




Knowledge and Attitude of Consumers about Natural Food Toxins: A Case of Tertiary Students in the Volta Region of Ghana

N.K. Kortei^{1*} , P.Y. Atsugah², E. Letsyo², A. Abaka-Yawson³, A.A. Boakye⁴, C.O. Tettey⁴, E.K. Essuman¹

1. Department of Nutrition and Dietetics, School of Allied Health Sciences, University of Health and Allied Sciences, PMB 31, Ho, Ghana

2. Department of Food Science and Technology, Ho Technical University, P.O. Box HP 217, Ho, Ghana

3. Department of Medical Laboratory Sciences, School of Allied Health Sciences, University of Health and Allied Sciences, PMB 31, Ho, Ghana

4. Department of Biomedical Sciences, School of Basic and Biomedical Sciences, University of Health and Allied Sciences, PMB 31, Ho, Ghana

HIGHLIGHTS

- A majority (90.48%) of students were aware of the Natural Food Toxins (NFTs).
- The male students showed significantly ($p < 0.05$) greater knowledge than the females.
- Totally, 190 (75.40%) respondents had prior-to-the-study knowledge about NFTs.
- Also, 245 (97.22%) respondents desired to learn more about NFTs.

Article type

Original article

Keywords

Knowledge
Attitude
Surveys and Questionnaires
Food
Toxicology
Ghana

Article history

Received: 27 Apr 2021

Revised: 12 Jul 2021

Accepted: 23 Jul 2021

Acronyms and abbreviations

NFT=Natural Food Toxin

ABSTRACT

Background: Natural Food Toxins (NFTs) are poisonous substances produced by the biological processes of living organisms. This study aimed to evaluate the knowledge and attitude of tertiary students of the Volta Region of Ghana about NFTs.

Methods: During March to June 2020, semi-structured questionnaires were used to examine knowledge and attitudes about NFTs among 252 tertiary students from various institutions of the Volta Region of Ghana. Data were statistically analyzed using IBM SPSS Statistics version 20.0.

Results: A majority (90.48%) of students were aware of the NFTs. The male students showed significantly ($p < 0.05$) greater knowledge than the females. Totally, 190 out of 252 (75.40%) respondents had prior-to-the-study knowledge about NFTs. Also, 245 out of 252 (97.22%) respondents desired to learn more about NFTs.

Conclusion: From this study, it was observed that tertiary students from the various institutions in the Volta Region of Ghana had enough knowledge and attitude about NFTs; but there are still slight deficits in the knowledge of students about types of NFTs. Hence, there is a need for more sensitization of the subject among the students and throughout the general public.

© 2021, Shahid Sadoughi University of Medical Sciences. This is an open access article under the Creative Commons Attribution 4.0 International License.

Introduction

Toxins are poisonous substances produced by the biological processes of living organisms. They may occur

naturally in food or be introduced synthetically or due to food mishandling (WHO, 2020). Natural Food Toxins

* Corresponding author (N.K. Kortei)

✉ E-mail: nkkortei@uhas.edu.gh

ORCID ID: <https://orcid.org/0000-0002-8863-4694>

To cite: Kortei N.K., Atsugah P.Y., Letsyo E., Abaka-Yawson A., Boakye A.A., Tettey C.O., Essuman E.K. (2021). Knowledge and attitude of consumers about natural food toxins: a case of tertiary students in the Volta Region of Ghana. *Journal of Food Quality and Hazards Control*. 8: 104-111.

(NFTs) include 8 categories; these are aquatic biotoxins, cyanogenic glycosides, furocoumarins, lectins, mycotoxins, solanines and chaconine, poisonous mushrooms, and pyrrolizidine alkaloids (Bernal-Algaba et al., 2021). Historically, we have been schooled on the potential toxicity of everything; where only the dose divides the toxic from the non-toxic. Water, a universally acclaimed vital substance is toxic if a large quantity (4-5 L) is consumed in a relatively short period (2-3 h) and this often results in hyponatremia and subsequently in cerebral edema, seizures, and finally death as the pathogenesis of intoxication (Dolan et al., 2010).

