

OF AGRICULTURE AND ALLIED SCIENCES (AJAAS)

lication of Faculty of Agriculture,
University of Abuja, Abuja



and comments should be forwarded to the editorial office;
culture, University of Abuja, P.M.B 117, Abuja FCT
a@uniabuja.edu.ng, Phone No:+234 (0)806 224 2866

nd by: University of Abuja Press Ltd.

AFRICAN JOURNAL OF AGRICULTURE AND ALLIED SCIENCES (AJAAS)

Vol. 3 (Issue 1)



PRINT ISSN: 2695-253X

ONLINE ISSN:2734-3413

AFRICAN JOURNAL OF AGRICULTURE AND ALLIED SCIENCES (AJAAS)

World - List Abbreviation: Afr. J. Agr. & Allied Sci.

Website: <https://ajaas.com.ng>, <https://ajaas.uniabuja.edu.ng>
e-mail: ajaas.foa@uniabuja.edu.ng

A Publication of
Faculty of Agriculture, University of Abuja

Professor Toba S. Anjorin | Professor Pa
Managing Editor | Editor-in-Chief

Vol. 3 (Issue 1) 2023



PRINT ISSN: 2695-253X

ONLINE ISSN: 2734-3413

Volume 3 (Issue 1) January 2023

AFRICAN JOURNAL OF AGRICULTURE AND ALLIED SCIENCES (AJAAS)

World - List Abbreviation: Afr. J. Agr. & Allied Sc.

Website: <https://ajaas.com.ng>, <https://ajaas.uniabuja.edu.ng>
e-mail: ajaas.foa@uniabuja.edu.ng

A Publication of
Faculty of Agriculture, University of Abuja

Vol. 3 (Issue 1) 2023

AFRICAN JOURNAL OF AGRICULTURE AND ALLIED SCIENCES (AJAAS)

Afr. J. of Agr. Sc. & Allied Sc.

Vol. 3: 2023 Edition

PRINT ISSN: 2695-253X

ONLINE ISSN: 2734-3413

(The Official Publication of Faculty of Agriculture, University of Abuja)

Copyright ©

This publication is an official document of **Faculty of Agriculture, University of Abuja** and no part of it should be reproduced without the permission of the Editor-in-Chief as approved by the Faculty of Agriculture University of Abuja, 2023

TABLE OF CONTENTS

1	FIRST REPORT OF PEPPER YELLOW VEIN MALI VIRUS ON TOMATO (<i>Solanum lycopersicum</i> L.) IN SOME NORTHERN STATES OF NIGERIA <i>Kashina B. D. and Chindo A. C.</i>	1
2	YIELD AND PROFITABILITY OF SWEET SORGHUM (<i>Sorghum bicolor</i> (L) Moench cv. <i>saccharatum</i>) VARIETIES AS INFLUENCED BY VARYING NPK RATES IN NORTHERN GUINEA AGROECOLOGICAL ZONE OF NIGERIA <i>Muhammad¹ A.N¹, Lawal A. B². and Adediran O. A³</i>	9
3	PATHOGENICITY OF ROOT-KNOT NEMATODE IN CUCUMBER AND <i>IN VITRO</i> TEST OF POULTRY MANURE AND BOTANICAL EXTRACTS AS BIONEMATICIDE <i>Baba H. S. and Izuogu, N. B.</i>	18
4	EFFECT OF WATER QUALITY PROPERTIES ON INFESTATION OF <i>Nymphae lotus</i> IN SELECTED WATERBODIES AT MAKURDI <i>Jimin A. A. ¹*, Ibrahim A. J. ² and Ahom R. I. ¹</i>	27
5	COMPARATIVE ANALYSIS OF THE EFFICACY OF CRACK-OPEN AND CANDLING FERTILITY TEST OF JAPANESE QUAIL (<i>Coturnix japonica</i>) EGGS <i>Chibuogwu I. C¹*, Adediran M. A.², Maduekwe I. M.³</i>	41.
6	ASSESSING THE POTABILITY OF WATER FROM DIFFERENT SOURCES USING WATER QUALITY INDEX METHOD IN SLUM AREAS OF THE ABUJA MUNICIPAL AREA COUNCIL, ABUJA, NIGERIA <i>Ishaya S¹ and Oloyede I.²</i>	52
7	INFLUENCE OF TREATED WASTEWATER ON THE PHYSICAL AND CHEMICAL PROPERTIES OF SOILS OF WUPA ABUJA, NIGERIA <i>¹Abba, A. Simon, ¹Ogwueleka, T.C. and ²Barnabas I. M.</i>	62
8	ASSESSMENT OF WOMEN INVOLVEMENT IN CASSAVA BASED AGRICULTURAL TRANSFORMATION AND EMERGING ISSUES FOR GENDER GENERATION STUDIES IN IMO STATE, NIGERIA <i>Eze S.O.¹, Ebe F. E² and Ibeawuchi B.O.¹</i>	71
9	ANTI-FUNGAL ACTIVITY OF <i>Artemisia annua</i> L. EXTRACTS AGAINST FUNGI ASSOCIATED WITH POST-HARVEST ROTTEN TOMATOES IN LAFIA MARKETS NASARAWA STATE NIGERIA <i>Kayode, E. A.¹*, Okunade, O.A.², Stephanie, M.E.², Ogbuagu, K.P.², Yusuf A.T² Atteh, A, P.², David, Z.O.³, Chris, G. O.³ and Ibrahim S. O.⁴</i>	85
10	EFFECT OF BANDITS' ATTACKS ON FOOD SECURITY IN NIGERIA: A REVIEW <i>Ameh, E. U.</i>	95

