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An overview of public health implications of mycotoxins contamination of maize and guinea corn from markets in Kogi State, Nigeria

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Abstract

Maize and guinea corn being one of the most important staple in Nigeria were evaluated for their mycotoxins contents., 20 samples of maize and 20 sample of guinea corn (10 samples collected from the markets and 10 samples collected from the ware house) were obtained from three different senatorial zone of Kogi State. A total of 30 samples of maize and 30 samples of guinea corn collected from the three zones of Kogi state were analyzed for the presence of Aflatoxin B1, AflatoxinB2, Fumonisin, Ochratoxin A, and Zearalenone. The result revealed the presence of the studied mycotoxins in 67 % of all the 60 samples. The results also revealed the presence of mycotoxins in 80 % of the 15 maize samples picked from the market and 73 % of the 15 maize samples picked from the ware house in the three senatorial zone. Also the percentage composition of all the mycotoxins present in the 30 samples of guinea corn was 67% of the 15 samples picked from the markets and 47% of the 15 samples picked from the ware house respectively. Among all the studied mycotoxins, only fumonisin have its concentration above the recommended limit approved by the Joint Expert Committee on Food Additives of the WHO and FAO (JECFA). The concentration of the remaining mycotoxins under study is nothing to be worried about but, adequate measure should be taken to checkmate the conditions that expose the food crops to the growth of fungi.

Keywords: Mycotoxins; Maize; Guinea corn; Zones; Percentage occurrence

1 Introduction

Mycotoxins are fungal secondary metabolites produced by the toxigenic strains of the fungi, and these compounds contaminate various food substances and agricultural crops [1]. *Aspergillus*, *Penicillium* and *Fusarium* are known to be the major mycotoxin-producing fungi. The most important mycotoxins produced include aflatoxin (AF), ochratoxins (OT), deoxynivalenol (DON), zearalenone (ZEA), fumonisin (FUM) and trichothecenes (T). Furthermore, DON, ZEA, FUM and T are all produced by the *Fusarium* species [2]. The predisposing conditions for mycotoxin production relate mainly to poor hygienic practices during transportation and storage, high temperature and moisture content and heavy rains [1]. These conditions are typically observed in different African countries. The demand for the storage of food substances has been increased due to the increasing in the population in African continent. However, improper storage, transportation and processing facilities may facilitate fungal growth and subsequently lead to mycotoxin production and contamination of food and feedstuffs [3].

The food-borne mycotoxins are of great importance in Africa and other parts of the world. The impact of such toxins on human health, animal production and economy has attracted worldwide attention [4]. There is a strong association between cancer risks in human population and exposure to foods naturally contaminated with AFs [5]. FUMs have been enclosed in some animal diseases, such as leukoencephalomalacia in equines, porcine pulmonary edema, rat liver cancer and hemorrhage in the brain of rabbits [6]. Many African countries had started to set up prevention, control and

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surveillance strategies to reduce the incidence of mycotoxins in foods. The available information on the incidence, public health importance, prevention and control of mycotoxins in many African countries is still lacking. This may be due to limited monitoring systems and failure to adopt preventive and control measures in these countries.

1.1 Commodities susceptible to aflatoxin contamination

Maize provides an excellent substrate for mould growth and mycotoxin contamination .Bouraima *et al.* (1993) [7] found aflatoxin B1 level up to 14 g/kg and aflatoxin G1 level up to 58 g/kg in stored maize from Benin. Setamou [8] found that the percentage of samples contaminated with aflatoxin was 42.5% in 1994 and 30% in 1995 in pre harvest maize from Benin. Udoh [9] reported that 33% of maize samples from different ecological zones of Nigeria were contaminated with aflatoxins. [10] found that the percentage of maize samples with more than 5 g/kg aflatoxin levels was between 9.9% and 32.2% in the different ecozones of Benin before storage, but that this increased to 15.0% and 32.2% after six months storage. All the maize samples collected from silos and warehouses in Ghana contained aflatoxins at levels ranging from 20 to 355 g/kg, while fermented maize dough collected from major processing sites contained aflatoxin levels of 0.7 to 313 g/kg [11]. The role of insects in the spread of *A. flavus* and in increasing aflatoxin contamination has also been stressed. [8] Reported that the percentage of grains infected with *A. flavus* and samples contaminated with aflatoxin as well as the mean aflatoxin content of samples increased with increasing insect damage in preharvest maize in Benin. Hell [10] found that no aflatoxin was detected in maize that was free of insect damage, whereas in maize with more than 70% of cobs damaged by insects, 30.3% were aflatoxin positive. The most important insects that spread *A. flavus* in preharvest maize was found to be the lepidopteran ear borer *Mussidia nigrivenella*, *Sitophilus zeamais* and *Carpophilus dimidiatus* [8] [10]. Pre harvest aflatoxin production in maize is dependent on weather conditions during crop maturations. The risk of aflatoxin contamination before harvest is highest when environmental conditions are characterized by soil moisture stress with elevated temperatures [5]. [12] Reported that most of the corn-groundnut snack ('donkwa') investigated contained aflatoxins above 30 g/kg immediately after preparation. Yameogo [13] reported that seeds of groundnuts from Burkina Faso inoculated with *A.flavus* excreted all the four major aflatoxins, which peaked at 170 ppb after 6 days. Aflatoxin formation in groundnut is favoured by prolonged end of season drought and associated elevated temperature [14].

