A QUESTIONNAIRE-BASED SURVEY ON AWARENESS STATUS ON AFLATOXINS AMONG EMPLOYEES AND STUDENTS AT THE INSTITUTE OF ADULT EDUCATION IN TANZANIA: A DESCRIPTIVE ANALYSIS

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ABSTRACT

The purpose of this study was to assess the level of aflatoxin awareness among employees and students at the Institute of Adult Education (IAE) in Tanzania, as a baseline study for understanding the level of aflatoxin awareness within the Tanzanian population. This study employed a quantitative research approach. The study adopted a descriptive design. Purposive and simple random sampling techniques were used in this study. A total of 68 respondents were included in the study. Before questionnaire administration, it was pre-tested and the internal consistency of components was assessed. A Cronbach's alpha of 0.8142 was obtained indicating acceptable reliability of the questionnaire used in this study. Data collected were analyzed using Statistical Package for Social Science (SPSS) version 20. A threshold of significance was set at $p < 0.05$. Wilcoxon-paired sample test was used to compare respondents' familiarity with the terms mold, fungi, and aflatoxins. Results were presented as descriptive statistics in tables, and graphs to facilitate interpretation. Results from the study indicated that most respondents (82.4% of n=56) had not heard about aflatoxins, suggesting a potential lack of awareness about this topic. There was no significant difference ($p>0.05$) between the socio-demographic characteristics of respondents and awareness and knowledge of aflatoxin. A relatively small percentage of respondents (23.5% of n=16) were aware that aflatoxins are produced by fungi/molds. A substantial number of respondents (32.4% of n=8) have observed molds on their food items. It is recommended that sufficient resources be committed to improving aflatoxin awareness levels in Tanzania, through public enlightenments and collaborations among local, regional, national, and international governmental and non-governmental agencies. The study concludes that the respondents had no adequate knowledge of aflatoxin contamination. Awareness campaigns and training through local televisions, radio stations, newspapers, social media, and agricultural extension services should be fast-tracked.

Keywords: Aflatoxins, fungal contamination, employees, students, awareness, Tanzania.

INTRODUCTION

Aflatoxins are a group of structurally related toxic, mutagenic, and carcinogenic mycotoxins that contaminate many food and agricultural products with a special affinity to cereals and nuts. Mycotoxins are chemical substances produced by certain species of fungi as secondary metabolites in the field and during the storage of agricultural products (Shephard, 2009). Among the many analogs and derivatives of aflatoxins that have been identified, the B-series (aflatoxins B1 and B2), the G-series (aflatoxins G1 and G2), and M-series (aflatoxin M1) are of the most relevance from a food safety point of view (Afsah-Hejri et al., 2013). Aflatoxins B1 (AFB1), B2 (AFB2), G1 (AFG1), and G2 (AFG2) are the four (4) main types of aflatoxins frequently found in contaminated food and AFB1 is the most virulent of the four (Omari et al., 2020). They have been associated with liver cancer and have been classified as class 1

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carcinogens, with peanut, maize, and their derivatives being the main vehicles (Benkerroum, 2020).

Depending on environmental factors (temperature, humidity, and rainfall) and farm management practices (cropping, harvesting, and storage conditions), fungal proliferation and subsequent mycotoxin excretion could happen at any stage of the crop production chain (Waliyar et al., 2015). Aflatoxin-producing fungi are found in areas with a hot, humid climate and their presence in food is a result of both pre-harvest and post-harvest fungal contamination (EFSA, 2020). Plant immunocompromising factors such as drought stress, injury, pest infestation, and poor fertilization are also known enablers of aflatoxin production in agricultural products (Bhat & Vasanthi, 2003). Aflatoxins are ubiquitous and occur in various food crops, including cereals, nuts, and dairy products, among other food and agricultural products. A recent review by Eskola et al. (2019) suggests that about 60% to 80% of the global food crops are contaminated with mycotoxins. This estimation pushed back the widely cited 25% estimation attributed to the Food and Agricultural Organization (FAO) of the United Nations. Nonetheless, these figures are staggering; a large proportion of the world's population is faced with the risks associated with exposure to aflatoxin and a host of other mycotoxins. A recent rise in global temperatures has also presented another scenario; aflatoxins are increasingly detected in some parts of Italy and South Europe in quantities not seen before (Moretti et al., 2019).