Food, even though nutritious and inevitable, may on some occasions pose threats to the consumer. Foods may contain both friendly and unfriendly microorganisms; these microorganisms are not harmful to the organisms themselves, but they may be toxic to other creatures, including humans, when consumed. During period of climate stress (drought or extreme humidity), plants and other microorganisms produce some toxins which are used as a natural defense mechanism against predators, insects, or microorganisms (Dolan et al., 2010; WHO, 2018).

The Ghanaian consumer's assert that anything natural can be considered as safe. Brewer and Prestat (2002) found that fear of chemical, novel processing, irradiation, and pesticide residue were prominent amongst consumers in a survey performed in 2001; amongst these were also the belief of absence or freshness of the food to be the primary food safety concern of consumers. The majority of consumers also believe that microbial issues prime in comparison to chemical residues (Maciorowski et al., 1999). Consumers may be unaware of or have low knowledge levels of the toxins that naturally occur in food.

In Ghana, toxins of fungal origin (mushroom toxins and mycotoxins) are another commonly reported causative agent of food poisoning (Apetorgbor et al., 2006; Kortei et al., 2019; Osemwegie et al., 2014) and the rare cases of severe food poisoning can be linked to consumption of other toxins such as phytotoxins and phycotoxins (cyanogenic glycosides which occur in cassava a staple widely consumed in Africa) (Kwaansa-Ansah et al., 2017; Nhassico et al., 2008; Opoku-Nkoom et al., 2013). Furthermore, contamination of aquatic foods (mostly fishes) with methyl mercury has been reported (Gbogbo et al., 2018; Kortei et al., 2020; Oppong et al., 2010). Methyl mercury (methyl derivative) that is formed by bacterial action in an aquatic environment may result in high toxicity (Dolan et al., 2010).

The Ghanaian Food and Drug Authority has enforced labeling as a requirement to provide the consumer with helpful information about content such as fats, carbohydrates, protein, potential allergens, caloric value, etc.;

nonetheless, the Ghanaian Food and Drug Authority does not supply information about toxins that may be intrinsic in the foods or formed during processing. The consumption of small quantities of food toxins is unavoidable due to the inability of food processing methods or cooking methods to completely remove these toxins. In addition, others may be created during these processes (Saalia and Phillips, 2010, 2011). Generally, food consumers who are students do not pay much attention to the safety of the foods they purchase or personally prepare (Abrunhosa et al., 2016; Ashiq, 2015; Milićević et al., 2010). Consumers pay less attention to the risks posed by NFTs and the ways by which they can be controlled.

This study aimed to evaluate the knowledge and attitude of tertiary students of the Volta Region of Ghana about NFTs.

Materials and methods

Ethics approval and informed consent

Ethical clearance and permission were sought from the University of Health and Allied Sciences (UHAS) Ethical Review Committee with Protocol Identification Number: UHAS-REC A.9[46] 20-21. Permission was also sought from the authorities of the various transport unions running the Ho main station and the participants were also made to grant permission through written informed consent.

Study site

The study was performed in Ho, the Volta Regional capital of Ghana. Ho is located at the following coordinates of the Volta Region, 6°36'43N 0°28'13E. The study took place amongst six sampled tertiary institutions in Ho. The individual university's and college's campuses served as the study site.

Study population

A number of 252 respondents (aged 18≤) participated in the study. The sample size was determined using the Raosoft software. The students were from Ho Technical University (HTU), Evangelical Presbyterian University College (EPUC), Ho Nurses Training College (NTC), University of Health and Allied Sciences (UHAS), Ghana Technology University College (GTUC), and Princefield University College. The target population is made up of students with different knowledge backgrounds and the respective programs of the study led to an expectation of different ideas and responses. The gathering of responses from the sample for the study was taken through the convenience sampling technique. Respondents from the sample were provided with online

Google form links through social media, emails, and personally. The link redirected them to the questionnaire when opened.

Data collection and questionnaires

During March to June 2020, semi-structured questionnaires were used to examine knowledge and attitudes about NFTs among 252 tertiary students. Adopting a modified methodology prescribed by Matumba et al. (2016), questionnaires were used as the main research instrument in the data collection. The questionnaire was divided into four sections. The first section (Section I) had a few open-ended questions, while the other sections (Sections II-IV) were made up of closed-ended questions.

