JOURNAL OF FOOD QUALITY & HAZARDS CONTROL
SHAHID SADOUGHI UNIVERSITY OF MEDICAL SCIENCES & HEALTH SERVICES

Journal of Food Quality and Hazards Control 8 (2021) 104-111

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

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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.

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

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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.

DOI: 10.18502/jfqhc.8.3.7196 Journal website: http://jfqhc.ssu.ac.ir

(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 (%)
Age (in years)	
18-20	91 (36.11)
21-25	114 (45.24)
26-30	36 (14.29)
>30	11 (4.37)
Gender	
Male	152 (60.32)
Female	100 (39.68)
Education	
1st Year	85 (33.73)
2nd Year	63 (25.00)
3rd Year	69 (27.38)
4th Year	35 (13.89)
Marital Status	
Single	238 (94.44)
Married	14 (5.56)
Institution	
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 (%)
Definition of natural food toxins	
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)
Plants and animals produce natural food toxins	
Yes	212 (84.13)
No	40 (15.87)
Immature potatoes, mushrooms, herbs, and sea-foods produce natural food toxins	
Yes	198 (78.57)
No	54 (21.43)
Cyanide in food is poisonous	
Yes	150 (59.52)
No	102 (40.48)
Disturbance of plants produce toxins	
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 (%)
Raw/Undercooked foods contain traces of natural food toxins	
Yes	236 (93.65)
No	16 (6.35)
Food Processing eliminates some toxins	
Yes	208 (82.54)
No	44 (17.46)
Exposure to foods toxins are dangerous to consumers	
Yes	160 (63.49)
No	92 (36.51)
Damaged, discolored, or moldy foods are thrown away	
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 (%)
Knowledge of natural food toxins before this study	
Yes	190 (75.40)
No	62 (24.60)
The desire for periodic information on natural food toxins	
Yes	245 (97.22)
No	7 (2.78)
Preferred mode of delivery of natural food toxins information	
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)
Reason for low knowledge on natural food toxins among students	
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	
Age (in years)				0.144
18-20	91	85(93.41)	6(6.59)	
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)	
Gender				0.015
Male	152	132(86.84)	20(13.16)	
Female	100	96(96.00)	4(4.00)	
Education				0.086
1st Year	85	80(94.12)	5(5.88)	
2nd Year	63	56(88.89)	7(11.11)	
3rd Year	69	58(84.06)	11(15.94)	
4th Year	35	34(97.14)	1(2.86)	
Marital Status				0.755
Single	238	215(90.34)	23(9.66)	
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 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.

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