TABLE OF CONTENTS

11	IMPACT OF TOPOSEQUENCE ON MICRONUTRIENTS IN FLOOD PLAIN IRRIGATED SOILS OF GADABIYU OF KWALI AREA COUNCIL, ABUJA FEDERAL CAPITAL TERRITORY, NIGERIA <i>Ahmad H. A.</i>	106
12	MYCOBIOTA OF COCOA (<i>Theobroma cacao</i>) BEANS FROM DRYING SITES IN THE SOUTH-WEST OF NIGERIA ¹ *Jeff-Agboola Y.A., ² Jeff-Agboola E.O., ³ Oyedokun J., ⁴ Plötz M., ⁵ Okunlola O.A. and ⁶ Elekofehinti O.O.	122
13	EFFECT OF NPK FERTILIZER ON GROWTH AND GRAIN YIELD OF SWEET SORGHUM (<i>Sorghum bicolor</i> (L) Moench cv. <i>saccharatum</i>) VARIETIES IN NORTHERN GUINEA SAVANNA OF NIGERIA Muhammad A.N ¹ , Lawal A. B. ² , Ishaya D. B ³	142
14	PLANT PARASITIC NEMATODES OF PHYTOSANITARY IMPORTANCE IN NIGERIA [*] Ubazi, C. C. ¹ , Asala, W. S. ¹ , Okafor, O. E. ² , Abdulkarim, B. M. ³ and Aliyu, R. H. ³	153
15	ASSESSMENT OF FISH FARMERS' ACCESSIBILITY TO EXTENSION SERVICES IN BORGU LOCAL GOVERNMENT AREA OF NIGER STATE, NIGERIA <i>Uyamas, I.M.¹, Jubril, A.E.¹ and Ajiboye, O.O.²</i>	164
16	ASSESSMENT OF FUNGI AND AFLATOXIN PROFILE IN AFRICAN WALNUT (<i>Tetracarpidium Conophorum</i> MULL. [ARG]) FRUIT SNACKS SOLD IN ABUJA, NIGERIA <i>Edeh, J. A.¹, Anjorin, T. S. ¹, Asala, S. W., Abdurazaq O. A. ² Ekwere, U. A. ³</i>	177
17	FACTORS INFLUENCING THE CONTRIBUTION OF ICTS TO YOUNG FARMERS' INVOLVEMENT IN AGRICULTURE IN KOGI STATE, NIGERIA <i>Nwele I. P. , Ajah J. and Idu E. E.</i>	184
18	GENDER PERCEPTION AND ADAPTATION PRACTICES OF SMALL HOLDER CASHEW FARMERS TO CLIMATE VARIABILITY IN ENUGU STATE, NIGERIA <i>Ebe, F. E.¹, Eze, S. O.² and Onyebinama C. I.¹</i>	197
19	USING DEEP LEARNING FOR IMAGE-BASED CROP DISEASE DETECTION IN ABUJA, NIGERIA <i>Anjorin, Toba Samuel ^{1*}, Ogbonna, Onyedikachi Benjamin ², Apeh, Ayo Igoche.....</i>	208
20	FIELD EVALUATION OF BIO-EFFICACY OF NEEM EXTRACTS AGAINST <i>Hymenia recurvalis</i> F. (LEPIDOPTERA: NYMPHALIDAE) ON <i>AMARANTHUS</i> IN IBADAN, NIGERIA <i>Aderolu I. A.¹ and Omoloye A. A. ²</i>	215

EDITORIAL BOARD OF AFRICAN JOURNAL OF AGRICULTURE AND ALLIED SCIENCES (AJAAS)

