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Mycotoxins in Local Spices : Black Ppper(*Xylopia aethiopica)*, Ashanti Pepper (*Piper guineense),* Calabash Nutme (*Monodora myristica*) and Their Health Implications in Humans - A Review

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Abstract

Mycotoxins are secondary metabolites from moulds and are capable of causing Mycotoxins are secondary metabolites from moulds and are capable of causing diseases in plants, human and animals. Although they occur more frequently in areas with hot and humid climate favourable for the growth of moulds, they can also be found in temperate zones. Exposure to many mycotoxins is mostly through ingestion. It is also obtained through inhalation .The contamination of mycotoxins results, generally, in inferior quality of products and produce end-products, food safety, and ultimately as barriers to the trans-border marketability of agro-produce. Black pepper (*Xylopia aethiopia*, Uda in Igbo), Ashanti pepper(*Piper guineese*; Uziza in Igbo), and calash nutmeg (Ehuru in Igbo) have been contaminated with such fungi as *Aspergillus* sp, *Penicillium* sp*Fiusarium* sp and *Rhizopus* sp which secrete some mycotoxins. The toxic effects of mycotoxins like aflatoxins, trichothecenes, ochratoxins, fumonisins, zearalenone, etc. are known to have deleterious effects on animal and human health, and the details of these and means of management are discussed in this paper.

Key words : *Monodora myristica,* Mycotoxins, *Piper guineese,*Spices, *Xylopia aethiopia*, *Piper guineese* .

1.Introduction

Mycotoxins are natural chemical substances produced by fungi (moulds) growing as contaminants on some food crops (iin the ield and in storage), in particular cereals, nuts, and fruits.According (FSAI, 2009),They are secondary metabolites produced by filamentous fungi on food crops that are capable of causing toxic responses such as diseases or death in humans and other animals when ingested, depending on the level and duration of exposure (Bandyopadhyay *et al*.,2007;Viljoen,2004)According to Enyiukwu *et al*.(2014), the contamination of mycotoxins results generally in inferior quality of products and end-products,reduced food safety, and ultimately reduced marketability of agro-produce. They are silent killers whose effects could be submerged over a long period of time, especially during intermittent exposures.

In Nigeria, several spices are routinely used in homes for cooking, for example, calabash nutmeg (*Monodora myristica*, Local name; Ehuru in Igbo), red pepper, seeds of Ashanti pepper, Ashanti pepper(*Piper guineese* Uziza in Igbo) Ginger, black pepper (*Xylopia aethiopia* Uda in Igbo), and many others . The fruits of black pepper (uda), and the seeds of ashanti pepper (uziza) are boiled daily for women who have just been delivered of new born babies, for three months (Enyiukwu *et al*.,2014) . These periods of using uda and uziza to make hot soups for new nursing mothers ar known as 'Omugo' in Igbo land. The hot soup is used to stabilize their wombs and bowels. The fruit of the calabash nutmeg (ehuru) is usually sold dry and used in stews, soups, cakes and deserts. The seeds are also added to food to enhance the flavour and taste to complement the dish. Despite their advantages, several deleterious effects of mycotoxins secreted by storage fungi which secrete them have been documented.

2. Some mycotoxin secreted by fungi and the their health hazards to humans

Some mycotoxin producing organisms like *Aspergillus*, *Fusarium* and *Penicillin* species cause diseases, including: systematic mycosis, cutaneous mycosis, subcutaneous mycosis, ear and eye infections (Ezekiel *et al.*, 2013;Enyiukwu *et al*.,2014). The oxigenic moulds have the capacity to invade and colonize a variety of food matrices and liberate aflatoxins, depending on the prevailing conditions of temperature, relative humidity and moisture levels of the food (Enyiukwu *et al*.,2014). Local spices, especially, calabash nutmeg, Ashanti pepper and black pepper, are prone to contamination by moulds, including toxigenic *Aspergillus* spp. Thus, the risk of being associated with mycotoxins may be high and, as such, may threaten public health safety due to regular consumption of the local spices.The presence of mycotoxins in crops, foods and animal feeds produced in them is undesirable, as they are toxic and have a number of adverse effects on health, both in humans and animals (Oranusi *et al*.2013).

