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Occurrence of toxigenic moulds isolated in maize (*Zea mays*) from Okitipupa metropolis, Ondo State, Nigeria.

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Abstract
The goal of this work is to provide adequate information about the mould associated with dry maize samples in Okitipupa metropolis and also generate data which will give an insight into management and prevention of mycotoxicoses outbreaks in the region. Dry maize (*Zea mays*) was obtained randomly from selected rural households and markets within Okitipupa, Ondo state, Nigeria. Moulds were isolated from all the samples with at least one genera of mycotoxigenic fungi present such as; *Aspergillus, Fusarium and Penicillium*. The frequently occurring mould species were; *Aspergillus flavus, Aspergillus tamarii, Aspergillus niger, Aspergillus fumigatus, Aspergillus terreus, Fusarium oxysporum, Fusarium proliferatum and Penicillium atramentous.* The occurrence of *A. flavus* was the highest in all the samples collected followed by *Fusarium proliferatum* and *Fusarium oxysporum. Penicillium* has the lowest frequency of occurrence. The highest occurring mould species were *Aspergillus flavus (40%), Aspergillus tamarii (20%), Aspergillus niger (4%), Aspergillus fumigatus (4%), Aspergillus terreus (4%), Fusarium oxysporum (12%), Fusarium proliferatum (16%) and Penicillium (4%).*

Key words: Maize, toxigenic mould

INTRODUCTION

Maize (*Zea mays*) is a member of the grass family (gramineae) which originated from South and Central America. It was introduced to West Africa by the Portuguese in the 10th century [1]. Maize is one of the most important grains in Nigeria, not only on the basis of the number of farmers that engaged in its cultivation, but also in its economic value. Maize is a major important cereal being cultivated in the rainforest and savannah zones of Nigeria. Maize has been in the diet of Nigerians for centuries. It started as a subsistence crop and has gradually become a more important crop. Maize has now risen to a commercial crop on which many agro-based industries depend on for raw materials [2]. Maize is the most important cereal in the world after wheat and rice with regard to cultivation areas and total production [3].

In industrialized countries, maize is largely used as livestock feed and as a raw material for industrial products, while in low-income countries, it is mainly used for human consumption [3]. Although maize is increasingly being utilized for livestock feed, it is still a very important staple food for millions of Nigerians.

Maize is one of the major crops in Nigeria, and it plays an important role in rotation with wheat in animal feed and direct human consumption. Maize grain as energy source is widely used in both human and animal nutrition (cows, sheep, goat, poultry and fish etc.). The nutritive value of maize grain depends on the nutrient contents and digestibility [3]. Maize grains are subjected to infection by a variety of toxigenic fungi, most commonly *Fusarium* spp., *Alternaria* spp., *Aspergillus* spp. and *Penicillium* spp [4]. Toxigenic *Alternaria* and *Fusarium* species are often classified as field fungi, while *Aspergillus* and *Penicillium* species are considered as storage fungi [4]. Contamination with fungi diminishes the quality of grain, toxigenic fungi species can produce highly toxic compounds known as mycotoxins. Fungal growth and toxin production in maize have been found to depend on several interacting factors which stress maize plants. Stress factors include low moisture content of soil, high day time maximum temperatures, high nighttime minimum temperatures, and nutrient-deficient soils [5].

The negative effect of mycotoxins on the growth and health of livestock make them a major problem for many production systems. Food and feed safety and hygiene represent a significant problem, and great attention is directed towards diseases that are closely related to different mycotoxicoses.

Mycotoxins cause a whole range of disorders in the body of animals, ranging from biochemical changes, through the functional and morphological damages of different tissues and organs, to the appearance of clinical signs of mycotoxicoses with even possible fatal consequences [5]. Therefore the **objective of the study are to;**

- Identify fungi associated with dry maize in Okitipupa metropolis
- Determine the percentage occurrence of each of the isolate

Justification and Significance of the study

The high incidences of mould in stored maize have caused great economic losses due to significant reduction in export value in African continent [6]. This then calls for assessment of the occurrence of the fungi and mycotoxin levels in stored maize as the first step in the prevention and management of mycotoxicoses. Okitipupa metropolis has appropriate attention in pursuit of the level of incidences of mould contaminating grains and its link to

mycotoxin contamination. Therefore, data generated from the study will give an insight into management and prevention future mycotoxicoses outbreaks in the region. It will also provide adequate information about the mould associated with dry maize samples in the region. The results will be compared to the recommended limit set by the Food and Agricultural Organization (FAO).