Biblical and other written records of human illness and death related to food spoilage suggest mycotoxins have haunted humans for an extended period, perhaps since the beginning of human engagement in crop production for food (Pitt & Miller, 2017). However, scientific research into aflatoxin did not start until 1960 when a sudden death of more than 100,000 young turkeys in England died due to an unknown condition termed "turkey X disease" which caught the attention of scientists (Stoloff, 1976). Turkeys died from acute necrosis of the liver and hyperplasia of the bile duct after consuming groundnuts infected with *A. flavus* (Strosnider *et al.,* 2006). Multidisciplinary scientific research attributed these deaths to feed contaminated with a toxin produced by the fungus Aspergillus flavus, thus the name "aflatoxin" (Nesbitt et al., 1962). Research resulted in a sufficient understanding of the toxin enabling the development of better analytical methods and a better understanding of its public health impact (Pitt & Miller, 2017).
Humans may be exposed to aflatoxins through the consumption of aflatoxin-contaminated foods or the ingestion of foods produced by animals previously exposed to aflatoxins (Leong et al., 2012). Chronic dietary exposure to aflatoxins poses severe health complications in humans and animals (Williams et al., 2004). Aflatoxin B1, due to its toxic, mutagenic, immunotoxic, teratogenic, and carcinogenic effect on humans and animals, is classified as a group 1 carcinogen in the International Agency for Research on Cancer (IARC) classification of carcinogenic substances (Ostry et al., 2017). As a potent carcinogen, aflatoxin B1 may affect organs like the liver and kidneys (Alvarez et al., 2020; Li et al., 2018). It is also reported to suppress humans' immune systems, rendering them vulnerable to infectious diseases like HIV and AIDS (Jiang et al., 2008; Jolly et al., 2013). Prolonged exposure to aflatoxin has also been linked to congenital disabilities and stunting in children (Smith et al., 2015).

Additionally, acute aflatoxin exposure can be life-threatening. Exposure to high levels of aflatoxin within a short period is found to cause aflatoxicosis (Williams et al., 2004). Recently, multiple outbreaks of acute aflatoxin exposure have been reported, particularly from regions with tropical climates, such as Kenya and Tanzania (Awuor et al., 2017; Kamala et al., 2018). The implications of aflatoxin contamination of agricultural products go beyond public health issues; it equally carries trade and economic ramifications for both developed and developing countries. Maize farmers in the United States incur an annual loss of $160 million due to aflatoxin-related issues (Wu, 2015). These figures are higher in developing countries, especially sub-Saharan Africa, where losses amount to $450 million, representing 38% of the global agricultural losses due to aflatoxin (Gbashi et al., 2018). Williams *et al.,* 2004 estimated that aflatoxins are ubiquitous and approximately 4.5 billion people were exposed to these carcinogens. Factors that contribute to aflatoxin contamination may include regional climate, crop genotype, soil type, and atmospheric moisture (Strosnider *et al.,* 2006). Furthermore, aflatoxin is responsible for a significant decline in agricultural trade between developed and developing countries (Wu, 2015-[25]). Attempts to quantify the health and economic burden of aflatoxin contamination of food crops have been made by Liu and Wu (2010) at a global scale, and country and regional studies published by Matumba et al. (2019).

Different mitigation and control measures are being applied to prevent or minimize human and animal exposure to aflatoxin. These include prevention of pre- and postharvest contamination of agricultural products, or their reduction to acceptable levels in already contaminated products through removal, degradation, or decontamination. Basic measures such as Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs) as aflatoxin preventive measures have proven effective when combined with proper postharvest handling practices (Hell & Mutegi, 2011). Scientific advances have also permitted the use of sophisticated biological, chemical, and physical measures for the prevention and decontamination of already contaminated agricultural products (Lizárraga-Paulín et al., 2013). The need for enlightenment as an intervention strategy has been emphasized over the years with insignificant follow-up. At higher learning institutions, comprising a large number of educated personnel is expected to constitute a pool that can teach the rest of society. To achieve this aim, there is a need to assess the level of awareness for the educated group of people in society. Therefore, this study aimed to assess the level of awareness of aflatoxin among employees and students in Tanzanian higher learning institutions, using the Institute of Adult Education as a reference point. Specifically, the study sought to: evaluate the current level of awareness and knowledge about aflatoxins among employees and students; assess the association between socio-demographic characteristics and knowledge of aflatoxins.

Research Questions and Hypothesis

i. What is the current level of awareness and knowledge about aflatoxins among employees and students?

Research Hypothesis

The following null hypothesis was tested in this study.

Ho: There are no statistically significant differences in the responses based on socio-demographic characteristics (sex, education level, and age).