Mycotoxins can affect the immune system, nervous system, liver, kidneys, blood, and some are known to be carcinogens (Ezekiel *et al.*, 2013;Enyiukwu *et al*.,2014). While hundreds of mycotoxins have been identified from a very large number of fungi, only 20–30 mycotoxins

have been associated with potential toxicity to animals and humans (FSAI,2009). Mycotoxins vary widely in their toxicity and the toxic effects may be acute (after a single exposure) or chronic (after repeated exposure). The most important mycotoxins in terms of their effect on health are the aflatoxins, ochratoxin A, patulin and fusarium toxins (tricothecenes including DON, zearalenone and fumonisins). Aflatoxins, which occur particularly in nuts, are considered to be the most toxic of the mycotoxins,and` long-term low level exposure to aflatoxins has been associated with liver diseases such as cancer, cirrhosis, hepatitis and jaundice in humans and animals(Sorrenti *et al*., 2013). Mycotoxins are toxic to humans and animals, and consumption of food containing high levels of these contaminants may cause illness, and three types (genera) of fungi are reported to be the major producers of mycotoxins – *Fusarium*, *Penicillium*, *Aspergillus* (Sorrenti *et al*., 2013).Within each type of fungus, particular species may be mycotoxigenic, or mycotoxin-producing, and the Food and Agricultural Organizations (FAO) estimates that 25% of the world's food crops are affected by mycotoxins,considering that these food crops include cereals, nuts, fruits and vegetables, which comprise a significant part of the world's consumers' diets, there is potentially a significant exposure to mycotoxins(WHO,2006).

Aflatoxins are polypeptide secondary metabolites from toxigenic strains of *Aspergillus* spp and other related species (Rosi *et al*.,2007). Chemically, they are difuro-coumarins, which are freely soluble in chloroform and methano and are stable at high temperatures, but unstable to UV light or polar solvents (Mensah *et al*., 2014). According to Ezekiel *et al.* (2013) , they are secondary metabolites with toxicological properties that induce a variety of health challenges when food contaminated with these compounds is ingested, and are produced mainly by two *Aspergillus* sp ; *Aspergillus parasiticus*, and *Aspergillus flavus*, the categories of food they contaminate being cereals and cereal products; herbs and spices; nuts and oil seeds; meat and poultry products, animal feeds; milk and milk products (Dacosta *et al*.,2010).

Mycotoxins from *A flavus* and *A. parasiticus* are closely related in structure, and there are 18 relatives of aflatoxins, out of which four, Aflatoxin B1, B2, G1, and aflatoxin G2 (AFB1, AFB2, AFG1,AFG2) are reported to be agriculturally common, AFB1 and AFB2 being the most important, and AFB1 has been adjudged the most toxic (Rosi *et al*.,2007; Fara,2008). *Aspergillus* spp. can attack various commodities, including groundnuts, maize species, among many other agricultural products (Enyiukwu *et al*.,2014). Affected grains may not appear overtly mouldy, and producing fungi that proliferate in improperly stored grains with a moisture content greater than 14%, a relative humidity greater than 70%, a pH rang of and temperature 30-40℃ (Segun *et al*., 2016). They are efficiently *absorbed in th*e small intestine, perhaps at the duodenum (Enyiukwu *et al*.,2014).Their contamination causes inferior crop quality, barrier to marketability of produce, and jeopardizes food safety by exceeding standards set for food for human consumption and impairing the exportability of these commodities into the USA or UAE

and EU with maximum allowable total aflatoxin limits of 20ppb and 4ppb respectively (Bhat *et al*., 2003;Whitlow and Haglar 2013).

Fumonisins B1, B2, and B3 are produced by *Fusarium* moniliforme , *F. proliferum, F. nygamai* and *Alternaria alternata*, f.sp. *Lycopersici* (Viljoen, 2004; **A**llameh *et al.*, 2011;Segun *et al*., 2016). *Fusarium spp*. are widely distributed plant pathogens and known contaminants of stored agricultural products or waste grains ,and hot humid conditions with temperature ranges of 40 - 65℃ is reported to favour fusariotoxin production on grains **(A**llameh *et al.*, 2011). Organisms exposed to fumonisins show pathological changes such as liver or pancreatic necroses, kidn0ey and liver weight increases, liver damage, increased concentrations of haemoglobin, diarrhea and neurotic effects (Tiffany,2013). Fumonisis are also possible human carcinogins(Segun *et al*., 2016).