Editor-In-Chief	Prof. P. O. Idisi Department of Agricultural Economics University of Abuja, PMB 117, Abuja park.idisi@uniabuja.edu.ng
Managing Editor	Prof. T. S. Anjorin Department of Crop Protection University of Abuja toba.anjorin@uniabuja.edu.ng
Deputy Managing Editor	Dr. I. M. Maduekwe Department of Agric. Economics University of Abuja innocent.maduekwe@uniabuja.edu.ng
Business Manager	Dr. O. S. Sennuga Department of Agric. Extension & Rural Sociology University of Abuja dr.yemisennuga@yahoo.co.uk
Associate Editors	Dr. A. A. Oyerinde Department of Crop Protection University of Abuja Prof. R. W. Ndana Department of Biology University of Abuja Dr. Sunday Ishaya Department of Geography University of Abuja Dr. R. A. Oluwafemi Department of Animal Science University of Abuja Dr. I. N. Abdullahi Department of Crop Science University of Abuja Dr. I. Mohammed Department of Soil Science University of Abuja Dr. T. O. Fadiji Department of Agric Extension & Rural Sociology University of Abuja Dr. M. T. Liadi Department of Crop Protection University of Abuja
National Advisory Board	Prof. O. S. Balogun University of Ilorin Prof. O. P. Ajagbonna University of Abuja Prof. B. Kashina Ahmadu Bello University, Zaria Dr. C. Adetunji Edo State University, Iyamho
Editorial Office Address	C/o Prof. T. S. Anjorin Faculty of Agriculture University of Abuja Main Campus, P.M.B 117, Abuja FCT +234 (0)806 224 2866

Instructions To Authors

GENERAL INFORMATION: *African Journal of Agriculture and Allied Sciences* is a scientific and periodic Journal that covers the broad fields of Agriculture; Agronomy, Crop Science, Crop Protection, Entomology, Horticulture, Animal Science, Plant Breeding/Bio-technology, Soil Science, Fisheries, Forestry, Agro-forestry, Agricultural Economics, Agricultural Extension and Rural Sociology, Food Science & Technology, Biosafety and Agricultural Education. The Environmental Science disciplines are Agro meteorology, Agricultural Engineering, Environmental Impact Assessment, Botany, Zoology, Microbiology Environmental Biology, Environmental Education, Applications of Remote Sensing, Geographic Information System (GIS), Crop Modeling in Agriculture and Climate Change. Review articles, original research reports and short communication are welcome from authors for publication in the Journal.

PREPARATION OF MANUSCRIPTS: Manuscripts should be prepared in standard English Language and typed in double space one side A4 size paper leaving 0.5 cm margins on all sides of the paper. The manuscripts should not be more than 15 pages, tables, figures and plates inclusive. However, more pages attract additional charges. **Coloured prints at Author's request** will attract additional charges as decided by the Editor-in-Chief.

TITLE: The title should be concise and typed in bold capital letters. Scientific names should be used as appropriate and should be italicized. The title should generally reflect the content of the article.

AUTHOR(S) NAMES: The name(s) of the author(s) should be indicated below the title of the article in full surname(s) and initials, followed by their full addresses. The chief or the corresponding author should be so indicated. The phone number(s) and e-mail address(es) should be written after the postal address.

ABSTRACT: The abstract should be written in concise form without losing the focus and clarity of the study. The summary should be able to answer the question on the objectives of the study, how it was carried out, the results obtained, the inference drawn from the results and the conclusion. The summary should not exceed 250 words.

KEYWORDS: Key words of not more than seven that conform with the content of the article should be provided as footnote of the abstract for indexing and other purposes.

MATERIALS AND METHODS: These aspects should contain detailed information of the methodology utilized in the study. It should contain repeatable methods which will remove any doubt in the confidence in the work of the author. In case of universal methodology, proper reporting and citations of relevant literature should be put in place for further referencing, and any deviation should be indicated with proper justification. Also, appropriate experimental design, mode of data collection and statistical analyses should be clearly indicated.

Instructions To Authors

RESULTS: The results should be concise and clear with relevant supporting data, transformation/aids such as, tables, graphs and pictures (plates). Appropriate numbering of the data transformation (tables, graphs and plates) in the relevant sections of the text where the supporting aids belong should be put in place. The results should only be reported in the section without discussing them. Duplication between this section and the discussion must be avoided. The results section should preferably be separated from the discussion.

DISCUSSION: The discussion should be the inference drawn from the results as indicated in the previous section. Furthermore, implications and consequences of the results reported here should be backed up with previous relevant and recent literature from past workers on the subject matter. Comparative analyses should be drawn from the inference in relation to previous works.

CONCLUSION: The contribution to scientific knowledge and suggestions for further research in line with the study should be indicated here.

REFERENCES: In the reference list, name and initials of all the authors must be given with the year of publication (in parenthesis), article title, journal title in full, volume, number, first and last page numbers. If there are three or more authors, the first author's name should be followed by *et al.*, ensuring the different references with the same name and date are differentiated by a, b, etc. For references to books (if different from authors of chapters), volume number, edition, page numbers of the chapter, publishers and town of publication should be indicated. Ensure that all references cited in the text are listed in the reference list and *vice versa*, and be consistent in the spelling of authors' names, date, etc. Note that the manuscript may be rejected, or publication delayed if it departs in any way from the required style.