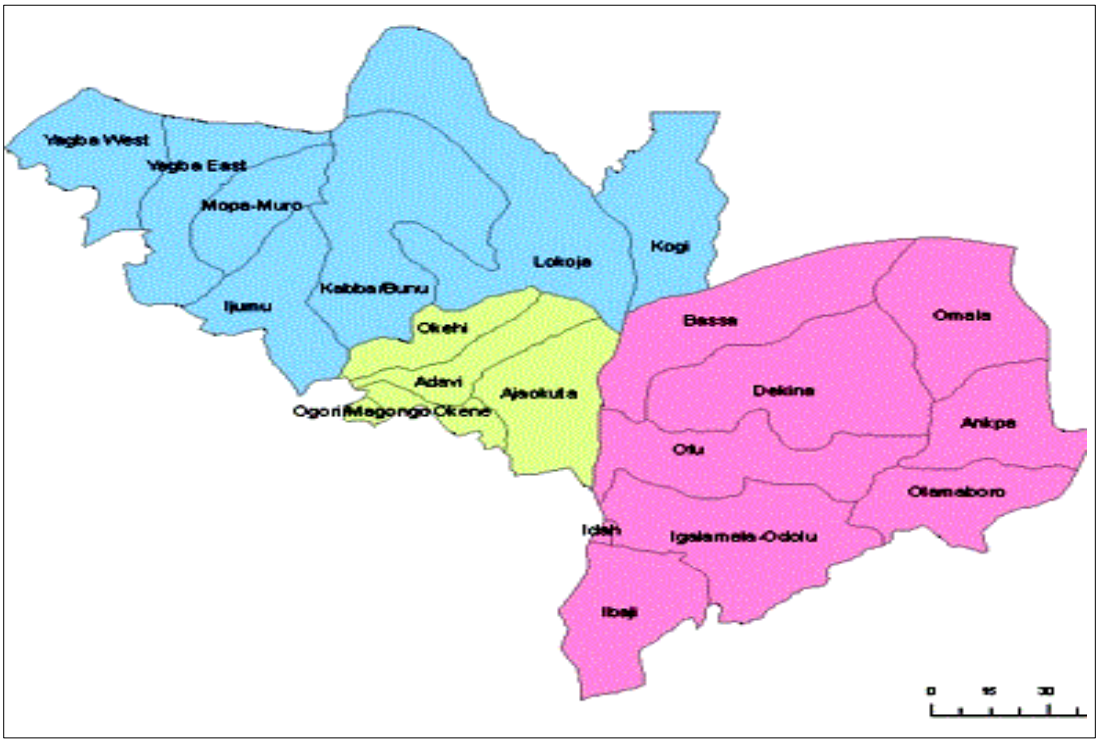
Aflatoxin was detected in 98% of samples of dried yam chips surveyed in Benin with levels ranging from 2.2 to 220 g/kg and a mean value of 14 g/kg [15] Aflatoxin B_1 was detected in 22% of yam chips in Ogun and Oyo States of Nigeria [16], while in a larger survey conducted later, 54.2% of dried yam chips were contaminated with aflatoxin B_1 (4– 186 g/kg; mean = 23 g/kg), 32.3% with aflatoxin B2 (2- 55 g/kg), while5.2% were positive for aflatoxin G1 (4-18 g/kg), and two samples tested positive for aflatoxin G2 [16]). Adebajo [17] reported the presence of aflatoxins in tiger nut (*Cyperus esculentus*) at toxicologically unsafe levels .detected aflatoxins in 35% of tiger nut with concentrations ranging from 10-120 g/kg collected from different parts of Nigeria, and the incidence of *A. flavus* and aflatoxin contamination was found to be correlated. Efuntoye [18] reported the fungal contamination of herbal drug plants stored for sale in Ibadan, and demonstrated the mycotoxin producing ability of the isolates on artificial medium[18] The problem with mycotoxin contamination in herbal plants is that they are consumed directly, unlike other products such as maize and groundnuts, which may undergo some processing before eating. In a recent survey, 27% of melon seed samples from farmers' stores contained aflatoxin B1 with mean levels of 14 g/kg in the forest and 11 g/kg in the savanna of Nigeria [19]. Rice, which is widely consumed in the country, has also been reported by various authors to favour aflatoxin production. A recent survey in UK shows that retail rice was contaminated with aflatoxins, though at toxicologically 'safe levels'.