3.Ochratoxins

Ochratoxins ar**e** naturally occurring mycotoxins soluble in organic solvents, a acqueous solution of sodium bicarbonate and slightly soluble in water Reddy *et al*., 2010). They chemically consist of an iso-coumarium moiety linked by a peptide bond to phenylalanine (Tiffany,2013)]. Four ochratoxins have been identified as ochratoxins A, B, C and D with ochratoxin A (OTA), a non-ribosomal peptide synthase, being the most potent poison, and having been adjudged nephrotoxic and carcinogenic (MI,2013). They are produced by *Aspergillius ochraceus*, *A. melleus, A. niger, Penicillium verucossum* and related fungi, and *Aspergillus ochraceus* is pan – tropical in distribution,as reported by (Enyiukwu *et al*.,2014), and entirely active in storage, though according to **(A**llameh *et al.*, 2011), *P. verucosum* was reported to infect produce between anthesis and harvest.Tiffany(2013), reported that ochratoxins caused kidney and bladder dysfunction, increased water consumption, blood in urine and faecal samples, liver damage, diarrhea and suppressed immunity to environmental and microbial stressors as some symptoms presented by organisms affected by OTA.

3.1 Ochratoxin A (OTA)

Influence on the health of exposed individuals exerted by secondary metabolites includes carcinogenic, teratogenic, mutagenic, hepatotoxic and nephrotoxic actions (Strosnider *et al*., 2006). Oesophageal cancer cases in China, Northeast Italy and the Tanskei region of South Africa were reported to be linked to fumonisins (**A**llameh *et al.*, 2011;Segun *et al*., 2016). Fumonisin toxicity is thought to result from electrolyte loss in affected tissues, blockage of Sphingolipid synthesis, or disruption of sphingolipid metabolism through inhibition of ceramide synthase activity (Segun *et al*., 2016). According to Fapohunda (2013), “no confirmed cases have been reported of acute human poisoning due to fumonisiin exposure; part of the difficult in discerning a specific effect of fumonisiin in acute poisoning is in their co-occurrence with

other micotoxins, notablly, afltoxins and trichothecenes". of these commodities into the USA or UAE and EU with maximum allowable total aflatoxin limits of 20ppb and 4ppb respectively (Bhat *et al*., 2003;Whitlow and Haglar,2013;Mensah *et al.*, 2014).

4-**The effects of mycotoxins from Ehuru, Uziza and Uda on human health**

According to Fapohunda (2013),alatoxins are the most deadly mycotoxins, produced by *Aspergillus* spp and are known to be deadly carcinogens due to detrimental effects they can exert on their consumers. They explained further that there is sufficient evidence in humans for the carcinogenicity of naturally occurring aflatoxins and classified them as group 1 carcinogens,which include five different types of aflatoxins that exist in nature: aflatoxin B1 (AFB1), aflatoxin B2 (AFB2), aflatoxin G1 (AFG1), aflatoxin G2 (AFG2), and aflatoxin M1 (AFM1), respectively. Aflatoxins are toxins produced mainly by two *Aspergillus spp*, that is; *A. flavus* and *A. parasiticus*(Dacosta *et al*.,2010). Aflatoxins are acutely toxic, immune-suppressive, mutagenic, teratogenic and carcinogenic compounds, and the main target organ for toxicity and carcinogenicity is the liver (Enyiukwu *et al*.,2014). They are hepatocarcinogenic, particularly, in conjunction with chronic hepatitis E virus infection and cause aflatoxicoses in episodic poisoning outbreaks (Eva *et al*;2010;Whitlow and Haglar,2013;Fapohunda,2013;Enyiukwu *et al*.,2014;IARC,2017).