MATERIALS AND METHOD

Sample Collection

Dry maize samples were collected from five different markets at Okitipupa metropolis (Okitipupa main market, Ilutitun market, Ayeka market, Idepe, Igodan) in Ondo state, Nigeria. The samples were collected in sterile resalable nylon to minimize further contamination. The samples were carried to the laboratory in a cool box and stored at -20°C to prevent further accumulation of moulds until analyses.

Isolation of mould from the maize samples

Moulds were isolated from dry maize samples using the direct plating technique. The samples were serially diluted up to dilution factor of 10^{-3} and 10^{-5}. 0.1ml and 1ml of the suspension was dispensed respectively from the sample unto the center of petri-dish that already contain lactic acid.10ml of the molten PDA was dispensed into the petri-dishes and allow to solidify. The plates were then incubated at 27±2˚C for 7days according to Klich, [6].

Identification of fungal Isolates

Moulds were identified based on cultural and morphological features using light microscope also number of colony isolated was recorded [6,7]. Cultural characterization was based on the rate of growth, presence of aerial mycelium, colour of aerial mycelium as well as colour on the obverse and reverse of the plates. Microscopic identification was based on spore and conidiophore morphology.

Data Analysis

The isolation frequency (Fq) of each fungal genus from the five regions was calculated according to the formula [7]. This was used to determine the distribution of the mycotoxigenic fungi in the five regions.

Frequency of occurrence (%)

$$= \frac{\text{Number of isolates of a genus} \times 100}{\text{Total number of samples collected}}$$

RESULT

Dry maize were obtained randomly from selected rural households and markets including Idepe, Ilutitun, Ayeka and Igodan markets, all within Okitipupa, Ondo state, Nigeria. All the samples were positive for moulds and contained at least one genera of mycotoxigenic fungi; *Aspergillus, Fusarium and Penicillium*. The samples contained more than two types of moulds, the occurring mould species were; *Aspergillus flavus, Aspergillus tamarii, Aspergillus niger, Aspergillus fumigatus, Aspergillus terreus, Fusarium oxysporum, Fusarium proliferatum and Penicillium atramentous.* The occurrence of *A. flavus* was the highest in all the samples collected. *A. flavus* occurred mostly in Ayeka and Okitipupa samples than other samples. *Fusarium oxysporum and Fusarium proliferatum* only occur in Ilutitun, Igodan and Idepe samples. *Penicillium* has the lowest frequency of occurrence and it only occur in Ilutitun samples. The highest occurring mould species were *Aspergillus flavus (40%), Aspergillus tamarii (20%), Aspergillus niger (4%), Aspergillus fumigatus (4%), Aspergillus terreus (4%), Fusarium oxysporum (12%), Fusarium proliferatum (16%) and Penicillium (4%)* (Table 8 and 9). Fungi isolated were later stained and the microscopic features were taken down as seen in table 3,4,5,6, and 7.

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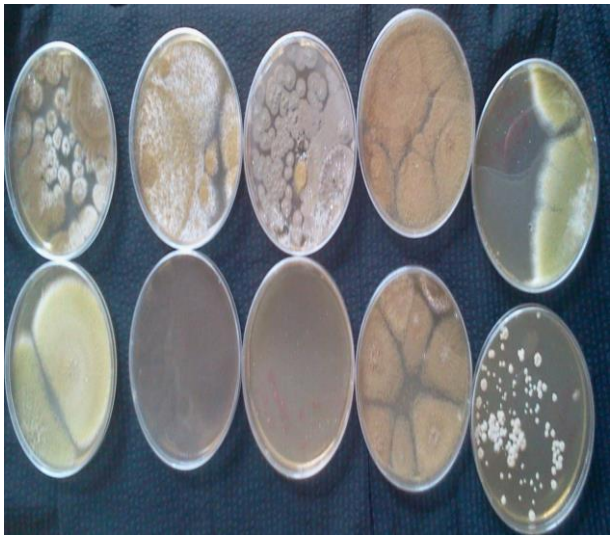

