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Aflatoxin as Toxic Fungal Secondary Metabolites and Its Nature

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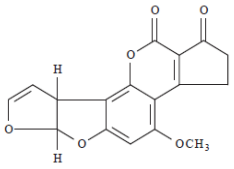
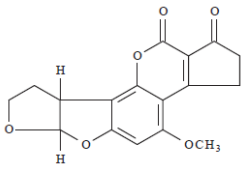
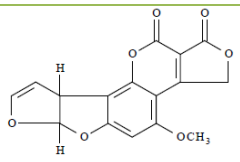
Aspergillus flavus and *A. parasiticus* are major aflatoxin producing fungi. *Aspergillus flavus* is ubiquitously present and observed in many ecological niches having capacity to produce a high range of aflatoxins (Raper and Fennell, 1965). Aflatoxins are fungal secondary metabolities which are produced by aflatoxigenic fungi cells which cannot grow anymore during the harsh and adverse conditions. Geographical, climatic and hygienic conditions during storage plays important role in aflatoxin accumulation (Curto *et al*., 2004). Aflatoxins are very stable compound found in most of the foods and affected by various formulating ways and process parameters including pH, duration of heat treatment, presence of the proteins, temperature, and the presence of organisms which help in starting the processes (Scudamore, 1998). Although, aflatoxin is low molecular weight compound but severely effects people health therefore its occurrence is now regulated and monitored in around 77 countries in the world. Toxicity and carcinogenicity caused by aflatoxins are broadly studied; it has been found that many animals like rats produce lesions in liver. Aflatoxin B1 causes induction of hepatic carcinoma up to 15ppb level of aflatoxin (Butler, 1969). The AFB1 is highly toxic and broad spectrum in nature with acute toxicity it may act as carcinogenic, genocides, immune suppression agents and in acute cases leading to death (Wild and Turner, 2002). Aflatoxins pose deleterious impact on agricultural and industrial food products in many different countries (Visconti, 2006). Maize kernels serve as good substrate for *A. flavus* growth and aflatoxin synthesis.

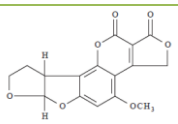
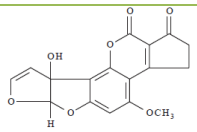
In the recent date, mortality rate of farm animals and poultry birds is very high due to consumption of higher concentration of aflatoxin present in feed which is responsible to decrease the overall productivity and more subtle effects of immune system suppression, reduced growth rates, and losses in feed efficiency (Vincelli *et al*., 1995). The adverse effect of aflatoxin is also reported in fiber crops (Setamou *et al*., 1997). Aflatoxin produced by *A. flavus* is considered to be very significant as regarding global food safety is concerned (Dorner, 2002). Aflatoxin B1 (AFB1) is the highly toxic and predominantly reported in many food crops (FAO and WHO 1997). It has projected that 25% of the global food grains contaminated with aflatoxin producing fungi (Smith *et al.*, 1994). Banswara district of Rajasthan and Panchmahal district of Gujarat from India was in news for human death toll increase due to consumption of aflatoxin contaminated maize (Krishnamachari *et al.*, 1975). Aflatoxins and ochratoxin predominance noticed in poultry feeds of India (Thirmula Devi *et al.*, 2002). This toxin is most potent source of cancer in humans and direct consumption of contaminated food may lead to cancer in liver and act as an immunosuppressant (Park and Liang, 1993). Aflatoxin considered as mutagenic, teratogenic, carcinogenic, and immunosuppressive agent in animals and humans (Yiannikouris and Jouany, 2002).