The questionnaires were created with the Google forms from which links were derived and distributed across social media networks, emails, and personally to the target population. This was to enable easy flow of questionnaires, prompt and convenient answering from respondents since the target population for the survey was youthful and characterized by the use of technological gadgets and social media. Section I evaluated the demographics and background of the respondent (information on age, sex, educational level). Section II assessed the knowledge levels of students of the respondents and find out the greater number of the group of students who were aware of these NFTs. Section III analyzed the attitudes of the respondents toward the risks posed by NFTs and the control of their presence in our foods and the body. Finally, section IV evaluated some information on toxins that may have been acquired and consumer preference on the best methods awareness of these toxins should be created.

Data analysis

The statistical analysis software (Statistical Package for the Social Sciences) IBM SPSS Statistics version 20.0 was used to analyze the quantitative data generated from the responses.

Results

Sociodemographic characteristics of respondents

The sociodemographic characteristics of 252 study participants are shown in Table 1. For the age range grouping, the majority of the respondents (45.24%) fell within the ranges of 12-25 and 18-20 years old. A majority of the sample (238; 94.44%) were single. Most of the respondents, 116 (46.03%) and 79 (31.35%) were from the University of Health and Allied Sciences (UHAS) and Ho Technical University (HTU), respectively.

Knowledge of participants about NFTs

From 252 respondents, 56.32% of them knew that NFTs are unsafe substances produced by biological agents (Table 2). A greater proportion of the participant (212 out of 252; 84.13%) stated that plants and animals possessed some amount of NFTs. Also, 150 out of 252 (59.52%) respondents agreed that cyanide is poisonous in foods (Table 2).

Attitude of participants about NFTs

The interactive attitudes respondents had concerning some issues surrounding NFTs which have been reported in Table 3. The issue of raw and undercooked foods containing traces of toxins was accepted by a majority of the respondents (93.65%). Likewise, 82.54% of participants agreed that processing of food can eliminate some toxins. In addition, 63.49% of respondents were aware that toxins were lethal to consumers' health upon exposure. A dominant proportion of 164 out of 252 (64.68%) participants also confirmed necessity of discarding moldy and damaged foods.

Mode of knowledge acquisition among participants

Totally, 190 out of 252 (75.40%) respondents had prior-to-the-study knowledge about NFTs. A majority (97.22%) of respondents desired to learn more about NFTs. Also, 166 out of 252 (65.87%) respondents preferred social media to acquire and share the information. Furthermore, 43.25% of respondents majorly attributed the perceived low knowledge on NFTs among students to lack of education while only 2 respondents (0.8%) thought it was due to the low patronage of radio and print media by students of modern times (Table 4).

Relations of knowledge and sociodemographic factors

Table 5 shows the differences in the knowledge of respondents on NFTs as affected by the different sociodemographic factors. Knowledge about NFTs did not show significant ($p>0.05$) relation with age, education stage, and marital status of respondents. However, knowledge of NFTs was significantly ($p<0.05$) related to gender, as males showed a greater knowledge.

Discussion

This survey showed that 90.48% of tertiary students in the Volta Region of Ghana had acceptable knowledge and attitudes about the occurrence of NFTs. The female participants were found to be significantly less knowledgeable than their male counterparts (Table 3). The number of males in the study dominated the females (152 males against 100 females). Akanferi et al. (2014) where

Table 1: Sociodemographic characteristics of tertiary students in the Volta Region of Ghana participated in this study

| Variables | Frequency (%) |
|-----------------------|---------------|
| <i>Age (in years)</i> | |
| 18-20 | 91 (36.11) |
| 21-25 | 114 (45.24) |
| 26-30 | 36 (14.29) |
| >30 | 11 (4.37) |
| <i>Gender</i> | |
| Male | 152 (60.32) |
| Female | 100 (39.68) |
| <i>Education</i> | |
| 1 st Year | 85 (33.73) |
| 2 nd Year | 63 (25.00) |
| 3 rd Year | 69 (27.38) |
| 4 th Year | 35 (13.89) |
| <i>Marital Status</i> | |
| Single | 238 (94.44) |
| Married | 14 (5.56) |
| <i>Institution</i> | |
| EPUC | 18 (7.14) |
| GTUC | 14 (5.56) |
| Ho NTC | 19 (7.54) |
| HTU | 79 (31.35) |
| PUC | 6 (2.38) |
| UHAS | 116 (46.03) |