Plates 1: Isolates from Okitipupa maize samples

Plate 2: Isolates from Idepe maize samples

Plate 3: Isolates from Igodan-lisa maize samples

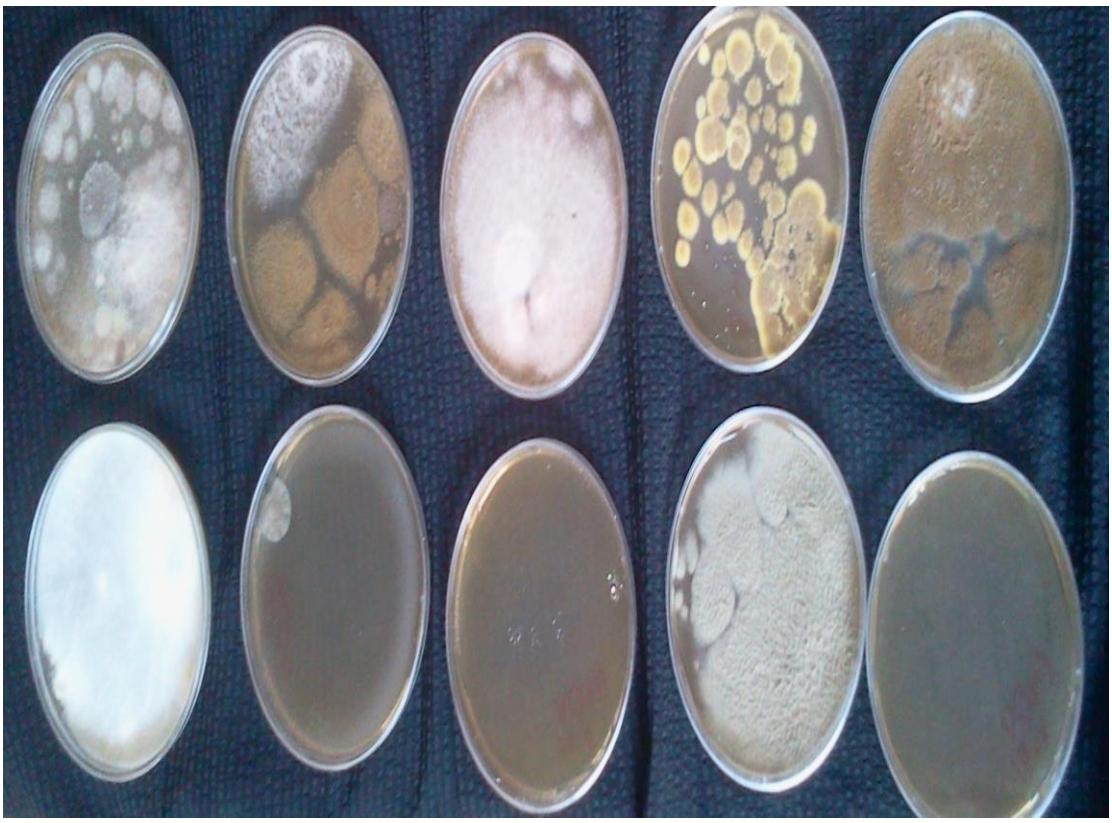

Plate 4: Isolates from Ilutitun maize samples

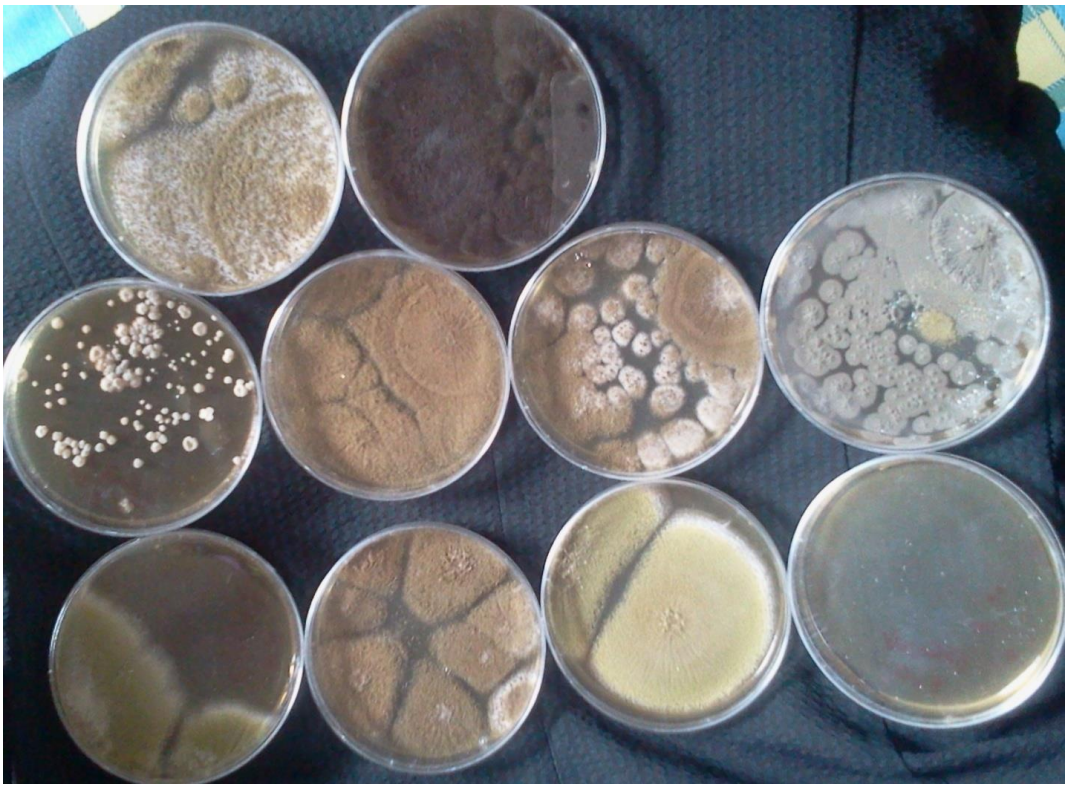

Plate 5 : Isolates from Ayeka maize samples

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Table 1: List of moulds isolated from samples collected from Okitipupa metropolis