SUBMISSION OF MANUSCRIPTS AND CORRESPONDENCE

Manuscripts should be sent via e-mail (as an attachment in Microsoft Word) to the Managing Editor (ajaas.foa@uniabuja.edu.ng). Submission of manuscript will be held to imply that it reports original unpublished research not under consideration for publication elsewhere and that if accepted, it will not be published again in any form either in English or in any other language without the Editor's prior consent. **A scanned copy of evidence of payment of the handling charge of five thousand naira (N5,000.00) should be sent along with the manuscript.** Upon acceptance, a publication fee of twenty thousand naira (N20,000.00) or Fifty Dollars (\$50.00) only will be charged per manuscript. All payments are to be made into the AJAAS account - Zenith Bank (Acc. No: 1007468158, Act. Name: *Anjorin Toba Sam*). Advertisement rates can be obtained from the Editor-in-Chief.

Signed: **Prof. P. O. Idisi**
 Editor-In-Chief

Prof. T. S. Anjorin
Managing Editor

ASSESSMENT OF FUNGI AND AFLATOXIN PROFILE IN AFRICAN WALNUT (*Tetracarpidium conophorum* MULL. [ARG]) FRUIT SNACKS SOLD IN ABUJA, NIGERIA

Edeh, Joy Anwuri¹, Anjorin, Toba Samuel¹, Asala Shatu Wudiri, Abdurazaq Olusegun Abdulkadir² Ekwere, Uwem Akpan³

¹Department of Crop Protection, Faculty of Agriculture, University of Abuja

²Kogi State Polytechnic, School of Agricultural Technology, Lokoja, Kogi State

³National Biotechnology Development Agency, Lugbe Abuja

[Corresponding author: oyindamola35@gmail.com](mailto:oyindamola35@gmail.com)

ABSTRACT

The study was carried out to determine the fungal and aflatoxin load of African walnut (*Tetracarpidium conophorum* (Mull, [Hutch and Dalziel]) fruits marketed in the Federal Capital Territory (FCT) Abuja, Nigeria. The fungal load assessment was carried out using standard mycological methods (Mirabile *et al.*, 2021) while the aflatoxin load was determined with High Performance Liquid Chromatography (HPLC). A total of 144 walnuts (72 raw and 72 cooked) were collected in the FCT, Abuja for the study. Fungi identification was done based on colony appearance and microscopic and biochemical evaluation using selective and differential agar. Five fungal species from 3 genera were isolated with *Aspergillus flavus* and *Aspergillus niger* having the incidence of 27% and 25% respectively. The highest AFB₁ concentration level in the walnut fruits sold in the FCT was found in the raw samples from Gwagwalada (7.0 µg/kg) which was above the maximum level permissible by EU (4.0 µg/kg) for the raw nuts. Cooked samples from the same Gwagwalada have the highest concentration of 3.2 µg/kg which was also above the permissible safe level of the EU (2.0 µg/kg). Though all the walnut snacks vendored in other markets in the FCT, Abuja are found to be safe in terms of mycotoxin load, walnuts especially the vendored cooked ones should always be checked and confirmed for safety before allowed to be sold or consumed.

INTRODUCTION

African walnut (*Tetracarpidium conophorum*), also referred to as black walnut is a climbing shrub, 3-6m long belonging to the family Euphorbiaceae. Walnuts are majorly cultivated in West Africa, particularly in the Southeastern and Southwestern parts of Nigeria (Akin-Osanaiye and Ahmad, 2018). Their seeds are delicacies which are cooked and consumed as snacks. The shells are either black or dark brown and the nuts are whitish when cracked and there is usually a thin layer seen when it is divided into two equal parts (Oni *et al.*, 2020).

African walnuts are rich in protein, carbohydrates and fat but low in fibre and ash contents. Studies have also proved them to be very good sources of vitamins A, B₁, B₂, B₆, E, and also mineral elements

such as copper, manganese, sodium, potassium, chloride, iron and the immune booster ascorbic acid. The green hulls which are immature fruits are an excellent source of vitamin C. The nut is a good source of energy as it has about 16.9% carbohydrate and calories of about 600J (Zhang, 2019). It is also an excellent source of polyunsaturated fatty acids such as alpha-linolenic acid (Kanu *et al.*, 2015; Oladiji *et al.*, 2007). Scientific studies show that habitual nut intake is associated with numerous health benefits such as dietary intervention for cardiovascular health (Ikpeme *et al.*, 2014; Neale *et al.*, 2017). The nuts are also beneficial as it is said to increase the prevention of diabetes associated with renal damage (Balogun *et al.*, 2021).