Table 2: Knowledge of tertiary students in the Volta Region of Ghana about natural food toxins

| Knowledge of natural food toxins | Frequency (%) |
|---|---------------|
| <i>Definition of natural food toxins</i> | |
| Anti-nutrients | 1 (0.40) |
| Metals and external chemicals in food | 40 (15.87) |
| Microorganisms in food | 66 (26.19) |
| The reaction of exposed food | 2 (0.80) |
| Unsafe chemicals in food | 1 (0.40) |
| Unsafe substances produced by biological agents | 142 (56.32) |
| <i>Plants and animals produce natural food toxins</i> | |
| Yes | 212 (84.13) |
| No | 40 (15.87) |
| <i>Immature potatoes, mushrooms, herbs, and sea-foods produce natural food toxins</i> | |
| Yes | 198 (78.57) |
| No | 54 (21.43) |
| <i>Cyanide in food is poisonous</i> | |
| Yes | 150 (59.52) |
| No | 102 (40.48) |
| <i>Disturbance of plants produce toxins</i> | |
| Yes | 145 (57.54) |
| No | 107 (42.46) |

Table 3: Attitude of tertiary students in the Volta Region of Ghana about natural food toxins

| Attitudes | Frequency (%) |
|--|---------------|
| <i>Raw/Undercooked foods contain traces of natural food toxins</i> | |
| Yes | 236 (93.65) |
| No | 16 (6.35) |
| <i>Food Processing eliminates some toxins</i> | |
| Yes | 208 (82.54) |
| No | 44 (17.46) |
| <i>Exposure to foods toxins are dangerous to consumers</i> | |
| Yes | 160 (63.49) |
| No | 92 (36.51) |
| <i>Damaged, discolored, or moldy foods are thrown away</i> | |
| Yes | 163 (64.68) |
| No | 2 (0.79) |
| Sometimes | 87 (34.52) |

Table 4: Mode of Knowledge Acquisition among tertiary students in the Volta Region of Ghana about natural food toxins

| Knowledge Acquisition | Frequency (%) |
|---|---------------|
| <i>Knowledge of natural food toxins before this study</i> | |
| Yes | 190 (75.40) |
| No | 62 (24.60) |
| <i>The desire for periodic information on natural food toxins</i> | |
| Yes | 245 (97.22) |
| No | 7 (2.78) |
| <i>Preferred mode of delivery of natural food toxins information</i> | |
| Social Media | 166 (65.87) |
| Basic Food Safety courses across schools | 46 (18.25) |
| Campus-based radio and television stations | 15 (5.95) |
| Health centers | 14 (5.56) |
| Campus notice boards | 4 (1.59) |
| Emails | 2 (0.80) |
| All of the above | 5 (1.98) |
| <i>Reason for low knowledge on natural food toxins among students</i> | |
| Low patronization of radio and print media | 2 (0.80) |
| The irregular occurrence of catastrophic events linked to food toxins | 33 (13.10) |
| Lack of education | 109 (43.25) |
| Careless attitude | 21 (8.33) |
| The rareness of the subject | 87 (34.52) |

Table 5: Differences in knowledge of students in the Volta Region of Ghana about natural food toxins as affected by sociodemographic factors

| Variables | Total participants | Knowledge of natural food toxins | | p-value* |
|-----------------------|--------------------|----------------------------------|-----------|----------|
| | | Yes | No | |
| <i>Age (in years)</i> | | | | |
| 18-20 | 91 | 85(93.41) | 6(6.59) | 0.144 |
| 21-25 | 114 | 98(85.96) | 16(14.04) | |
| 26-30 | 36 | 34(94.44) | 2(5.56) | |
| >30 | 11 | 11(100.00) | 0(0.00) | |
| <i>Gender</i> | | | | |
| Male | 152 | 132(86.84) | 20(13.16) | 0.015 |
| Female | 100 | 96(96.00) | 4(4.00) | |
| <i>Education</i> | | | | |
| 1 st Year | 85 | 80(94.12) | 5(5.88) | 0.086 |
| 2 nd Year | 63 | 56(88.89) | 7(11.11) | |
| 3 rd Year | 69 | 58(84.06) | 11(15.94) | |
| 4 th Year | 35 | 34(97.14) | 1(2.86) | |
| <i>Marital Status</i> | | | | |
| Single | 238 | 215(90.34) | 23(9.66) | 0.755 |
| Married | 14 | 13(92.86) | 1(7.14) | |