Sample collection Site	Type of mould isolated
Idepe A	*Aspergillus flavus, Fusarium proliferatum*
B	*Aspergillus fumigatus, Fusarium oxysporum*
C	No growth
D	*Fusarium oxysporum, Aspergillus tamari*
E	*Fusarium proliferatum*
Okitipupa A	*Aspergillus flavus*
B	*Aspergillus flavus*
C	*Aspergillus tamari*
D	*Aspergillus tamari*
E	*Aspergillus flavus*
Igodan A	*Aspergillus tamari, fusarium oxysporum*
B	*Aspergillus flavus*
C	*Fusarium proliferatum*
D	*fusarium oxysporum*
E	*Aspergillus fumigatuss*
Ilutitun A	*fusarium oxysporum, Penicilium atrametous*
B	*Penicilium atrametous, Aspergillus flavus*
	Aspergillus tamari
C	*fusarium proliferatum*
D	*Aspergillus terreus*
E	*Aspergillus fumigates*
Ayeka A	*Aspergillus flavus*
B	*Aspergillus tamari, Aspergillus flavus*
C	*Aspergillus flavus, Aspergillus tamari*
D	*Aspergillus flavus*
E	*Aspergillus niger, Aspergillus flavus*

Key: A=1st sample, B= 2nd sample, C=3rd sample, D= 4th sample and E=5th sample.

Table 2: Morphological identification of the isolates collected from Ayeka market

Sample site	Isolate	Morphological characteristics	Microscopic identification
A	*Aspergillus flavus*	Obverse: yellow-green becoming green with age. Reverse: creamish-yellow	Conidial head showing verrucose stipe, domed-shaped vesicle and philades borne directly on vesicle
B	*Aspergillus tamari*	Obverse: rusty brown Reverse: creamish-brown	Conidial head with long chain of conidia, phialides bearing conidia and rough stipe
C	*Aspergillus flavus*	Obverse: yellow-green becoming green with age. Reverse: creamish-yellow	Conidial head showing verrucose stipe, domed-shaped vesicle and philades borne directly on vesicle
	Aspergillus tamari	Obverse: rusty brown Reverse: creamish-brown	Conidial head with long chain of conidia, phialides bearing conidia and rough stipe
D	*Aspergillus flavus*	Obverse: yellow-green becoming green with age. Reverse: creamish-yellow	Conidial head showing verrucose stipe, domed-shaped vesicle and philades borne directly on vesicle
E	*Aspergillus niger*	Obverse: blackish-brown often with yellow mycelium	conidial head with metulae and philades,
		Reverse: creamish-yellow to yellow.	brownish colour of stipe.
	Aspergillus flavus	Obverse: yellow-green becoming green with age. Reverse: creamish-yellow	Conidial head showing verrucose stipe, domed-shaped vesicle and philades borne directly on vesicle

Key: A=1st sample, B= 2nd sample, C=3rd sample, D= 4th sample and E=5th sample.

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Table 3: Morphological identification of the isolates collected from Ilutitun

Sample site	Isolate	Morphological characteristics	Microscopic identification
A	Fusarium	Obverse: whitish-cream	Microconidia borne on
	Oxysporum	Reverse: pale to bluish-violet	Monophialides, Microconidia, chlamydospores.
B	*Penicillium*	Obverse: olive-green	Conidiosphores, conidia
	atramentous	Reverse: creamish-brown	
	Aspergillus tamari	Obverse: rusty brown Reverse: creamish-brown	Conidial head with long chain of conidia, phialides bearing conidia and rough stipe.
C	*Penicillium sp*	Obverse: olive-green Reverse: creamish-brown	Conidiosphores, conidia
	Fusarium proliferatum	creamish-peach Reverse: pale yellow	Short chains of microconidia on polyphialidic conidiophores. Macroconidia is also present.
D	Aspergillus terreus	Obverse: cinnamom Reverse: brown	Conidial showing metulae and philades.
E	*Aspergillus tamari*	Obverse: rusty brown Reverse: creamish-brown	Conidial head with long chain of conidia, phialides bearing conidia and rough stipe.