2 Methodology

2.1 The Study Area

Kogi State which was created in 1991 is one of the thirty-six (36) states of the Federal Republic of Nigeria. Kogi State is located in the North Central part of Nigeria. The State lies between latitudes 70 300'N and 80 10'N and Longitudes 60 01'E and 7º 50'E, covering an area of about 27,747 km2. It shares common boundaries with Niger, Kwara, Nasarawa and The Federal Capital Territory to the north. In the East, the state is bounded by Benue and Enugu States; in the south by Enugu and Anambra States; and in the west by Ondo, Ekiti and Edo States. Lokoja, the Niger/Benue confluence town is the state capital. The 1991 census in Nigeria puts the population of the state at 2,147,756 which spreads over 395,389 households. Politically, the state is divided into 3 senatorial districts – Kogi central, Kogi east and Kogi west. The state is further divided into 21 local government areas (LGA), with Kogi central, east and west having 5, 9 and 7 LGAs respectively (Fig. **1**). The population of the state is mostly rural, as in most Nigerian rural communities, the economy of the area is largely agrarian. The sector employs a vast majority of the total workforce in the state. Farm labour is supplied mainly by families, hired labourers and work groups. In terms of infrastructural development, the area is still largely backward. Community effort towards development is very visible in the state.

Many rural communities in Kogi State still lack access to good health care facilities. Although, a number of primary health care centers dot the landscape, the poor services rendered at some of these centers call to question the rationale behind their establishment in the first place. Secondary and tertiary health care facilities are few in the state. Therefore, people have to travel several kilometers on bad roads in order to have access to good health care particularly secondary and tertiary care services. Besides the problem of inadequacy of health care facilities, the problem of bad roads and high cost of transportation makes accessibility to available health care facilities in the state and the referral services available outside the state highly difficult. Therefore, the issue of accessibility in rural areas goes beyond the straight-line measurement of people's location relative to the facilities in question. Other geographic and socio-economic factors must be taken into consideration.



Source: http://www.nigeria.com/nigeria/state-nigeria/kogi-state.html.

Figure 1 Map of Kogi State Showing Research area

2.2 Sample Collection

Samples of maize and guinea corn were collected between August and September, 2022 from designated markets and store/warehouses within the state according to the three senatorial districts. Multistage sampling technique was employed in selecting the markets used for the study. Each market were sub divided into two segments for the purpose of sample collection: grains in storage in the warehouse and grains for sale directly to consumers in the open market. Using simple random sampling, a quantity of each sample were collected from ten (10) different sampling points from each market. All samples were pooled together to obtain one composite/representative sample of each grain for each sampling location (i.e. market) in the study area. A total of 20 (10 for maize and 10 for guinea corn) composite/representative samples (comprising of 60 individual samples: 20 samples x 3 Senatorial sampling points = 60) were obtained for this study. Each composite sample was then blended using an electric blender to obtain a quantity of finely ground powder which were then transported collected into airtight zip locked bags. All ground samples were properly packaged according to IATA (International Air Transporters Association) standards and were subsequently sent to the host laboratory, Central Research laboratory, University road, Ilorin. Kwara State here they were stored at -700C until analysis.