* p-value less than 0.05 considered as statistically significant.

the male respondents for a generic study of university students in Ghana had males dominating (493 males against 440 females). It seems that the women play an important role in prevention of food-borne diseases, because they are the first individuals which are responsible for food preparation, cooking, storage, etc. Similarly, Raney et al. (2011) explained that in the African culture, women have a principal role in food production and utilization; however, the relatively lower knowledge among the females could be attributed to the fact that a larger proportion of this group are usually busily indulged with household work, and so they hardly find enough time to receive information from social media.

We found that the level of tertiary education attained had no statistically significant ($p>0.05$) effect on the respondent's knowledge about NFTs. Contrary to our findings, Matumba et al. (2016) reported a significant ($p<0.01$) difference in knowledge on natural toxins among respondents of different education levels in Malawi. This observation is supported to this fact that a large number of people in both developing countries are not aware of the risk associated with contaminated foods (Siegrist and Cvetkovich, 2000).

In a similar study among university students in Saudi Arabia, Sharif and Al-Malki (2010) showed that 74.95% of students had good knowledge on food poisoning. Also,

Haapala and Probart (2004) reported high knowledge of food safety among middle school students in Pennsylvania, (USA). Generally, there is a relationship between education level and knowledge on food-borne diseases (Sudershan et al., 2008).

Results from this study indicated that the age range of 18-25 years old had the most knowledge of NFTs. Generally, tertiary students have some knowledge about food safety because of frequent education. Similarly, Mahami and Odonkor (2012) recommended that food safety intervention and awareness creating programs should be directed towards young people in the age group of less than 35 years old.

Among the respondents, students from University of Health and Allied Sciences (UHAS) were observed to have the best general knowledge of NFTs. Respecting the general knowledge of participants of this study, the analyzed responses indicated that the most participants had a general idea about NFTs. This corroborates the findings of Akabanda et al. (2017) who reported satisfactory knowledge of food safety among food-handlers in Ghana. Recently, Kuo and Weng (2021) have found acceptable food safety knowledge among grade 5 and 6 school children who were taught food safety courses in Taiwan. Likewise, Yusof et al. (2018) reported adequate knowledge but poor attitude and practice of food safety among dietetics students in Malaysia.

According to attitude of most respondents in this study, NFTs are eliminated by some food processing techniques. This assertion may not be entirely true since most mycotoxins are known to be generally thermally stable and are therefore not destroyed during most normal cooking processes (Bationo et al., 2015; Saalia and Phillips, 2011). Nonetheless, some thermal processes cause parent mycotoxins to yield products that are more toxic (Dombrink-Kurtzman et al., 2000; Voss et al., 2001) or to be reversible under simulated gastrointestinal tract conditions, for example the case of aflatoxin and nixtamalization of maize (Méndez-Albores et al., 2004). Likewise, various food processing methods have been reported to have minimal influence on ciguatoxins which are natural toxins in fishes produced by microalgae cells (Abraham et al., 2012). Nonetheless, very few reports exist on the influence of physical processes on the chemical content (cyanide) of food prepared from cassava (Ndam et al., 2019). While it might also be helpful to find ways to convey these concepts, it might be even more important to address the differences in terminology of what constitutes a "chemical" and the non-existent differentiation between "natural" and "synthetic" in science communication efforts. Interestingly, there is no distinction between chemicals of artificial and natural origin; essentially any substance can be harmful as the dose or exposure is the determinant (Dolan et al., 2010).