Materials and Methods

Study settings

The current study was conducted among employees and students at the Institute of Adult Education in Tanzania. The study took place from November to December, 2023. Twelve (12) employees were conveniently selected and fifty-six (56) students were systematically selected from the population at Morogoro-Campus. The study was conducted at the Institute of Adult Education in Tanzania because it was convenient for the researcher to collect the data as he works as a lecturer in the same Institute.

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Research Approach and Design

This study employed a quantitative research approach. The research design was a descriptive study using survey techniques.

Population and Sampling Techniques

Quantitative data were collected from employees and students. A total sample of 12 employees and 56 students comprised the sample size of the study (36 male; and 32 female). A total of 68 respondents were included in the study. Mixed sampling techniques including simple random sampling and purposive sampling were used in this study to get respondents who were categorized into two groups namely employees and students at the Institute of Adult Education. Simple random sampling was employed to select the respondents to represent others from a group of students at IAE. A sampling frame was prepared and then respondents were selected using the Table of Random Numbers. A total of 56 respondents were randomly selected using this method. Purposive sampling was employed to select the 12 employees at IAE.

Sample size determination

The minimum sample size was calculated using the Leslie and Kish formula for descriptive studies $n = p\ (1\text{-}p)\ Z^2/e^2$ where n is the minimum sample size needed; e is the level of error that can be tolerated (0.087) absolute precision) and p, the estimated proportion of aflatoxin knowledge among employees and students, 16% i.e. p= 0.16. Z is the standard variation corresponding to the confidence level. At a confidence level of 95%, Z= 1.96. Therefore:

$n = 0.16(1\text{-}0.16)^*\ 1.96^2/0.087^2$

n=68 respondents. Therefore, the sample size of the study was 68 respondents.

Data collection tool and procedure

The researchers developed a five-point Likert-scale questionnaire it consisted of two sections the first section was used to collect the demographic data and the second section was used to collect the core data. A total of eight items were included in the second section of the questionnaire. The scale of the questionnaire ranged from level 1 to level 5 in which level 1 = "strongly disagree" and level 5 = "strongly agree". A pilot study was conducted to measure the validity of the Likert-scale questionnaire. A unit score was given to each Yes or No answer. In addition, several statements were included in the questionnaire to measure the level of awareness of the respondents, about mold infestation of food products and its consequences.

Data analysis

All quantitative data were analyzed using IBM Statistical Package for Social Software (SPSS) version 20. Wilcoxon paired sample test was used to compare respondents' familiarity with the terms mold, fungi, and aflatoxins. All statistical tests were conducted at a significance level of p = 0.05. Results were presented as descriptive statistics in tables and graphs to facilitate interpretation.

Validity and reliability of the questionnaire

Prior to questionnaire administration, it was pre-tested and the internal consistency of components was assessed. A 10-sample pre-test questionnaire was used to validate the questionnaire and to evaluate its clearness and consequently, some adjustments were made in the final set of the questionnaire. A Cronbach's alpha reliability of 0.8142 was obtained indicating an acceptable reliability of the questionnaire used in this study.

Ethical Considerations
A verbal consent was given by the respondents. The author hereby declares that the study has therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

Findings

Aflatoxin awareness and knowledge levels among Employees and Students at the Institute of Adult Education, Tanzania

The aflatoxin awareness levels among employees and students are depicted in Table 1. Only, 12 (17.6%) of participants from the sample population had heard about the term "aflatoxin". A significant large portion (82.4%) of respondents had not heard about aflatoxins, indicating a potential lack of awareness about this topic. The majority of those who haven't heard about aflatoxins attribute their lack of knowledge to a lack of awareness campaigns or a perceived lack of relevance to their field. A relatively small percentage of respondents (23.5%) are aware that aflatoxins are produced by fungi/molds. A substantial number of respondents (32.4%) have observed molds on their food items. Only 19.1% of respondents know the physical appearance of food items as a possible indicator of fungal infestation (Table 1).