2.3 Mycotoxin Analysis of Ground Grain Samples

Ground samples were prioritized accordingly and subsequently analyzed for aflatoxins, fumonisin, Ochratoxin and Zearalenone acid using the High Performance Liquid Chromatography (HPLC) technique with different extraction methodology for each mycotoxin.

2.3.1 Aflatoxin HPLC Procedure

Sample Extraction

5g of the grounded sample was weighed out into a blender jar and an extraction solvent (methanol: 2% NaHCO3 in water, 70+30) added. This was blended at high speed for 2 minutes. The blender contents was allowed to settle before opening it. Mixture was filtered through Whatman No. 4 filter paper. 25ml of the filtered extract was pipetted into a 250ml separation funnel. 100ml of *n*-hexane (to de-fat the extract) was added and the mixture mixed gently to avoid the formation of an emulsion. After separation to two layers, the lower aqueous layer was carefully transferred into another separation funnel. 50ml of 10% KCL in water was added to the aqueous solution from the step above and the *n*-hexane discarded. The solution was then acidified with 2ml of 6N HCL. 50ml of chloroform was added and the solution mixed gently. The lower organic layer was collected in an Erlenmeyer flask.

The extraction process was repeated with additional 50ml chloroform and the two extracts was combined in the same Erlenmeyer flask. 50g of anhydrous sodium sulfate (Na2SO4) was added allowed to stand for 1 hour. The extract was then filtered and collected into a 200ml rotary evaporator flask. Extract was evaporated to dryness at 400C in a rotary evaporator.

2.3.2 Column Chromatography

Dried evaporated sample was re-suspended in mobile phase (2mls of acetonitrile: 50mM ammonium acetate;

3:1 v/v). Extract solution was filtered through 0.2µm cellulose filter into a fresh tube. 20µL of the final extract sample was injected into HPLC for cyclopiazonic acid.

2.3.3 High Performance Liquid Chromatography Technique

Analysis of aflatoxin samples was carried out by employing a HPLC equipment with the following specifications: a JascoFP-920 fluorescence detector (365 nm excitation wavelength; 435 nm emission wavelength), using a photochemical post-column derivatization reactor (PHRED unit — Aura Industries, USA). Chromatographic separations wasperformed on a reverse phase C18 column (Waters SpherisorbODS2, 4.6 mm×250mm, 5 µm), fitted with a pre-column with the same stationary phase. The mobile phase was a mixture of water: acetonitrile: methanol (3:1:1, v/v) pumped at 1.0mL/min. The injection volume was 50µL. Aflatoxins standard (a mix containing 2 µg/mL each of AFB1 and AFG1, and 0.5 µg/mL of AFB2 and AFG1) to be supplied by Biopure (Austria). Cyclopiazonic acid samples was analyzed using a HPLC system equipped with a Varian 2050 UV detector (285 nm). Chromatographic separations was performed on a EuroSpher 100 NH2 column (Knauer, 4.6 mm×250 mm, 5 µm), fitted with a precolumn with the same stationary phase. The mobile phase used was pumped at 1.0 mL/min and consisted of a mixture of acetonitrile: 50mM ammonium acetate (3:1, v/v), pH5. The injection volume was observed to be 50 µL. CPA standard was supplied by Sigma (St. Louis, MO, USA). Fumonisin samples was analyzed by a HPLC method using a Jasco FP-920 fluorescence detector (420nm excitation wavelength; 500nm emission wavelength). Chromatographic separations was performed on a reverse phase C18 column phase. The mobile phase was Acetonitrile: water: acetic acid (60:40:1, v/v) pumped at 1.0mL/min. the injection volume was 50µL. Fumonisin B2 standard to be supplied by Sigma (USA).

3 Results

The result in table 1 show the concentration of some mycotoxins detected in some composite samples picked in the markets and ware house at the central axis of Kogi State. In the result, the concentration of aflatoxin B_1 detected in the market and ware house sample were 7.1209 µg/kg1.1380 µg/kg respectively and while the concentration of aflatoxin B_2 in both market and ware house samples were 0.1362 µg/kg and 6.2012 µg/kg . also the concentration of fumonisin, zearalenone and Ochratoxin A in the maize samples from the market and ware house were8.1225 µg/kgand 4.1213 µg/kg, 9.3292 µg/kg and 0.1420 µg/kg , 9.4950 µg/kg and 0 µg/kg respectively (i.e Ochratoxin was not detected in the ware house sample).

