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ISSN 2321 - 6328

Research Article

A CASE STUDY OF *FUSARIUM EQUISETI* PRODUCED VARIOUS TOXINS IN PLANT HOSTS

Suthar Ramchandra S. *[1], Bhatt P. N. [2] and Bhatt D. P. [3]
[1]Assistant Professor, Department of Biotechnology, P. S. Science & H. D. Patel Arts College, kadi, India
[2]KSV University, Gandhinagar. Gujarat, India
[3]Sunagrigenetics P. Ltd, Vadodara, India
*Corresponding Author Email: ram_v2@yahoo.com

Article Received on: 05/02/18 Accepted on: 14/03/18

DOI: 10.7897/2321-6328.06175

ABSTRACT

Fusarium equiseti produced various mycotoxins and secondary metabolite in plant hosts. The present study showed that extracellular pigments and mycotoxins produced by *Fusarium equiseti*, when eluted on TLC and easily used for the identification of *Fusarium* spp., together with their micro- and macro morphological characters. Zearalenone, a well-known estrogen has been previously reported from *F. equiseti, F. moniliforme* and *F. semitectum*. Moniliformin has been reported from *F. equiseti, F. oxysporum* and *F. semitectum.* Equisetin, an antibiotic that inhibits growth of certain bacteria has been produced from *F. equiseti*. Likewise two more toxins were reported T-2 and HT-2 toxin from *F. equiseti*.

Keywords: *Fusarium equiseti,* mycotoxins, secondary metabolite, Zearalenone, Equisetin.

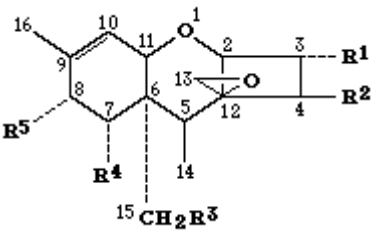
INTRODUCTION

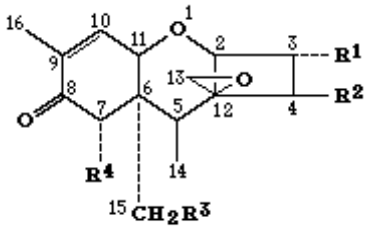
A large number of microorganisms are known to produce toxic secondary metabolites. These metabolites are products of amino acids, cyclic peptides, aromatic, phenols, terpenoids and plant growth regulator[1]. Pathogenic strains of *Fusarium oxysporum have* been studied for more than 100 years. *Fusarium* toxins are produced by over 50 species of *Fusarium* and have a history of infecting the grain of developing cereals such as wheat and maize. They include a range of mycotoxins, such as: Fusaric acid[2]. Fusaric acid is mycotoxins with low to moderate toxicity, which is of concern since it might be synergistic with other co-occurring mycotoxins[3]. Fusaric acid is widespread on corn and corn-based food and feeds and is frequently found in grain, where *Fusarium* species are also isolated causing diseases[4].

The toxicological interest in *Fusarium* species arises from their ability to produce a wide range of chemically different toxic compounds, such as fusaric acids, fumonisins, beauvericin, enniatin, moniliformin and trichothecenes, but probably fusaric acids are the most produced ones[5]. Seven classes of mycotoxins biosynthetic genes or gene clusters have been identified in *Fusarium* to date; four are polyketide synthase gene clusters for equisetin, fumonisins, fusarins, and zearalenones. Theses mycotoxins were described in Table-1 with chemical characterization and structure (Fig.-1).

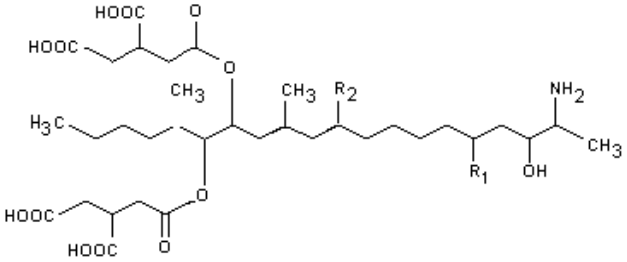
Table-1 Chemical characterization of mycotoxins derived from *Fusarium* spp.

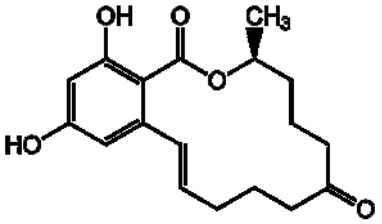
Mycotoxins	Chemical characterization
Trichothecenes	*Fusarium* trichothecenes are tricyclic sesquiterpenes that contain a double bond between carbons 9 (C-9) and 10 and a 12,13-epoxide ring, and are thus designated as 12,13-epoxytrichothec-9-enes[6].
Fumonisins	Fumonisins are long-chain amino polyalcohols. The major fumonisin homologue in cereal grains is fumonisin B1, a propane-1,2,3-tricarboxylic diester of 2-amino-12,16- dimethyl-3,5,10,14,15-pentahydroxyicosane[7]
Zearalenones	Zearalenones are non-steroidal estrogenic mycotoxins are derived by cyclization to form a resorcyclic acid lactone, and have a close structural relationship to antibiotic metabolites produced by a number of fungi[8-10].
Beauvercin and enniatins	Beauvericin and enniatins are members of a family of fungal N-methylated cyclic hexadepsipeptides[6].
Butenolide	Butenolide is a 4-acetamido-4-hydroxy-2-butenoic acid lactone that is produced by *F. graminearum* and a number of other trichothecene-producing Fusarium species[11].
Equisetin	Equisetin is a derivative of N-methyl-2,4-pyrollidone (1- methyl-3-acyl-5 hydroxymethyl-2,4-dione) and is of particular interest due to its activity against the human immunodeficiency virus. Equisetin was reported as a metabolite of *F. equiseti* and *F. semitectum*[12].
Fusarins	Fusarins are 2-pyrrolidones with a methylated, polyunsaturated side chain, but differ in the structure and substitution of the 2- pyrrolidone moiety[10].