Table 1: Aflatoxin awareness and knowledge of respondents

S/No	**Questions** regarding aflatoxins knowledge	**Answers**	**Total(n=68)**	
			n	%
1.	Have you heard of the word aflatoxin?	Yes	12	17.6%
		No	56	82.4%
2.	Are you aware that aflatoxins are produced by fungi?	Yes	16	23.5%
		No	52	76.5%)
3.	Are you aware of the harmful effects of aflatoxin on humans?	Yes	20	29.4%
		No	48	67.6%)
4.	Are you aware of the presence of aflatoxins in foods?	Yes	16	23.5%
		No	52	76.5%)
5.	Have you ever observed damaged food by moulds on your food items?	Yes	8	32.4%
		No	4	67.6%
6.	Foods items mostly affected by aflatoxins are cereals and oil based foods	I Know	14	20.6%
		Not sure	16	23.5%
		I Don't Know	38	55.9%
7.	Economically, aflatoxin contamination of food produce may negatively impact international trade	I Know	8	11.8%
		Not sure	20	29.4%
		I Don't Know	40	58.8%
8.	Physical appearance of food items is a possible indicator of fungal infestation and possible aflatoxin contamination	I Know	13	19.1%
		Not sure	21	30.9%
		I Don't Know	34	50.0%
9.	Aflatoxin is the cause of a toxic syndrome known as aflatoxicosis	I Know	9	13.2%
		Not sure	5	7.4%
		I Don't Know	54	79.4%
10.	By preventing fungal infestation, we also prevent aflatoxin contamination of food products	I Know	15	22.1%
		Not sure	10	14.7%
		I Don't Know	43	63.2%

As to how familiar the respondents were with the terms mold and fungi, a mean score of 2.431 was obtained; how familiar the respondents were with the term aflatoxin recorded a mean score of 2.014 which is lower than the average mean of the knowledge of respondents. The results show that there is no statistically significant difference between the familiarities with the three terms. Essentially, respondents' levels of familiarity with "molds, fungi, and eukaryotic organisms" are not significantly different from their familiarity with "aflatoxins." ($p > 0.05$) (Table 2). The fact that the p-value is $p>0.05$, means that familiarity with both sets of terms is consistently low across respondents. In a real sense, filamentous fungi and molds can produce harmful mycotoxins, posing significant health risks to humans and animals.

Table 2: Respondents familiarity with the terms mold, fungi, and aflatoxins using Wilcoxon paired sample comparison test (n=68)

Statements	Responses % (n)			Mean	Std.Dev	p-value
	1*	2*	3*			
1. How familiar are you with these terms: molds, eukaryotic organisms and fungal spores?	73.53(50)	17.65(12)	8.82(6)	1.35	0.64	>0.05
2. How familiar are you with the term aflatoxin?	82.35(56)	7.35(5)	10.29(7)	1.28	0.64	
Overall mean score				**1.315**	**0.64**	

1* No idea, 2* Quite familiar, 3 * Very familiar. Significant values are in bold

Practical implication: These results might suggest that educational or awareness campaigns regarding these terms (molds, fungi, and aflatoxin) could be necessary, as respondents generally seem to be unfamiliar with them.

Association between Socio-demographic Characteristics and Knowledge of Aflatoxin

Socio-economic variables were analyzed with aflatoxin contamination variables to determine their associations/correlations. The sex of the respondent was not significantly associated with knowledge of aflatoxin ($\chi2$, 1 =1.24, $p > 0.05$). Likewise, the education level of respondents was not found to be significantly associated with knowledge/awareness of aflatoxin ($\chi2$, 4=1.06, $p>0.05$), and also, the age of respondents was not significantly associated with knowledge of afflation ($\chi2$, 5 =0.725, $p>0.05$) **(**Table 3**).** Generally, there are no statistically significant differences in the responses based on sex, education level, or age in this dataset. All demographic characteristics investigated (sex, education level, and age) were found to have no significant ($p > 0.05$) influence on the knowledge status of the respondents.

Table 3: Association between Socio-demographic Characteristics and Knowledge of aflatoxins

Variables	Category	Yes Frequency f (%)	No Frequency f(%)	Chi-square(χ2)	p-value	Remarks
Sex	Male	8(11.8%)	28(41.2%)	1.24	0.266*	Not significant
	Female	12(17.6%)	20(29.4%)			
Education level	Certificate	1(1.5%)	4(5.9%)	1.06	0.900**	Not significant
	Diploma	5(7.4%)	15(22.1%)			
	Bachelor	3(4.4%)	13(19.1%)			
	Master	6(8.8%)	16(23.5%)			
	PhD	2(2.9%)	3(4.4%)			
Age(in years)	21-24	5(7.4%)	8(11.8%)	2.84	0.725***	Not significant
	25-29	4(5.9%)	13(19.1%)			
	30-34	2(2.9%)	3(4.4%)			
	40-44	9(13.2%)	11(16.2%)			
	45-49	1(1.5%)	4(5.9%)			
	>50 years	2(2.9%)	6(8.8%)			