Table 2 show the concentration of some mycotoxins detected in some composite maize samples picked the market and ware house at the eastern part of Kogi State. The concentration of aflatoxin B_1 present in the markets and ware house samples were 8.1478 µg/kg and 6.1548 µg/kg while aflatoxin B_2 were.1087 µg/kg and it was not detected in the ware house samples. The concentration of fumonisin were 5.2510 µg/kg and 6.2040 µg/kg. zearalenone were 11.4381 µg/kg and 7.001 µg/kg. ochratoxin were not detected both at the market and were house sample in this zone

Table 1 Occurrence and safety status of some mycotoxins present in maize samples in Kogi central

MYCOTOXIN	Average concentration in market sample (µg/kg)	Average concentration in ware house sample(µg/kg)	Permissible concentration by JECFA(µg/kg)	SAMPLE above permissible concentration
Aflatoxin B1	7.1209	1.1380	4.0 – 20	Nil
Aflatoxin B2	0.1362	6.2012	4.0 – 20	Nil
Fumonisin	8.1225	4.1213	2.0	M &W
Ochratoxin A	9.4950	ND	0.09 – 26	NIL
Zearalenone	9.3292	0.1420	2.9 – 50	NIL

Key: M= market W= warehouse

Table 2 Occurrence and safety status of some mycotoxin present in maize samples in Kogi east

MYCOTOXIN	Average concentration in market sample (µg/kg)	Average concentration in ware house sample (µg/kg)	Permissible concentration by JECFA (µg/kg)	SAMPLE above permissible concentration
Aflatoxin B1	8.1478	6.1548	4.0 – 20	NIL
Aflatoxin B2	6.1087	ND	4.0 – 20	NIL
Fumonisin	5.2510	6.2040	2.0	M & W
Ochratoxin A	ND	ND	0.09 – 26	NIL
Zearalenone	11.4381	7.001	2.9 – 50	NIL

Mycotoxins were also determined in the maize samples picked from the markets and ware house in western zone of Kogi State, thus aflatoxin B_2 in the market and the ware house samples is 0.0013 µg/kg and 0.249 µg/kg ,fumonisin 11.2010 µg/kg and 9.10 µg/kg, ochratoxin A 6.3211 µg/kg and 3.371 µg/kg respectively. Zearalenome in the ware house sample is 5.101 but was not detected in the market sample. Aflatoxin B_1 was not detected in the market and the ware house samples.

Table 3 Occurrence and safety status of some mycotoxins present in maize samples in Kogi western zone

MYCOTOXIN	Concentration in market sample (µg/kg)	Concentration in ware house sample (µg/kg)	Permissible concentration by JECFA (µg/kg)	SAMPLE above permissible concentration
Aflatoxin B1	ND	ND	4.0 – 20	NIL
Aflatoxin B2	0.0013	0.249	4.0 – 20	NIL
Fumonism	11.2010	9.10	2.0	M &W
Ochratoxin A	6.3211	3.371	0.09 – 26	NIL
Zearalenone	ND	5.101	2.9 – 50	NIL

The result in table4 show the concentration of some mycotoxins detected in some composite guimea corn samples picked the markets and ware house at the central axis of Kogi State. In the result, the concentration of aflatoxin B_1 detected in the market and ware house sample were 0.103µg/kg1.214 µg/kg respectively and while the concentration of aflatoxin B_2 in the market samples was1.144µg/kg and it was not detected in the ware house samples.. Also the concentration of fumonisin and zearalenone in the guinea corn samples from the market and ware house were 0.108 µg/kg and 3.520 µg/kg, 8.401 µg/kg and 4.120µg/kg . Ochratoxin A was not detected in the samples.

Table 4 Occurrence and safety status of some mytotoxins present in guinea corn in Kogi central

MYCOTOXIN	Concentration in market sample (µg/kg)	Concentration in ware house sample (µg/kg)	Permissible concentration by JECFA (µg/kg)	SAMPLE above permissible concentration
Aflatoxin B1	0.103	1.214	4.0 – 20	NIL
Aflatoxin B2	1.144	ND	4.0 – 20	NIL
Fumonisin	0.108	3.520	2.0	W
Ochratoxin A	ND	ND	0.09 – 26	NIL
Zearalenone	8.401	4.120	2.9 – 50	NIL

Table 5 show the concentration of some mycotoxins detected in some composite guinea corn samples picked the market and ware house at the eastern part of Kogi State. Aflatoxin B_1 and zearalenone were not detected in the samples in this zone but the concentration of aflatoxin B_2 was 8.122.µg/kg and it was not detected in the ware house samples. The concentration of fumonisin were 3.0129µg/kg and µg/kg 1.342, ochratoxin A were 8.3301µg/kg and 2.52µg/kg.