Aflatoxins, which are secondary metabolites produced by some fungi such as *Aspergillus* species, often grow on crop produce including nuts during storage under favorable conditions of temperature and humidity. Nuts and dried fruits such as walnuts, dates and groundnut are consumed as snacks as well as part of the ingredients of certain dishes in our daily diet, are prone to mould and aflatoxin contamination (Oranusi and Braide, 2012). Consumption of commodities contaminated with aflatoxins could lead to chronic aflatoxicosis causing acute poisoning resulting in death (Omotayo *et al.*, 2019). Despite the number of studies that have been carried out on the nutritional value of walnut, not many studies have been done to determine the mycobiota load and aflatoxin profile of walnut seeds marketed in the Federal Capital Territory, Abuja. Thus the objectives of this study were to assess the fungi load and aflatoxin levels in raw and cooked walnut fruit sold in Abuja, Nigeria.

MATERIAL AND METHODS

Sample collection

Seventy two each of raw and cooked African walnut seeds (Plate 1) were obtained from retailers in the Federal Capital Territory, Abuja. Twelve raw and twelve cooked walnut each were collected from each of the markets in the Area Councils (AC) namely Bwari AC - Dutse and Kubwa markets; Gwagwalada AC - Zuba and Gwagwalada markets and Abuja Municipal AC Garki and Wuse markets. A total of 144 walnuts were collected for the study. Six raw and cooked nuts from the three locations in each markets were randomly picked, cracked and crushed using a pre-sterilized mortar and pestle, then producing a total of 12 bulked samples prepared for analysis. The samples were collected in properly labelled study bags to minimize further moulding and toxigenic fungal contamination. Half of each of the samples were used for analysis of fungi contamination determination at the Crop Protection Laboratory of the University of Abuja. The other half from each sample were rapidly transported under complete aseptic conditions to Central Research and Diagnostic Laboratory, Ilorin Kwara State Nigeria for the aflatoxin analysis and determination.



**Plate 1: African black walnut seeds
Enumeration and identification of fungal isolates**

The Petri dishes, conical flasks and universal bottles used were first washed accordingly, dried and properly sterilized in an autoclave at 121°C for 15 min. Samples (10 g) were added to 90 ml of 0.1% peptone water (CM0009, Oxoid LTD, Basingstoke, UK) and homogenized for 2 mins in a blender (Waring Products, Torrington, USA). Three-stage 1:10 serial dilution of each sample was carried out using 0.1% sterile peptone water as the diluent. An aliquot (0.1 ml) from the third dilution (10^{-3}) of each sample was plated on Potato Dextrose Agar (PDA) culture media containing 133 mg chloramphenicol (antibiotic for 1 litre of media) to prevent the growth of bacteria. The sterile glass spreader was used to collect 0.1 ml of the diluted walnut suspension which was even. The plates were incubated at 25 °C and monitored daily for fungal growth for 7 days. Single spore cultures of the moulds were prepared on Potato Dextrose Agar (PDA) media.

The distinct colonies were isolated and sub-cultured to obtain pure cultures which were examined under the microscope after staining with lactophenol cotton blue. Fungal species identification were based on cultural and morphological characteristics using taxonomic keys (Klich, 2002; Nyongesa *et al.*, 2015). After incubation, the fungal colonies were counted

using a colony counter and the number of colonies per gram of sample was calculated and expressed in colony-forming units per gram (CFU/g) as

$$\text{Cfu/g} = \frac{\text{Number of colonies} \times \text{reciprocal of the dilution factor}}{\text{Plating volume (1 ml)}}$$

Determination of aflatoxin level in raw and cooked walnut seeds

The samples were carried to the laboratory in zip lock bags in a cool box and ground using laboratory mill to a particle size less than 500 µm thereafter stored at -20 °C to prevent further accumulation of moulds until analyses.

Sample extraction and extract dilution

Twenty-five grams of the walnut sample was weighed and mixed with 5g salt (NaCl) and placed in a blender jar, 125 ml methanol: water (60:40) was added into the jar, and then the mixture was blended at high speed for 1 minute. The extract was filtered using a fluted filter paper. The filtrate was collected in a clean container, 20ml of the filtered extract was pipette in a clean vessel and diluted with 20ml of distilled water and filtered through a glass microfiber filter into a clean vessel.

High Performance Liquid Chromatography Techniques

The quantitative detection of the AFs, OTAs and FUMs was performed by the HPLC system (Thermo Fisher Scientific, Waltham, MA 02451, USA) using 100 microlitres of the extract as before stated by Herzallah (29). Each of the mycotoxins quantities of standards and from samples was determined using HPLC with fluorescent detection. The HPLC system consisted of a pump (Knauer, Germany) and a fluorescence detector (Knauer, Germany). The prepared sample was injected automatically using an injection volume of 20 µl. Aflatoxins were separated in HPLC column with a mobile phase of water:methanol:acetonitrile

(60:30:15, v/v/v).