Key: A=1st sample, B= 2nd sample, C=3rd sample, D= 4th sample and E=5th sample.

Table 4: Morphological identification of the isolates collected from Okitipupa market

Sample site	Isolate	Morphological characteristics	Microscopic identification
A	*Aspergillus flavus*	Obverse: yellow-green becoming green with age. Reverse: creamish-yellow.	Conidial head showing verrucose stipe, domed-shaped vesicle and philades borne directly on vesicle.
B	*Aspergillus flavus*	Obverse: yellow-green becoming green with age. Reverse: creamish-yellow.	Conidial head showing verrucose stipe, domed-shaped vesicle and philades borne directly on vesicle.
C	No growth	NIL	NIL
D	*Aspergillus tamari*	Obverse: rusty brown Reverse: creamish-brown	Conidial head with long chain of conidia, phialides bearing conidia and rough stipe.
E	*Aspergillus flavus*	Obverse: yellow-green becoming green with age. Reverse: creamish-yellow	Conidial head showing verrucose stipe, domed-shaped vesicle and philades borne directly on vesicle.

Key: A=1st sample, B= 2nd sample, C=3rd sample, D= 4th sample and E=5th

Table 5: Morphological identification of the isolates collected from Idepe market

Sample site	Isolate	Morphological characteristics	Microscopic identification
A	*Aspergillus flavus*	Obverse: yellow-green becoming green with age. Reverse: creamish-yellow.	Conidial head showing verrucose stipe, domed-shaped vesicle and philades borne directly on vesicle.
	Fusarium proliferatum	creamish-peach Reverse: pale yellow	Short chains of microconidia on polyphialidic conidiophores. Macroconidia is also present.
B	*Aspergillus fumigatuss*	Obverse: bluish-green Reverse: creamish-green.	Conidia head with philiades, metulae is absent.
	Fusarium oxysporum	Obverse: whitish-cream Reverse: pale Tobrown	Microconidia borne on monophialides. Microconidia, chlamydospores.
C	NO growth	NIL	NIL
D	*Fusarium oxysporum*	Obverse: whitish-cream Reverse: pale to brown.	Microconidia borne on monophialides. Microconidia, chlamydospores.
	Fusarium proliferatum	creamish-peach Reverse: pale yellow	Short chains of microconidia on polyphialidic conidiophores. Macroconidia is also present.

Key: A=1st sample, B= 2nd sample, C=3rd sample, D= 4th sample and E=5th sample.

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Table 6: Morphological identification of the isolates collected from Igodan

Sample site	Isolate	Morphological characteristics	Microscopic identification
A	*Aspergillus tamari*	Obverse: rusty brown Reverse: creamish-brown	Conidial head with long chain of conidia, phialides bearing conidia and rough stipe.
B	*Aspergillus flavus*	Obverse: yellow-green becoming green with age. Reverse: creamish-yellow.	Conidial head showing verrucose stipe, domed-shaped vesicle and philades borne directly on vesicle.
	Aspergillus flavus	Obverse: yellow-green becoming green with age. Reverse: creamish-yellow.	Conidial head showing verrucose stipe, domed-shaped vesicle and philades borne directly on vesicle.
C	*Fusarium proliferatum*	creamish-peach Reverse: pale yellow	Short chains of microconidia on polyphialidic conidiophores. Macroconidia is also present.
D	*Fusarium oxysporum*	Obverse: whitish-cream Reverse: pale to brown.	Microconidia borne on monophialides. Microconidia, chlamydospores.
E	*Aspergillus fumigatus*	Obverse: bluish-green Reverse: creamish-green.	Conidia head with philiades, metulae is absent.

Key: A=1st sample, B= 2nd sample, C=3rd sample, D= 4th sample and E=5th sample.

Table7: Showing percentage occurrence of moulds isolated from each sample

Sample site	Isolates	No of samples collected	No of occurrence	% Occurrence
Ayeka	*Aspergillus flavus*	5	3	60%
	Aspergillus tamarri	5	1	20%
	Aspergillus niger	5	1	20%
Ilutitun	*Fusarium oxysporum*	5	2	40%
	Aspergillus flavus	5	1	20%
	Aspergillus tamarii	5	1	20%
	Penicillium atramentum	5	1	20%
	Fusarium proliferatum	**5**	1	20%
Igodan	*Aspergillus flavus*	5	2	40%
	Aspergillus fumigatus	5	1	20%
	Fusarium proliferatum	5	1	20%
	Fusarium oxysporum	5	1	20%
Idepe	*Aspergillus flavus*	5	1	20%
	Aspergillus fumigatus	5	1	20%
	Fusarium proliferatum	5	2	40%
	Fusarium oxysporum	5	1	20%
Okitipupa	*Aspergillus flavus*	5	4	80%
	Aspergillus tamarii	5	1	20%