Level of significance as determined by Pearson chi-square test $p < 0.05$

Discussion

This study assessed the level of aflatoxins awareness among employees and students at the Institute of Adult Education in Tanzania. The current study revealed low levels of awareness and knowledge of aflatoxins. The study showed that 82.4% of respondents were not aware of the term aflatoxin. Only, 12(17.6%) of respondents had heard of aflatoxin. The level of awareness was substantially low among employees and students at the Institute of Adult Education. A relatively small percentage of respondents (23.5%) are aware that aflatoxins are produced by fungi/molds. This finding is similar to what was reported in Kenya and Mali; awareness and knowledge of the potential danger posed by aflatoxin contamination in foodstuffs is extremely low (Narrod *et al*., 2011). Studies conducted in various regions of the world demonstrate that the knowledge of aflatoxin is low. Part of the documented levels are for instance, 25% in Vietnam (Lee et al., 2017), 6% in Zimbabwe (Loreen and Moses, 2015), 12% in Ethiopia (Gizachew et al., 2015), and 20% in Tanzania (Kamala et al., 2016; Ngoma et a., 2017). Regarding awareness of the presence of aflatoxins in foods, only 23.5% were aware of the presence of aflatoxins in foods. Respondents in this study were not aware of the health problems associated with the consumption of food contaminated with fungal toxins (Table 1). Their ignorance can be traced to their low level of education as reported by Magembe et al. (2016) in Tanzania.

The Chi-square test was used to examine the relationship between three categorical variables (sex, education level, and age) and respondents' answers (Yes or No). All p-values (0.266 for sex, 0.900 for education level, and 0.725 for age) are higher than the standard cut-off of 0.05. Therefore, none of the variables (sex, education level, or age) have a statistically significant relationship with the response**.** There was no significant association ($p<0.05$) between the socio-demographic characteristics of respondents and knowledge of aflatoxin. Previous studies have also shown that awareness of aflatoxin contamination tends to increase with an increase in education level (Jolly et al 2009, Dosman et al 2001), which is in contrast with the current study. Likewise, education level has been observed to positively affect awareness level on aflatoxin, knowledge, and management strategies in combating aflatoxin contamination as it was stated by Jolly et al 2009 but this finding is contrary to this current study.

Although aflatoxin contamination and its effects are not the subjects of concern, especially in Tanzania's formal education system, illiteracy may suggest the observed results. Several studies conducted in Tanzania and other parts of the world revealed that education plays a greater role in creating awareness and reducing aflatoxins contamination of crops (Ayo et al 2018; Jolly et al 2009). To this end, awareness campaigns and training through local television, radio stations, newspapers, social media, and agricultural extension services should be fast-tracked.

Conclusion

In conclusion, the findings of this study shed light on the level of aflatoxins awareness among employees and students at the Institute of Adult Education in Tanzania. Several key observations emerged from the data, providing valuable insights into the knowledge and awareness of the surveyed population. From this study, it was observed that the majority of the respondents were not aware and did not have enough knowledge of aflatoxin and its effect on human health. Hence, there is a need for more sensitization of the subject among employees and students and throughout the general public.

Recommendations

Based on the findings and conclusions of this study, here are some recommendations for further action:

1. Educational Campaigns

It is advised to develop and implement targeted educational campaigns to enhance public awareness of aflatoxin contamination, its visual indicators, and the potential economic and health consequences. Collaborate with health agencies, agricultural extension services, and educational institutions to disseminate accurate information.

2. Visual Indicator Guidance

It is advised to provide clear and accessible guidance on the visual indicators of aflatoxin contamination in food items. This could include educational materials, workshops, and online resources that will help individuals recognize and understand the significance of discoloration, unpleasant odor, and moldy appearance.

3. Community Engagement

It is advised to engage local communities in discussions and workshops to address concerns and dispel misconceptions regarding aflatoxin contamination. Community involvement can foster a sense of shared responsibility and empower individuals to actively participate in ensuring food safety.

4. Research and Innovation

Encourage research initiatives and innovation in agricultural and food processing technologies to develop solutions for aflatoxin prevention. Investing in research can lead to the identification of new and improved methods for reducing aflatoxin contamination throughout the food supply chain.

5. Academic and research institutions

It is also important for educational institutions and research organizations to partner in training students on aflatoxin management and other phytopathology concerns. This may ensure continuity in capacity development for the management of aflatoxigenic fungi, their toxins, and other food security and food safety threats.

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Conflict of interest

The author declares no conflict of interest

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