A larger section of our respondents always discarded deteriorating (moldy, discolored, etc.) and deteriorated foods, while a smaller section discarded these types of foods only on some occasions. Matumba et al. (2016) noted that some members of the general public in Malawi also affirmed to consume mold-colonized foodstuffs such as maize grains and fruits. It is necessary to note that fungal toxin (especially aflatoxins) could exist in deteriorating foods as well as processed foods which may result in safety concerns (Bertero et al., 2018; Kortei et al., 2019; Portell et al., 2020).

Conclusion

From this study, it was observed that tertiary students from the various institutions in the Volta Region of Ghana had enough knowledge and attitude about these natural toxins; but there are still slight deficits in the knowledge of students about types of NFTs. Hence, there is a need for more sensitization of the subject among students and throughout the general public.

Author contributions

P.Y.A. and N.K.K. designed the original study, did the experiments, and wrote the manuscript; A.A-Y., P.Y.A., and E.K.E. were responsible for statistical analysis; N.K.K., E.L., A.A.B., A.A-Y., C.O.T., E.K.E., and P.Y.A. interpret the experiments and revised the manuscript; P.Y.A., N.K.K., and C.O.T. did the sampling. All authors read and approved the final manuscript.

Conflicts of interest

The authors have no conflicts of interest to disclose.

Acknowledgements

We acknowledge and sincerely extend our heartfelt appreciation to all friends and colleagues who helped especially with data collection. A big thank you also goes to the administrations of the various tertiary institutions for giving us access to the students. Last but not least, we are also grateful to the families of the researchers for their support. This study did not receive any specific grant from funding agencies in the public, commercial, or non-for-profit sectors.

References

- Abraham A., Jester E.L.E., Granade H.R., Plakas S.M., Dickey R.W. (2012). Caribbean ciguatoxin profile in raw and cooked fish implicated in ciguatera. *Food Chemistry*. 131: 192-198. [DOI: 10.1016/j.foodchem.2011.08.059]