Table 8: Total percentage occurrence

Isolates	Total Occurrence	Total % occurence
Aspergillus flavus	10	40
Aspergillus fumigatus	1	4
Aspergillus niger	1	4
Aspergillus tamarri	5	20
Fusarium oxysporum	3	12
Fusarium proliferatum	4	16
Penicillium atramentosum	1	4

Table 9: Showing number of colony counted from each location

Sample location	Isolate	No of colony counted (cfu/g)
Ayeka A	*Aspergillus flavus*	**2×10^5**
B	*Aspergillus tamarii*	**8×10^5**
C	*Aspergillus flavus*	**5×10^5**
D	*Aspergillus tamarri*	**3.2×10^6**
E	*Aspergillus flavus*	**9×10^5**
	Aspergillus niger	**1.7×10^6**
Idepe A	*Aspergillus flavus*	**1×10^5**
	Fusarium proliferatum	**4×10^5**
B	*Aspergillus flavus*	**1×10^5**
C	*Fusarium oxysporum*	**7×10^5**
D	*Fusarium oxysporum*	**8×10^5**
E	*Aspergillus tamarii*	**4×10^5**
	Fusarium proliferatum	**1.0×10^6**
Igodan A	*Aspergillus tamarii*	**8×10^5**
B	*Aspergillus flavus*	**2.1×10^6**
C	*Fusarium proliferatum*	**3.8×10^6**
D	*Fusarium oxysporum*	**2.4×10^6**
E	*Aspergillus fumigatus*	**1×10^5**
Ilutitun A	*Fusarium oxysporum*	**2.8×10^5**
B	*Aspergillus tamarii*	**4×10^5**
	Penicillium	**1×10^5**
C	*Fusarium proliferatum*	**1.1×10^6**
D	*Aspergillus terreus*	**3.3×10^6**
E	*Aspergillus tamarii*	**1.1×10^5**
Okitipupa A	*Aspergillus flavus*	**2×10^5**
B	*Aspergillus flavus*	**3.2×10^6**
C	*Aspergillus niger*	**8×10^5**
D	*Aspergillus tamarii*	**8×10^5**
E	*Aspergillus flavus*	**2×10^5**

Key: A=1st sample, B= 2nd sample, C=3rd sample, D= 4th sample and E=5th sample.

DISCUSSION

The total number of *Aspergillus, Penicillium and fusarium* species isolated from each grain sample and the percentage occurrence of each genus and species was determined and compared. Each of the 25 samples of maize analyzed contained from at least one of the genera; *Aspergillus, Penicillium and Fusarium*. The major mould species isolated in the samples collected include; *Aspergillus flavus, Aspergillus tamarii, Aspergillus niger, Aspergillus terreus ,Penicillium atramentous, fusarium oxysporus, fusarium proliferatum.*

The maize samples collected in all five locations were positive for moulds and were contaminated with at least one of the known genera of mycotoxigenic fungi, namely *Aspergillus, Penicillium* and *Fusarium*. These are among the most common moulds as reported [8]. The isolated mould may have contaminated the maize from either the field or during storage. Toxigenic mould can be divided into three groups, field fungi namely, genus *Fusarium*, storage fungi including the genus *Aspergillus* and *Penicillium*, for example *A. flavus and A. niger* and advanced deterioration fungi which normally do not infect intact grains but easilly attack damaged ones, they require high moisture content. Examples of the third group are *A. Clavatus, A.fumigatus, A. chaetomium, Rhizopus,Mucor* etc. [9].

In this study, high incidences of *Aspergillus* sp. were found in the maize samples that were collected from the 25 Divisions in the five locations. The highest recorded incidence of *Aspergillus* species in maize from the study was 40%. The high incidences of *Aspergillus* species in this study conform to what has been previously reported in Nigeria in post-harvest maize [10]. It is likely that pre-harvest infections and the storage structures greatly influence the mycoflora in storage. Also the high incidence elucidated in this study could possibly be attributed to some of the storage structures, examples of some structures used for maize storage in Okitipupa metropolis include woven polypropylene bags, heaping on the floor and on the verandah, above fire racks, and out-door storage practices like granaries (11), some of these structures do not guarantee maize freedom from moisture pick-up, mould infection and hence protection of the grains against aflatoxin contamination. The high moisture content in some of the maize samples could also possibly have contributed to the high incidences of *Aspergillus* species. *Aspergillus* species can survive and grow in grains with moisture content as low as 15% while moisture levels below 12 to 13% inhibit growth of the fungus at any temperature.