The fluorescence sensor was set at an excitation wavelength of 365nm and emission wavelength of 435 nm to determine AF. Aflatoxin retention times with a 1.2 ml/min flow rate were 8-9 min for AFG₂, 10.5–11.5 min for AFG₁, 13-14 min for AFB₂ and 16-17 min for AFB₁. The total run time in the HPLC was 33 min. To confirm and ensure the truthfulness of the test, approximately 25 g of aflatoxins-free sample (for each sample type) was spiked (enriched) with aflatoxin B₁ at levels of 3, 5, and 10 µg/ kg. The protocol was performed in three replicates. The spiked specimens were assessed employing the HPLC, followed by the estimation of both the recovery and standard deviation (Herzallah, 2008). The % recovery is the level of analyte found divided by the level of standard analyte added to the sample.

2.4 Statistical Data Analysis

Incidence of fungal and bacterial colonies was expressed in percentages and aflatoxin's concentrations were analyzed in triplicates from each location and recorded as means ± standard errors (SE).

RESULTS

Five different fungi species were isolated from the various cooked samples as shown in Table 1 of which *A.flavus* has the highest fungi percentage (27%) while *A. fumigatus* and *A. alternaria* both have the lowest fungi percentage (13%) as shown in Table 2.

Table 1: Suspected Fungi spp in walnut seeds sold in the FCT, Nigeria

Area Council	Location	Suspected fungi spp in raw walnut	Suspected fungi spp in cooked walnut
Bwari	Dutse	<i>A. flavus</i> , <i>Penicillium</i> spp, <i>F.solani</i>	<i>A.niger</i> , <i>A.flavus</i>
Bwari	Kubwa	<i>Penicillium</i> spp <i>Aspergillus niger</i> <i>A.flavus</i>	<i>A.flavus</i> , <i>A.fumigatus</i> <i>F.solani</i>
Gwagwalada	Zuba	<i>A. niger</i> <i>A.flavus</i> <i>A.fumigatus</i> <i>F.solani</i>	<i>A.niger</i> , <i>F.solani</i> <i>A.flavus</i> <i>A.fumigatus</i>
Gwagwalada	Giri	<i>A. niger</i> , <i>A. flavus</i> , <i>F.solani</i>	<i>A.flavus</i> <i>A.niger</i> , <i>A.fumigatus</i>
AMAC	Wuse	<i>A. niger</i> <i>Penicillium</i> spp, <i>F.solani</i>	<i>F.solani</i> , <i>Penicillium</i> spp, <i>A.niger</i> <i>A. flavus</i> .
AMAC	Garki	<i>A.niger</i> , <i>A.flavus</i> <i>A.fumigatus</i> , <i>F.solani</i>	<i>Penicillium</i> spp, <i>F.solani</i> <i>A.flavus</i> <i>A.niger</i>

Table 2: Incidence of fungi in cooked walnut samples in the FCT, Abuja

Fungi species	No of colony	Percentage
<i>Aspergillus flavus</i>	11	27
<i>Aspergillus niger</i>	10	25
<i>Aspergillus fumigatus</i>	5	13
<i>Alternaria alternaria</i>	5	13
<i>Fusarium solani</i>	9	22
<i>Penicillium</i> spp		
Total	40	100

Assessment of Aflatoxin in walnut sold in the FCT, Abuja

Results on the aflatoxin concentration of walnut are as shown in Table 3. AFB₁ was detected in samples from six locations with varying concentrations ranging from the lowest of 1.6 µg/kg in the cooked samples from Wuse, AMAC and the highest concentration of 7.0 µg/kg in raw samples from Gwagwalada. The AFB₁ samples from Gwagwalada and Garki were higher than the permissible range of 2 µg/kg for ready-to-eat seeds or nuts by EU standard (EU, 2006). It was further indicated that AFB₂ was detected in the samples from all six locations. The concentration levels in the samples in three of the locations - AMAC, Bwari and Gwagwalada exceeded the permissible level of 4.0 µg/kg for ready-to-eat seeds by the EU. The highest

concentration (8.8 µg/kg) was found in a raw sample from Garki, AMAC while the lowest concentration was found in cooked samples from Zuba, Gwagwalada.

The study further revealed that AFG₁ was below detectable levels in the samples from five locations. This aflatoxin was however detected in samples in four locations i.e three in Gwagwalada and one in AMAC but the concentration level in the samples from only one out of the four locations that was above the permissible level by EU standard. AFG₂ was present in samples from only one-third of the locations i.e the raw and cooked samples from Gwagwalada and cooked samples from Zuba, and they all fall below the permissible level by EU standard.