- Abrunhosa L., Morales H., Soares C., Calado T., Vila-Chã A.S., Pereira M., Venâncio A. (2016). A review of mycotoxins in food and feed products in Portugal and estimation of probable daily intakes. *Critical Reviews in Food Science and Nutrition*. 56: 249-265. [DOI: 10.1080/10408398.2012.720619]
- Akabanda F., Hloritsi E.H., Owusu-Kwarteng J. (2017). Food safety knowledge, attitudes, and practices of institutional food-handlers in Ghana. *BMC Public Health*. 17: 40. [DOI:10.1186/s12889-016-3986-9]
- Akanferi A.A., Aziade L.K., Asampana I. (2014). An empirical study on mobile phone usage among young adults in Ghana: from the viewpoint of university students. *International Journal of Computer Applications*. 98.
- Apetorgbor M.M., Apetorgbor A.K., Obodai M. (2006). Indigenous knowledge and utilization of edible mushrooms in parts of southern Ghana. *Ghana Journal of Forestry*. 19: 20-34. [DOI: 10.4314/gjf.v19i1.36908]
- Ashiq S. (2015). Natural occurrence of mycotoxins in food and feed: Pakistan perspective. *Comprehensive Reviews in Food Science and Food Safety*. 14: 159-175. [DOI:10.1111/1541-4337.12122]
- Batono J.F., Nikiéma P.A., Koudougou K., Ouédraogo M., Bazié S.R., Sanou E., Barro N. (2015). Assessment of aflatoxin B₁ and ochratoxin A levels in sorghum malts and beer in Ouagadougou. *African Journal of Food Science*. 9: 417-420. [DOI: 10.5897/AJFS2015.1306]
- Bernal-Algaba E., Pulgarín-Alfaro M., Fernández-Cruz M.L. (2021). Cytotoxicity of mycotoxins frequently present in aquafeeds to the fish cell line RTGill-W1. *Toxins*. 13: 581. [DOI: 10.3390/toxins13080581]
- Bertero A., Moretti A., Spicer L.J., Caloni F. (2018). *Fusarium* molds and mycotoxins: potential species-specific effects. *Toxins*. 10: 244. [DOI: 10.3390/toxins10060244]
- Brewer M.S., Prestat C.J. (2002). Consumer attitudes toward food safety issues. *Journal of Food Safety*. 22: 67-83. [DOI: 10.1111/j.1745-4565.2002.tb00331.x]
- Dolan L.C., Matulka R.A., Burdock G.A. (2010). Naturally occurring food toxins. *Toxins*. 2: 2289-2332. [DOI: 10.3390/toxins2092289]
- Dombrink-Kurtzman M.A., Dvorak T.J., Barron M.E., Rooney L.W. (2000). Effect of nixtamalization (alkaline cooking) on fumonisin-contaminated corn for production of masa and tortillas. *Journal of Agricultural and Food Chemistry*. 48: 5781-5786. [DOI: 10.1021/jf000529f]
- Gbogbo F., Arthur-Yartel A., Bondzie J.A., Dorleku W.-P., Dadzie S., Kwansa-Bentum B., Ewool J., Billah M.K., Lamptey A.M. (2018). Risk of heavy metal ingestion from the consumption of two commercially valuable species of fish from the fresh and coastal waters of Ghana. *Plos One*. 13: e0194682. [DOI:10.1371/journal.pone.0194682]
- Haapala I., Probart C. (2004). Food safety knowledge, perceptions, and behaviors among middle school students. *Journal of Nutrition Education and Behavior*. 36: 71-76. [DOI: 10.1016/S1499-4046(06)60136-X]
- Kortei N.K., Agyekum A.A., Akuamofo F., Baffour V.K., Alidu H.W. (2019). Risk assessment and exposure to levels of naturally occurring aflatoxins in some packaged cereals and cereal based foods consumed in Accra, Ghana. *Toxicology Reports*. 6: 34-41. [DOI: 10.1016/j.toxrep.2018.11.012]
- Kortei N.K., Heymann M.E., Essuman E.K., Kpodo F.M., Akonor P.T., Lokpo S.Y., Boadi N.O., Ayim-Akonor M., Tettey C. (2020). Health risk assessment and levels of toxic metals in fishes (*Oreochromis niloticus* and *Clarias anguillaris*) from Ankobrah and Pra basins: impact of illegal mining activities on food safety. *Toxicology Reports*. 7: 360-369. [DOI: 10.1016/j.toxrep.2020.02.011]
- Kuo S.-C., Weng Y.-M. (2021). Food safety knowledge, attitude, and practice among elementary schoolchildren in southern Taiwan. *Food Control*. 122: 107818. [DOI: 10.1016/j.foodcont.2020.107818]
- Kwaansa-Ansah E.E., Amenorfe L.P., Armah E.K., Opoku F. (2017). Human health risk assessment of cyanide levels in water and tuber crops from Kenyasi, a mining community in the Brong Ahafo region of Ghana. *International Journal of Food Contamination*. 4: 16. [DOI: 10.1186/s40550-017-0061-y]
- Maciorowski K.G., Ricke S.C., Birkhold S.G. (1999). Consumer poultry meat handling and safety education in three Texas cities. *Poultry Science*. 78: 833-840. [DOI: 10.1093/ps/78.6.833]
- Mahami T., Odonkor S.T. (2012). Food safety risks associated with tertiary students in self-catering hostels in Accra Ghana. *International Journal of Biology, Pharmacy and Allied Sciences*. 1: 537-550.