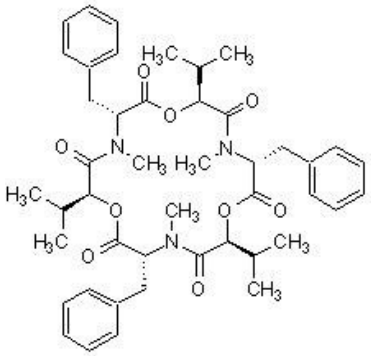
Type-A & B Trichothecenes

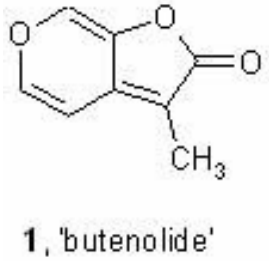




Fumonisins

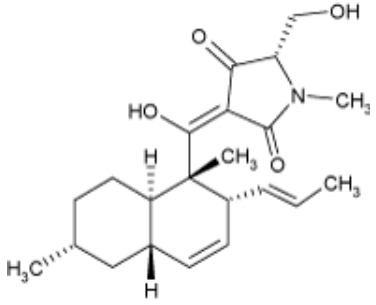
Zearalenones

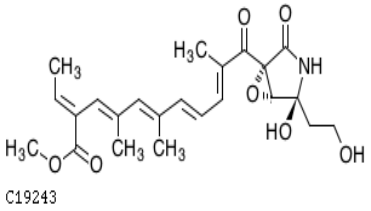




Beauvercin and enniatins

Butenolide





Equisetin

Fusarins

Fig.-1 Structure of mycotoxins derived from *Fusarium* sp.

Most of these toxins were studied in terms of the human and animal health problems as well as for their metabolic effects on plants including phytotoxic activities like necrosis, chlorosis, wilting and inhibition of seed germination[13] in addition to their herbicidal properties[14]. The fungal metabolites which are directly or indirectly responsible for disease symptoms in higher plants are normally called phytotoxins[15]. This term could include substances produced in pure culture, which may not necessarily be formed as a consequence of an interaction between the fungus and a higher plant[16].

DISCUSSION

Fusarium equiseti is reported to produce several phytotoxins like equisetin, fusaric acid and alternaric acid and their production is correlated to virulence of pathogenic strains[17]. *Fusarium equiseti* is known to produce the several phytotoxic mycotoxins including T-2 toxin[18] Neosolaniol[19] Diacetoxyscirpenol monoacetoxy - scirpenol and Scirpenol[20] Zearalenone[21] Fusaric acid[22] Equisetin[6].

Fusarium equiseti is also known to produce an antibiotic "equisetin" *in vitro*. Equisetin is active against several strains of

Gram-positive bacteria- *Mycobacterium phlei*, *Bacillus subtilis* and *Staphylococcus areus* and the Gram-negative bacterium *Neisseria perflava*. Equisetin however, is ineffective against other Gram-negative and fungi[23-24].

Fusarium oxysporum Schlecht. is the most destructive species of plants all over the world. It is capable of living almost indefinitely as mycelium or chlamydospore in soil[25]. These are known to be seed-borne causing wilt in various hosts including Cumin as reported from India[26-28] Earlier investigators reported *Fusarium oxysporum* f. sp. *Cumini* is causative agent of vascular wilt of Cumin, *Fusarium equiseti* is most dominant fungi to causing wilt in Cumin in Israel[29]. Recently rediscovered and first reported same species was responsible for wilt in Cumin in India[30] (Table 2).

Table-2 Vascular Wilt disease of Cumin reported in literature

Seed-borne pathogen	Disease	Geographical Distribution	References
Fusarium oxysporum	Wilt	India	Mathur and Prasad, 1964 Gour and Agrawal, 1988
Fusarium oxysporum	Wilt	India	Deepak *et al*., 2008
Fusarium equiseti	Wilt	Israel	R. Reuveni, 1982
Fusarium equiseti	Wilt	India	Suthar and Bhatt, 2012

CONCLUSION

Screening of Cumin varieties cultivated in Gujarat led to selection of *Fusarium equiseti* wilt tolerant cultivars through Bioassay by carrying seed germination test, shoot/root length and vigour index assessments. FT-IR and MS analysis of *Fusarium equiseti* RC-17 culture filtrate fragment concentrate indicates an undescribed novel Toxin. The structure of secondary metabolite and molecular mass were determined using MS analysis. The molecular mass 449.4 were comparable to trichothecenes family with the broad range of 424.5 to 466.5. So the secondary metabolite may be trichothecenes family with the empirical formula of $C_{24}H_{34}O_9$ (T-2) and $C_{22}H_{32}O_8$ (HT-2).

This is the first study carried out on the secondary metabolites profiles such as production of a trichothecenes derivative by *Fusarium equiseti* isolated from vascular wilt of Cumin in Gujarat, India.

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Cite this article as:
Suthar Ramchandra S *et al*. A case study of *Fusarium equiseti* produced various toxins in plant hosts. J Biol Sci Opin 2018;6(1): 13-16.
http://dx.doi.org/10.7897/2321-6328.06175

Source of support: Nil; Conflict of interest: None Declared