Nature of aflatoxin

The toxin produced in the form of secondary metabolites when temperature ranging between 24 to 35°C. The agri-commodities exceeds 7% moisture content are more prone to aflatoxin production. The fungi became most catastrophic in developing countries dietary foods *viz.*, rice, corn, cassava, nuts, peanuts, chillies, and spices. Usually the fungi contaminate more during pre-harvest and post-harvest and aflatoxin production continues till the storage. More than 20 types of aflatoxins were identified. Among major types B_1, B_2, G_1 and G_2. B1 aflatoxin showed pale-white to yellow color, crystalline solid, soluble in methanol, chloroform, acetone and acetonitrile solvants. B_1 and B_2 emits blue fluorescence under UV light where as G_1 and G_2 emits green yellow fluorescence **(Table 1)**. Aflatoxin emits intense fluorescent under UV light and form colorless to pale-yellow crystals which dissolves in water and soluble in chloroform, methanol and dimethyl sulfoxide (IARC, 2002). AFB1 was reported as highly toxic and most predominant in contaminated raw and processed food materials and their consumption lead to severe health risk to human, animals and poultry birds FAO and WHO (1997). Butler (1969) found that many animals like rats produce lesions in liver especially due to aflatoxin B1 which is responsible for induction of hepatic carcinoma up to 15ppb level. Doi *et al*. (2002) reported that difurano coumarin compounds designated as aflatoxin B_1, B_2, G_1 and G2 on the basis of emission of blue or green fluorescence under U.V. light. P_1, Q_1, B_2A and G_2A are metabolic products of aflatoxin in animals and humans. Neal *et al*. (1998) documented that AFB1converts into M_1 after hydroxylation in animal tissue. Masoero *et al*. (2007) showed that when the animal ingest AFB1 and AFB2 contaminated feed converts into AFM1 and AFM2 and its contamination is observed in milk and dairy products.

Table 1 Types and property of aflatoxin

S. No.	Aflatoxin types	Chemical name	Chemical structure and formula	Property	Reference
1.	Aflatoxin B1	(6a*R*,9a*S*)-2,3,6a,9a-Tetrahydro-4-methoxycyclopenta[*c*]furo-(3′,2′:4,5) furo[2,3-*h*][*l*]benzopyran-1,11-dione	 $C_{17}H_{12}O_6$ Relative molecular mass:312.3	Blue fluorescent under UV light	IARC 1972, 1976, 1987, 1993 and 2002
2.	Aflatoxin B2	(6a*R*,9a*S*)-2,3,6a,8,9,9a-Hexahydro-4-methoxycyclopenta[*c*]-furo[3′,2′:4,5] furo[2,3-*h*][*l*]benzopyran-1,11-dione	 $C_{17}H_{14}O_6$ Relative molecular mass:314.3	Blue fluorescent under UV light	IARC 1972, 1976, 1987, 1993 and 2002
3.	Aflatoxin G1	(7a*R*,10a*S*)-3,4,7a,10a-Tetrahydro-5-methoxy-1*H*,12*H*furo-[3′,2′:4,5]furo[2,3-*h*]pyrano[3,4-*c*][*l*] benzopyran-1,12-dione	 $C_{17}H_{12}O_7$ Relative molecular mass:328.3	Green fluorescent under UV light	IARC 1972, 1976, 1987, 1993 and 2002

4.	Aflatoxin G2	(7a*R*,10a*S*)-3,4,7a,9,10,10a-Hexahydro-5-methoxy-1*H*,12*H*-furo[3′,2′:4,5]furo[2,3-*h*]pyrano[3,4-*c*][*l*]benzopyran-1,12-dione	 $C_{17}H_{14}O_7$ Relative molecular mass:330.3	Green-blue fluorescent under UV light	IARC 1972, 1976, 1987, 1993 and 2002
5.	Aflatoxin M1	(6a*R*,9a*R*)-2,3,6a,9a-Tetrahydro-9a-hydroxy-4 methoxycyclopenta[*c*]furo[3′,2′:4,5]furo[2,3-*h*][*l*]benzopyran-1,11-dione	 $C_{17}H_{12}O_7$ Relative molecular mass:328.3	Blue-violet fluorescent under UV light	IARC 1972, 1976, 1987, 1993 and 2002

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