- Matumba L., Monjerezi M., Kankwamba H., Njoroge S.M.C., Ndiolwe P., Kabuli H., Kambewa D., Njapau H. (2016). Knowledge, attitude, and practices concerning presence of molds in foods among members of the general public in Malawi. *Mycotoxin Research*. 32: 27-36. [DOI: 10.1007/s12550-015-0237-3]
- Méndez-Albores J.A., Villa G.A., Del Rio-García J.C., Martínez E.M. (2004). Aflatoxin-detoxification achieved with Mexican traditional nixtamalization process (MTNP) is reversible. *Journal of the Science of Food and Agriculture*. 84: 1611-1614. [DOI:10.1002/jsfa.1853]
- Miličević D.R., Škrinjar M., Baltić T. (2010). Real and perceived risks for mycotoxin contamination in foods and feeds: challenges for food safety control. *Toxins*. 2: 572-592. [DOI: 10.3390/toxins2040572]
- Ndam Y.N., Mounjouenpou P., Kansci G., Kenfack M.J., Meguia M.P.F., Eyenga N.S.N.N., Akhobakoh M.M., Nyegue A. (2019). Influence of cultivars and processing methods on the cyanide contents of cassava (*Manihot esculenta* Crantz) and its traditional food products. *Scientific African*. 5: e00119. [DOI:10.1016/j.sciaf.2019.e00119]
- Nhassico D., Muquingue H., Cliff J., Cumbana A., Bradbury J.H. (2008). Rising African cassava production, diseases due to high cyanide intake and control measures. *Journal of the Science of Food and Agriculture*. 88: 2043-2049. [DOI: 10.1002/jsfa.3337]
- Opoku-Nkoom W., Asibey-Berko E., Lartey A. (2013). Cyanide contents of leaves of commonly consumed cassava varieties from three geographical regions of Ghana. *Journal of Food Science and Engineering*. 3: 648-656.
- Opong S.O.B., Voegborlo R.B., Agorku S.E., Adimado A.A. (2010). Total mercury in fish, sediments and soil from the river Pra Basin, Southwestern Ghana. *Bulletin of Environmental Contamination and Toxicology*. 85: 324-329. [DOI: 10.1007/s00128-010-0059-0]
- Osemwegie O.O., Okhuoya A.J., Dania A.T. (2014). Ethnomycological conspectus of West African mushrooms: an awareness document. *Advances in Microbiology*. 4: 39-54. [DOI: 10.4236/aim.2014.41008]
- Portell X., Verheecke-Vaessen C., Torrelles-Ràfales R., Medina A., Otten W., Magan N., García-Cela E. (2020). Three-dimensional study of *F. graminearum* colonisation of stored wheat: post-harvest growth patterns, dry matter losses and mycotoxin contamination. *Microorganisms*. 8: 1170. [DOI: 10.3390/microorganisms8081170]
- Raney T., Anriquez G., Croppenstedt A., Gerosa S., Lowder S., Matuscke I., Skoet J., Doss C. (2011). The role of women in agriculture. ESA Working Paper No. 11-02.
- Saalia F.K., Phillips R.D. (2010). Degradation of aflatoxins in aqueous buffer in the presence of nucleophiles. *Food Control*. 21: 1066-1069. [DOI: 10.1016/j.foodcont.2009.12.028]
- Saalia F.K., Phillips R.D. (2011). Degradation of aflatoxins by extrusion cooking: effects on nutritional quality of extrudates. *LWT-Food Science and Technology*. 44: 1496-1501. [DOI: 10.1016/j.lwt.2011.01.021]
- Sharif L., Al-Malki T. (2010). Knowledge, attitude and practice of Taif University students on food poisoning. *Food Control*. 21: 55-60. [DOI:10.1016/j.foodcont.2009.03.015]
- Siegrist M., Cvetkovich G. (2000). Perception of hazards: the role of social trust and knowledge. *Risk Analysis*. 20: 713-720. [DOI: 10.1111/0272-4332.205064]

- Sudershan R.V., Subba Rao G.M., Rao P., Vishnu Vardhana Rao M., Polasa K. (2008). Food safety related perceptions and practices of mothers-a case study in Hyderabad, India. *Food Control*. 19: 506-513. [DOI: 10.1016/j.foodcont.2007.05.017]
- Voss K.A., Poling S.M., Meredith F.I., Bacon C.W., Saunders D.S. (2001). Fate of fumonisins during the production of fried tortilla chips. *Journal of Agricultural and Food Chemistry*. 49: 3120-3126. [DOI: 10.1021/jf001165u]
- World Health Organization (WHO). (2018). Natural toxins in food. URL: <https://www.who.int/news-room/fact-sheets/detail/natural-toxins-in-food>.
- World Health Organization (WHO). (2020). Food safety. URL: <https://www.who.int/news-room/fact-sheets/detail/food-safety>.
- Yusof A.M.M., Rahman N.A.A., Haque M. (2018). Knowledge, attitude, and practice toward food poisoning among food handlers and dietetic students in a public university in Malaysia. *Journal of Pharmacy and Bioallied Sciences*. 10: 232-239. [DOI: 10.4103/JPBS.JPBS_141_18]