There were two different major species of *Aspergillus* isolated and identified from the maize samples collected from the five locations in this study, they include; *Aspergillus flavus* and *Aspergillus tamari*, although the

distribution of members of *Aspergillus species* varied across the location, *A. flavus* was the most dominant species in most of the areas studied. The fungus recorded the highest incidences in three out of the five locations and 21 out of the 25 samples analyzed. Contamination of maize by mycotoxin producing fungi is a significant health and economic problem in the world [12]. Findings from the five study sites revealed that, potentially mycotoxigenic fungal isolates were found on maize samples. Maize samples from each location were more infested by a specific fungal genus. Maize grains from Ayeka, Okitipupa, Igodan were heavily infested by *Aspergillus* species (80%)**.** This possibly shows that the *Aspergillus* species encounter more favorable conditions than the other fungal isolates in those locations due to the high frequency of occurrence. *Penicillium* specie has the lowest frequency of occurrence with just 20% in Ilutitun samples. The agroecological conditions prevailing in each location could favor the development of a certain fungal genera as opposed to another. This concurs with other study findings where it has been reported that, high soil temperature and drought are associated with increased mould infestation and incidence of mycotoxigenic species or strain [20]. Environmental conditions favorable to mycotoxin producing moulds differs, *A. flavus* is known to compete poorly under chilly conditions while their occurrence is higher in warmer environments (above 25°C) than cooler environments (20 -25 °C) [13]. Drought conditions are more likely to occur in Okitipupa, idepe and Ayeka which stresses plants making them more susceptible to contamination by *Aspergillus* species. [13]. From the current study, fungi belonging to the genera *Fusarium* were isolated in maize samples from Igodan and Idepe at 40% and 30% respectively. From the two regions, the frequent isolation of the species shows there could be possibility of maize contamination by Fumonisins produced by *Fusarium oxysporum*. In Idepe especially, farmers are known to habitually leave their maize yields in the field upon maturity to allow drying [14]. In addition, the maize harvest coincides with second rains which increase rotting and infestation by moulds. This may be a reason for the frequent occurrence of Fusarium species in these maize samples.

Also in this study, maize samples from Okitipupa and Ayeka had no infestation by Fusarium moulds compared to Ilutitun, Igodan and Idepe that had (40%, 40% and 30%) respectively. This could be as a result of the different maize varieties grown in these regions as well as varied methods of storage used by the market women and farmers which may not be favorable to the *Fusarium* moulds. From other study findings, the major factors that influence the risk of *Fusarium* infection and Fumonisin contamination are temperature, insect injury, stress and water activity [13]. This high contamination level of various moulds may be attributed to a number of factors, the surrounding environment, moisture content and plant susceptibility to fungal infestation. In addition, poor pre-harvest and postharvest handling, physical damage of the grain due to pests, improper drying method and poor storage of the grains are possible contributing factors. Environmental factors, particularly high humidity and temperature are known to promote fungal growth in foods and feeds . In the current study, farmers and traders were found to be drying their grains on bare ground and such traditional drying methods have been reported to be a major source of fungal contamination [14]. Poor storage practices were evident in the sample collection sites where some household stored grains inside damp and poorly ventilated rooms. Therefore, a combination of these factors may have contributed to the high levels of moulds contamination. Unfavourable conditions during transportation and marketing are also possible contributing factors to fungal growth and mycotoxins production [14]. In addition, mechanical damage during and after harvest may have offered the entry to fungal spores either in maize cob or grains and after predisposed the maize to moulds attack as earlier reported [13]. Insect damage which was evident in some of the maize samples that were observed to be infested by weevils may also have aggravated the moulding. Insect attack maize in the field as well as in storage and plays an important role in infection of the grains by moulds, either by wounding the plants or acting as vectors.

At farm levels, the real problem is that mycotoxin contaminated maize may appear just like the normal grains without any outward physical signs of fungal infection. Mycotoxins, especially aflatoxin are silent killers and there is an urgent need to make Okitipupa food grains safe from the deadly mycotoxins. Possible intervention strategies include good agricultural practices like early harvesting, proper drying, good sanitation, proper storage and insect management, breeding for resistance, use of antimicrobial agents to protect the grains, surveillance and awareness creation. Policy makers should establish and enforce quality standards and regulations related to moulds and mycotoxin contamination across the region to minimize health hazards related to consumption of contaminated grains and their products. The results of this study showed that good and clean maize are heavily contaminated with various species of moulds. This poses a serious danger to human and animal health and calls for immediate intervention to avert future mycotoxicoses outbreaks.

