcotoxins are one of them. This paper features mycotoxins as a risk factor as well as therapeutic tools of MS.

Keywords: mycotoxins, metabolic syndrome, prospection

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Abbreviations: CVD, cardiovascular disease; MS, metabolic syndrome; HDL, high-density lipoprotein; NDDs, chronic neurodegenerative diseases; LPS, lipopolysaccharides; NTIS, non-thyroidal illness syndrome

Introduction

Abdominal (central) obesity, elevated blood pressure, elevated fasting plasma glucose, high serum triglycerides and low high-density lipoprotein (HDL) levels are the key features of the metabolic syndrome (MS) that is associated with the risk of developing cardiovascular disease (CVD) and type 2 diabetes.¹

Various strategies have been proposed to prevent/management the development of MS. Among them, changing of lifestyle and food habit is most common. A number of drug therapies are also recommended to treat or control of MS. To date, a number of risk factors also identified for the development of MS. Mycotoxins, toxic secondary metabolites produced by fungus kingdom,² are not only evident to cause MS but also helpful to treat MS. This article depicts a perspection on myotoxins in MS.

Methodology

A search was made in the PubMed database for published articles on the following keywords: mycotoxins in metabolic syndrome; mycotoxin-induced metabolic syndrome; mycotoxins in the treatment of metabolic syndromes. Articles from the past to till date, concerning the search topic was collected and used for this review. Articles falling outside the scope of this study were discarded by reading the titles, abstracts and contents.

Mycotoxins causing ms

Aflatoxin, in chicks showed a strong malabsorption syndrome characterized by steatorrhea, hypocarotenoidemia, and decreased concentrations of bile salts and pancreatic lipase, trypsin, amylase, and RNase, while T-2 characterized by steatorrhea and decreased levels of pancreatic lipase, trypsin, amylase, and RNase.³ In the same study, ochratoxicosis was evident to show severe hypocarotenoidemia. Though, T-2 toxicosis exhibited lipid malabsorption in the absence of hypocarotenoidemia, ochratoxicosis exhibited hypocarotenoidemia in the absence of lipid malabsorption, but aflatoxicosis exhibited both symptoms.

In low content of vitamin E (6mg/kg as compared with 100 mg/kg in control), T-2 mycotoxin in rats decreased in activity of lysosomal enzymes, aniline hydroxylase, carboxyl esterase and in content of cytochrome P-450 in liver tissue simultaneously with twofold activation of epoxide hydrolase and UDP-glucuronosyl transferase; decreased in non-sedimented activity of lysosomal enzymes; decreased in activity of alkaline phosphatase and of lysosomal enzymes in blood serum.⁴

The role of large-conductance Ca²⁺-activated K⁺ (BK (Ca)) channels in the regulation of coronary microvascular function is widely appreciated. In a study, male Ossabaw miniature swine consumed in 3-6 mo a normal diet (11% kcal from fat) or an excess-calorie atherogenic diet that induces MetS (45% kcal from fat, 2% cholesterol, 20% kcal from fructose). MetS significantly impaired coronary vasodilation to the BK(Ca) opener NS-1619 *in vivo* (30 - 100µg) and reduced the contribution of these channels to adenosine-induced microvascular vasodilation *in vitro* (1 - 100µM). MetS reduced whole cell penitrem A (1 µM)-sensitive K⁺ current and NS-1619-activated (10µM) current in isolated coronary vascular smooth muscle cells. MetS increased the concentration of free intracellular Ca²⁺ and augmented coronary vasoconstriction to the L-type Ca²⁺ channel agonist BAY K 8644 (10pM - 10nM). BK (Ca) channel alpha and beta (1) protein expression was increased in coronary arteries from MetS swine. Coronary vascular dysfunction in MetS is related to impaired BK (Ca) channel function and is accompanied by significant increases in L-type Ca²⁺ channel-mediated coronary vasoconstriction⁵. In another study of this research group, penitrem A (10µg/kg, i.v) revealed that the exercise-induced increases in blood pressure were significantly elevated in MetS swine.⁶

Chronic neurodegenerative diseases (NDDs) are associated with obesity and diabetes worldwide, mainly the Parkinson's and Alzheimer's disease. MS involves lipoprotein abnormalities and insulin resistance is the major cause of induction of NDDs. The effects of bacterial lipopolysaccharides (LPS) on dyslipidemia and NAFLD indicate that the clearance and metabolism of fungal mycotoxins are linked to hypercholesterolemia and amyloid beta oligomers. LPS and mycotoxins are associated with membrane lipid disturbances with effects on cholesterol interacting proteins, lipoprotein metabolism, and membrane apo E/amyloid beta interactions relevant to hypercholesterolemia with close connections to NDDs.⁷

Long-term exposure to dampness microbiota induces multi-organ morbidity. One of the symptoms related to this disorder is non-thyroidal illness syndrome (NTIS). A retrospective study was carried out in nine patients with a history of mold exposure, experiencing chronic fatigue, cognitive disorder, and different kinds of hypothyroid symptoms. Mycotoxin exposure *via* the diet is underlined as DIO2 genetic polymorphism and dysfunction of DIO2 play an important role in the development of symptoms.⁸

Mycotoxins against ms

Drugs or products acting as chemo-modulators were assayed for their effect on the chemotactic activity. Cytochalasin B is evident by interfering with the cytoskeletal elements (microtubules and microfilaments) cyclic nucleotides involved in the metabolic activity during the cell motility.⁹ In another study, AFB1 (0.1, 0.3 or 1 µg/mL) in Li-Fraumeni patient, but not cells from normal individuals, can induce immortalization.¹⁰

Conclusion

Mycotoxins are one of the important causes of MS. However, some MS along with the related phenomena could be taken into account that there is an option to select mycotoxins and their laboratory derivatives to be treated. Mycotoxins are important lead compounds in MS and MS-related complications.

Conflict of interest

None declared.

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