Table 5 Occurrence and safety status of some mytotoxins present in guinea corn in Kogi eastern zone

MYCOTOXIN	Concentration in market sample (µg/kg)	Concentration in ware house sample (µg/kg)	Permissible concentration by JECFA (µg/kg)	SAMPLE above permissible concentration
Aflatoxin B1	ND	ND	4.0 – 20	NIL
Aflatoxin B2	8.122	ND	4.0 – 20	NIL
Fumonisin	3.0129	1.342	2.0	M
Ochratoxin A	8.3301	2.52	0.09 – 26	NIL
Zearalenone	ND	ND	2.9 – 50	NIL

Mycotoxin were also determined in the guinea corn samples picked from the markets and ware house in western zone of kogi State, thus the concentration of aflatoxin B_1 and zearalenone in the market and the ware house samples were 2.101 µg/kg and 4.120 µg/kg,1.750 µg/kg and 2.830 µg/kg respectively. Aflatoxin B_2 and ochratoxin A were not detected in the market and the ware house samples.

Table 6 Occurrence and safety status of some mytotoxins present in guineacorn in Kogi west

MYCOTOXIN	Concentration in market sample (µg/kg)	Concentration in ware house sample (µg/kg)	Permissible concentration by JECFA (µg/kg)	SAMPLE above permissible concentration
Aflatoxin B1	2.101	4.120	4.0 – 20	NIL
Aflatoxin B2	ND	ND	4.0 – 20	NIL
Fumonisin	4.307	ND	2.0	M
Ochratoxin A	ND	ND	0.09 – 26	NIL
Zearalenone	1.750	2.830	2.9 – 50	NIL

4 Discussion

In table 1, Ochratoxin A have the highest concentration of 9.4950 µg/kg in the composite maize sample in Kogi cemtral , followed by zearalenone (9.3292 µg/kg) and fumonisin (8.1225 µg/kg in market sample and 4.1213 µg/kg in the ware house sample) but only the concentration of fumonisin in both the samples picked from the market and ware house is above the permissible concentration of 2.0 µg/kg by The joint expert Committee on Food Additives of the WHO and FAO (JECFA 2016 ,56th meeting) [20]**.** None among the studied mycotoxins in the ware house samples have its concentration above the permissible limit by JECFA [21] however the studied, mycotoxins are detected in 99% of the samples picked at both the markets and warehouse in the central zone of Kogi state.

The concentration of mycotoxins determined in the Kogi east maize samples are in these order; zearalenone> aflatoxin B_1> aflatoxin B_2>fumonisin >ochratoxin A (Table 2). The highest concentration is zearalenone 11.4381 µg/kg. Among all, fumonisin occurrence (5.2510 µg/kg in market sample and 6.2040 µg/kg in ware house sample) is higher than the permissible level according to JECFA 2016 [20].

In table 3, the mycotoxin among those being determined with highest concentration in this research is fumonisin. The concentration of fimonisin in market sample from the western zone of Kogi state is 11.2010 µg/kg and that of the ware house sample is 9.10 µg/kg . The two value is above the permissible level of 2.0 µg/kg by JECFA 2016[20].

The mycotoxin with the highest concentration in Kogi central is zeaealenone, 8.401 µg/kg (Table 4) but among all the mycotoxins, the maize sample picked from ware house have its fumonisin concentration 3.520 µg/kg higher than the permissible level by WHO/FAO(JECFA 2016) [20]. Also, the maize samples picked from kogi eastern zone (Table 5) contain high proportion of ochratoxin A, 8.3301 µg/kg and aflatoxin B_2 8.122 µg/kg but the only mycotoxin with concentration higher than the normal permissible limit is fumonisin (3.0129 µg/kg). the highest concentration of mycotoxin in the maize samples picked in the western zone of Kogi state is 4.307 µg/kg and the mycotoxin is fumonism next is aflatoxin B_1 having a concentration of 4.120 µg/kg.,