CONCLUSION

In conclusion, it was important to determine the incidence of fungi that exist in maize from different regions in Okitipupa metropolis. Plant stress, climatic factors, poor pre-harvest and post-harvest handling, physical damage of the grain due to pests, improper drying method and poor storage of the grains are possible contributing factors to the production of different mycotoxin-producing fungi. Therefore, all these factors mentioned above affect the existence of mycotoxigenic fungi in maize and food security in Okitipupa metropolis. Five regions were infested by different mycotoxigenic fungi according to the test

carried out. Generally, a sample from each of this location are totally infested with different moulds and moulds on the maize samples shows the possibility of occurrence of more than one mycotoxin in grains. The current study also highlights the importance of future work that will seek to determine shifts in pathogen populations in different locations.

RECOMMENDATION

In view of the research carried out to date, the following recommendations can be made:

- Maize grown for human consumption in areas where conditions are frequently favorable to fungal invasion and mycotoxin production in the field should be tested for mould and mycotoxin contamination before use.
- Additional research is needed to develop the ability to predict when and where environmental conditions may make mycotoxin contamination probable and to develop the means to disseminate warnings to farmers and processors.
- If invasion in the field is probable and environmental conditions are favorable for mycotoxin production in the field, care should be taken to reduce sources of inoculum and to minimize plant stress and insect damage.
- Once it is determined that field contamination is likely, care should be taken to minimize the growth of the fungus after harvest and while in storage. Planning should begin for decontamination and include the diversion of contaminated maize away from human consumption or consumption by sensitive species.
- Maize cultivars that are resistant to drought stress, insect damage and fungal infection need to be developed.
- Easy and economical decontamination procedures need to be developed.

REFERENCES

[1] Menkir, A., Ejeta, G., Butler, L. G., Melakeberhan, A., and Warren, H.L., 1996a. Fungal invasion of kernel and grain mold damage assessment in diverse sorghum plasm. Plant disease 80: 1399-1402.

[2] Iken, K.E and N.A Musa (2004) maize research and production in Nigeria. Institute of Agricultural Rearch and Training (IART&T) Obafemi Awolowo University.Moor plantation, Ibadan, Nigeria.

[3] Osagie A.U., Eka O.U. (1998) Nutritional Quality of Plant Foods. Post Harvest Research Unit, University of Benin, Benin pp. 34 – 41.

[4] IITA (2001). International Institute of Tropical Agriculture, Ibadan, Oyo State. Annual Report on Maize Production.

[5] Ikram U., Mohammed A., Arifa F., (2010). Chemical and nutritional properties of some maize (Zea mays L.) varieties grown in NWFP, Paskistan. Pakinstan journal of Nutrition. 9(11)1113-1117.

[6] Klich, M., 2002. Identification of Common Aspergillus Species. ASM Press, Washington, DC, USA, pp: 116. Kozakiewicz, Z., 1989. Aspergillus species on stored products. Mycol. Pap., 161: 1-188.

[7] Bennett, J.W. and M. Klich, 2003. Mycotoxins. Clin. Microbiol. Rev., 16: 497-516.

[8] Ryan, K.J. and C.G. Ray, 2004. Sherris Medical Microbiology. 4th Edn., McGraw Hill, New USA., ISBN: 808-815.

[9] Hussaini, A.M., A.G. Timothy, H.A. Olufunmilayo, A.S. Ezekiel and H.O. Godwin, 2009. Fungi and some mycotoxins found in mouldy Sorghum in Niger State, Nigeria. World J. Agric. Sci., 5: 5-17.

[10] Bankole, S. S. and Adebanjo, A. (2003). Mycotoxins in food West Africa: Current situation and possibilities of controlling it. African Journal of Biotechnology 2:254-263.

[11] Fandohan, P., Zoumenou, D., Hounhouigan, D. J., Marasas, W. F. O., Wingfield, M. J., & Hell, K. (2005). Fate of aflatoxins and fumonisins during the processing of maize into food products in Benin. International Journal of Food Microbiology, 98, 247–259.

[12] Wagacha, J.M. and J.W. Muthomi, 2008. Review on mycotoxin problem in Africa: Current status, implications to food safety and health and possible management strategies. Int. J. Food Microbiol., 124: 1-12.

[13] Okello, D.K., A.N. Kaaya, J. Bisikwa, M. Were and H.K. Oloka, 2010. Management of Aflatoxins in Groundnuts: A manual for Farmers, Processors, Traders and Consumers in Uganda. National Agricultural Research Organisation, Entebbe, Uganda, ISBN: 978-9970-401-00-0, Pages: 38.

[14] Bhat, R.V. and S. Vasanthi, 2003. Food safety and food security and food trade-mycotxin food safety risk in developing countries. International Food Policy Research Institute.