Table 3: Aflatoxin concentrations (µg/kg) in walnut samples sold in the FCT, Abuja

Area Council	Location	Sample status	AFG ₁	AFG ₂	AFB ₁	AFB ₂
Bwari	Kubwa	Raw	-	-	-	2.0±0.3
Gwagwalada	Gwagwalada	Raw	5.1±0.4	0.1±0.1	7.0±1.0	9.4±0.3
AMAC	Garki	Raw	-	-	4.8±0.9	8.8±1.8
Gwagwalada	Zuba	Cooked	4.1±0.5	1.0±0.2	3.2±1.1	0.1±0.1
Gwagwalada	Gwagwalada	Cooked	0.3±0.1	0.4±0.3	2.0±0.7	2.0±0.4
Bwari	Dutse,	Cooked	-	-	-	2.3±0.6
Bwari	Kubwa	Cooked	-	-	1.9±0.5	7.4±1.1
AMAC	Wuse	Cooked	2.4±0.2	-	1.6±0.6	4.0±0.8
AMAC	Garki	Cooked	-	-	-	3.9±0.9

Note that the maximum permissible levels of AFG₁, AFG₂ and AFB₂ by EU in fruit ready-to-eat is 4 µg/kg while that of AFB₁ is 4 µg/kg

DISCUSSION

The walnut market is faced with many constraints amongst which are product seasonality, spoilage during storage and the use of poor marketing skills as well as inadequate storage facilities. Due to the unique removal of the fleshy husks of walnut after harvest, the surface is unavoidably infected by several microorganisms in the environment (Martinovic *et al.*, 2016; Zhang and Wang, 2017). Cooked walnuts stored for several days are considered unsafe for consumption thus are sold within 2-3 days as they begin showing signs of spoilage such as foul-smell, unpleasant taste, discoloration and slimy nature (Kanu *et al.*, 2015). Walnuts requires proper storage as improper

storage makes walnuts susceptible to insect, bacteria, and mould infestations; the latter produces [aflatoxin](#) – a potent carcinogen (Zhang and Wang, 2017). The ideal temperature for the extended storage of walnuts is - 3 to 0 °C with low humidity for industrial and home storage (NUTTECH, 2022). However, such refrigeration technologies are unavailable in developing countries where walnuts are produced in large quantities. In developing countries storage is done under high temperatures and low humidity leading to rapid and high spoilage losses attributed to fungal molds that release dangerous aflatoxin (Adejumo and Adejoro, 2014).

Some fungi contaminants were detected in the raw

and cooked walnut being sold in Abuja, Nigeria. The identified fungi associated with the walnut included *Aspergillus flavus*, *Aspergillus niger* and *Fusarium oxysporum* and *Penicillium* spp. *Aspergillus fumigatus* were for the first time reported in walnut. This finding is not at par with that of Oni *et al.* (2020) as *Aspergillus fumigatus* was not identified in the walnut studied.

Crop produce especially fruits are often contaminated due to poor post-harvest handling or from the vendors to the consumers (Michael *et al.*, 2022). The activities of certain toxigenic fungi have been known to lead to the production of aflatoxins in nuts and crop seeds during storage under favorable environmental conditions (Andleeb *et al.*, 2015; Kumar *et al.*, 2017)

CONCLUSION

Results from this study reveal that spoiled walnuts are a reservoir of various kinds of fungi and

bacteria which are known to cause food spoilage. Although the fungal contamination and aflatoxin levels in the samples analyzed were within the acceptable range as stated by regulatory bodies like European Commission and ICSMF, the presence of these human disease-causing organisms such as *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus fumigatus*, *Penicillium*, *Fusarium solani* is a red flag to consumers health and safety.

Microbial contamination can be greatly reduced by sensitization and regulation of fruit snack sellers by appropriate government agencies on personal hygiene, better storage techniques as well as careful post-processing handling. More so, walnut marketers are to be encouraged to subject the nuts to proper sorting and periodical analysis to certify the quality and safety status before being sold or consumed. The toxigenicity of the *A. flavus* associated with walnut in the FCT Abuja and beyond should be investigated.

REFERENCES

- Adejumo, T.O. and Adejoro, D.O., (2014). Incidence of aflatoxin, fumonisins, trichothecenes and ochratoxins in Nigerian foods and possible intervention strategies. *Food Science and Quality Management*; Makun, H., Ed, pp.123-136.
- Akin-Osanaiye, B. C., and Ahmad, A. A. (2018). Nutrient Composition Analysis of African Walnut (*Tetracarpidium conophorum*) and Isolation of Microorganisms Responsible for its Spoilage. *Direct Research Journal of Agriculture and Food Science*, 6 (7): 173-181.
- Andleeb S, Ashraf M, Hafeez-ur-Rehman., Jabbar, M.A., Abbas, F. and Younus, M. (2015). Effect of aflatoxin B1-contaminated feed on growth and vital organs of advanced fry of *Catla catla*. *Journal of animal and plant science*; 25(3) 1018-7081.
- Balogun, P. O., Coker, F. C., Amolegbe, O. A. and Balogun, O. B. (2021). Microbiological quality assessment of African walnut (*Tetracarpidium conophorum*) obtained from selected areas of Yaba metropolis, Lagos nigeria. *International, Journal of Science & Society*; 7(1): ISSN: 2276-7924.
- EU2006, "Setting maximum levels for certain contaminants in foodstuffs," "Official Journal of the European Union, p.364, 2006.
- "Food, Nutrition & Agriculture Prevention of aflatoxin". *FAO, United Nations*. 1998. [Archived from the original on 2011-03-07](#).
- Herzallah S.M. (2009). Determination of aflatoxins in eggs, milk, meat, and meat products using HPLC fluorescent and UV detectors. *Food Chemistry*. 114(3):1141 Available from DOI : [org/10.1016/j.foodchem.2008.10.077](https://doi.org/10.1016/j.foodchem.2008.10.077).
- Ikpeme, E. V. Ekaluo, U. B. Udensi, O. Ekerette, E. E. , Ekpo, P. B. and Asuquo, B. O. (2014).