IARC(2017), reported that *acute aflatoxicosis* is produced when moderate to high levels of aflatoxins are consumed, and specific acute episodes of disease includes hemorrhage, acute liver damage which manifests as severe hepatotoxicity with a case fatality rate of approximatel 25%, edema absorption and / or metabolism of nutrients and alteration in digestion, acute high-level exposure can progress to potentially lethal hepatic failure and death (Ahene *et al*., 2011). Chronic aflatoxicosis results from ingestion of low/moderate levels of aflatoxins,and the effects are usually sub-clinical and difficult to recognize (IARC, 2017). Some of the common symptoms are impaired food conversion and slower rates of growth with or without the production of an overt aflatoxin syndrome (Fapohunda, 2013;IARC, 2017).

4.1 Management of Mycotoxins

4.1.1 These include Pre- and post Harvest management

4.1.1.1 Pre-harvest management include good agronomic Practices (GAPs)

According to (Dacosta *et al*., 2010;Fischer and Dott (2013),GAPs include the use of resistant cultivars of a given crop wherever available, crop rotation, clean tillage,and seed and/or soil health, which help reduce the amount of fungal inoculum available against the crop. Others are

adjusting the time of planting to make for crop maturation and harvesting to coincide with peak rain regimes, adjusting plant populations improved air circulation in the field, judicious use of insecticides, proper fertilization of crops to boost their vitality and vigor,weeding to eliminate alternate host phenomena, competition for nutrients, insulation, and space and many such practices targeted at improving crop vigour and performance .

According to **A**llameh *et al.*, (2011), management of mycotoxins through pre-harvest control methods remains imperative and the best approach is initiating their control. According to Bryden (2007), pre-harvest stress factors such as drought and insect infestations make crops succumb easily to fungal invasion; ,hence,GAPs, which aim at improving the crop vigor, and breeding to improve the genetic resistance of field crops to mycotoxigenic fungal attacks, contribute to a great extent in reducing the mycotoxin contamination of produce.

4.1.1.2 Post-Harvest involve proper harvesting, handling, and storage of produce

According to **(A**llameh *et al.*, 2011;Whitlow and Haglar,2013), significant levels of grain mould infection begin in the field, encouraged by damp conditions at the time of harvesting, delayed harvesting and continued storage of produce due to improper or insufficient drying. Insect infestation and poor storage conditions of stored produce also play some role; hence, proper harvesting and handling of agro-produce are good starting points for post-harvest control of mycoto4.1.2xins in produce, as such practices minimize abrasions and breakages of produce, which provide portals of entry for mycotoxigenic fungi. According to WHO (2006), good post harvest practices are directed towards achieving the minimization of mycotoxin contamination through proper drying and storage techniques, as well as the elimination of undue moisture migration into produce during storage or marketing.

In many world economies, the combination of insufficient drying and humid atmospheric conditions warranted unacceptable levels of mycotoxins on harvested maize, groundnut etc, and parameters of moisture and temperature are known to influence to a large degree the activities of fungi (WHO, 2006;Bryden (2007); with moisture regarded as the single most important determinant of how rapidly mycotoxigenic moulds grow in storage (Segun *et al*., 2016). Hence, grains are recommended to be dried to safe moisture content of 13-14% before storing. Usually, drying should be done on covered surfaces, not on bare grounds, as this will increase the propensity of mycotoxin contamination , and only clean grains should be stored in insecticide treated bags on racks in a properly maintained, fumigated and ventilated store-house. Ensure that produce are dried to safe moisture levels before storing, and it is important that stored produce are only stored for shortest possible time periods (Segun *et al*., 2016).

Conclusion

Commodities contaminated with mycotoxins may be toxic to humans and animals depending on a number of factors such as, the extent of contamination, frequency and amount of consumption of the contaminated food by various populations, exposure and absorption into the host species affected, and therefore, can be a major health issue for consumers. The hazard analysis and critical control point (HACCP) principle, good agronomic practices (GAPs), proper harvesting, handling, and storage of produce etc,could be applied to prevent and minimize mycotoxins infestation on crops. For the safety of health, proper washing and drying of these spices when purchased, eating fruits that contain saponin and consumption of natural detoxifiers like lemon are advised.

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