The concentration of fumonisin in the guinea corn samples collected from the ware house in kogi central and the market samples collected from both kogi east and kogi western zone were found to be higher than the recommended level approved by JECFA [20]

The concentration of Fumonisin is not the highest in the samples but it is the only mycotoxin whose concentration is higher than the permissible level.Fumonisins are produced by a number of *Fusarium* species, notably *Fusarium Fusarium verticillioides* (formerly *Fusarium moniliforme = Gibberella fujikuroi*), *Fusarium proliferatum,* and *Fusarium nygamai.* This fungus is so intimately associated with maize because it was frequently observed in symptomless maize kernels in Nigeria [21]. fumonisin B1 produced liver cancer, decreased the life span in female mice, and also induced liver carcinoma in male rat, but did not decrease the life span. [22]

However there is no enough conclusive evidence of the human health hazards associated with fumonisin contaminated food, though human health risks associated with fumonisin are possible [23] hence some correlation studies have suggested a link between the consumption of maize with high incidence of *F. verticillioides* and fumonisins and the high incidence of human oesophageal carcinoma in certain parts of South Africa and China [24]. The fungi *A. flavus*, *A. parasiticus* and *A. nominus*, produce aflatoxin. *A* [25]. Aflatoxin contaminated diet has been linked with the high incidence of liver cancer in Africa . Also, Ochratoxin A (OTA) one of the mycotoxin detectedis a mycotoxin produced by different species of *Aspergillus* and *Penicillium*, though it was first isolated from cultures of *Aspergillus ochraceus* [26] The Committee on Toxicity of Chemicals in Food, Consumer Products and Environment (COT) that OTA is a genotoxic carcinogen, and proposed that levels in foods be reduced to the lowest level that can be technologically attained [27]. The joint expert Committee on Food Additives of the WHO and FAO set a provisional maximum intake of 100 ng/kg body weight (bw), while the Scientific Committee on Food of the European Union proposed that the maximum daily intake of OTA should not exceed 5 ng/kg bw [4]

The presence of these mycotoxins is due to poor hygiene during transportation of the commodities, poor storage and processing facilities, heavy rain, high moisture contents and other conditions that support the growth of fungi.

5 Conclusion

Out of all the mycotoxins determined in this study, Fumonisin is the only mycotoxin whose concentration is higher than the recommended concentration by the joint expert Committee on Food Additives of the WHO and FAO (JECFA 2016)

[20]. Mycotxins were detected in 67 percent of all the 60 samples of maize from the three zones. The studied mycotoxins were also found in 80% of the maize samples picked from the ware house of Kogi central zone while 100% of the maize samples collected at the markets of the same zone contains the studied mycotoxins, Also mycotoxins were detected in 80% of the maize samples collected at the market of the kogi eastern zone while60% of the maize samples collected at the ware house in the same zone also contain the mycotoxin under study. Finally mycotoxins were observed at 60% of the maize samples collected at the markets from kogi western zone while 80% percent mycotoxins were observed in the maize samples collected at the ware house of the same zone

Similarly, mycotoxins were found in 67% of all the total guinea corn samples collected from the markets from the three zones while 47% of those samples collected from the ware house from the three zones contain mycotoxins

From this study, the concentrations of aflatoxins B_1 and B_2, zearalenone and ochratoxin A detected in the maize and guinea corn samples collected from both markets and warehouse are low because the concentrations in the samples are lower than their permissible limit recommended by the regulatory body. The percentage occurrence of the studied mycotoxins is higher in maize samples compared to guinea corn samples, however the fumonisin contents detected in most maize and guinea corn samples from the three zone call for serious alarm especially in the samples picked from the markets. Mycotoxins are metabolites of fungi, food items can be contaminated with mycotoxin if expose to conditions that support the growth of fungi for example, if the moisture content of cereals and other grains are left for a long period of time, can support the growth of fungi. Other factors include poor agricultural practices, poor storage conditions, poor handling of the food items or poor hygiene.

The results of this study calls for farmers and the masses attention in the area of handling foods crops and other food items. Food crops should be treated with organic insecticides and fungicides while in farms and when being stored. This is highly recommended especially in humid zones

Good agricultural practice and good storage facilities to adequately preserve the food crops

Also, the moisture contents of grains should be kept low to discourage the growth of mold and fungi.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors hereby declare no conflict of interest.

Statement of informed consent

Informed consent was obtained from individual participants included in this study.

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