- “Sperm quality and hormone profile of male albino rats FED with seeds of African Walnut (*Tetracarpidium conophorum*, Mull),” *Annual Research and Review in Biology*, vol. 4(9): pp. 1379–1386,
- Kanu, A.M., Kalu, J.E., and Okorie, A.C. (2015). Nutritional And Health Values Of African Walnut (*Tetracarpidium conophorum*). *International Journal of Scientific & Technology Research*, 4, 215-220.
- Klich, M.A. (2002) Biogeography of *Aspergillus* Species in Soil and Litter. *Mycologia*, 94, 21-27. <http://dx.doi.org/10.2307/3761842>
- Kumar P, Mahato D.P, Kamle M, Mohanta T.K and Kang S.G. (2017). [Aflatoxins: a global concern for food safety, human health and their management](#). *Frontier Microbiology* 2017; 7: 2170. Available from DOI: 10.3389/fmicb.2016.02170.
- Martinovic, T., Andjelkovic, U., Gajdosik, M. S., Resetar, D. and Josic, D. (2016). Foodborne pathogens and their toxins. *Journal of Proteomics*. 147: 226–235.
- Micheal A.O., Adenike A.K., Oluwaseun A.B., Ademola A.D., Olutope O.S., Joy O.O, Olajumoke A.E., (2022). Microbial contamination of some ready-to-eat vended fruits in Sango open-market, Saki, Oyo State, Nigeria. *Microbes and Infectious Diseases*; 3(1): 160
- Mirabile, G. Bella, P. Vella, A. Ferrantelli V. and Torta, L. (2021). Fungal Contaminants and Mycotoxins in Nuts. *Nuts and nuts products in Human Health and Nutrition* DOI:10.5772/intechopen.100035
- Neale, E.P.; Tapsell, L.C.; Guan, V., Batterham, M.J. (2017). The effect of nut consumption on markers of inflammation and endothelial function: *A systematic review and meta-analysis of randomized controlled trials*. *BMJ Open*, 7, e016863.
- NUTTECH, 2022. NUT Technology (2022). Walnut moisture standards. Temperature and storage conditions on an industrial scale. <https://nuttechnology.com>
- Nyongesa, B. , Okoth, S. and Ayugi, V. (2015) Identification Key for *Aspergillus* Species Isolated from Maize and Soil of Nandi County, Kenya. *Advances in Microbiology*, 5, 205-229. doi: [10.4236/aim.2015.54020](https://doi.org/10.4236/aim.2015.54020).
- Oladiji T.P, Musa Yakubu A.T., Abodunrin and (2007). [Some physicochemical characteristics of the oil from *Tetracarpidium conophorum* \(Mull. Arg.\) Hutch.](#) *Journal of Biochemistry and Molecular Biology*. 22(2):93-98
- Omotayo O.P, Omotayo A.O, Mwanza M and Babalola OO. (2019). Prevalence of Mycotoxins and Their Consequences on Human Health. *Toxicology Research.*, 35(1):1-7. DOI:10.5487/TR.2019.35.1.001
- Oni E.O., Aladesida, B A., Obuotor, T.M., Alder, F.O., Badmos, A.O., Adeleye Tolulope Modupeola, Taiwo A.O., and Adeleke A.J., (2020). Mycoflora and aflatoxin levels in walnut samples stored in different packaging materials in ogun state. *Journal of Natural Science, Engineering and Technology*, 19(1&2):186-194.
- Oranusi US and Braide W. (2012). A study of microbial safety of ready-to-eat foods vended on highways: Onitsha-Owerri, south east Nigeria. *International Research Journal of Microbiology (IRJM)*, 1. 3(2) pp. 066-071.
- World Health Organization (WHO) (2008). Foodborne disease Outbreaks, Guidelines for Investigation and Control. World Health Organization; 208. ISBN 978 92 41547222
- Zhang, L., Wang, S. (2017). Bacterial community diversity on in-shell walnut surfaces from six representative provinces in China. *Sci Rep* 7, 10054 (2017). <https://doi.org/10.1038/s41598-017-10138-y>
- Zhang, Y. and Zhang, D.Z. (2019). Relationship between Nut Consumption and Metabolic Syndrome: A Meta-Analysis of Observational Studies. *Journal of American College of Nutrition*, 38: 499– 505.