Daagu International Journal of Basic and Applied Research 5(2023): 226-239
DOI: https://doi.org/10.20372/DIJBAR41582.V5I2.2023

Original article

Awareness and Knowledge of Stakeholders in Wheat Flour Aflatoxins Contamination Zone one Towns, Afar Region, Northeastern Ethiopia

Ephrem Guchi[1*] and Abdella Ibrahim[1]

[1]Samra University, College of Natural and Computational Sciences, Department of Biology, Semera, Ethiopia

*Corresponding author: Email: ephremg21@gmail.com; Mobile: +251911767906; P.o. Box: 132, Semera, Ethiopia. ORCID**:** https://orcid.org/0000-0001-5306-2959

Abstract

Aflatoxin-producing *Aspergillus* species restrict wheat production. The study was aimed to assess stakeholders' awareness and knowledge about aflatoxin contamination of wheat flour and its associated problems. The study was conducted in the Afar region northeastern Ethiopia. Primary data were collected using a semi-structured questionnaire administered to 90 purposively selected stakeholders'. The result revealed that 57.5% of respondents, i.e., 83.7% of traders, 27.2% of supporters, and 61.7% of consumers, were unaware of aflatoxin and its consequences. Moreover, 96.7% of traders responded that knowledge of long-term exposure to fungi and aflatoxin could not be as harmful to health. Marriage, educational level, and household income were the main factors significantly ($\chi2 = 13.461$, $\chi2 = 14.217$ and $\chi2 = 13.750$, $p \leq 0.05$) associated with knowledge about fungi and aflatoxin contamination in wheat flour. In conclusion, there is low stakeholders awareness and knowledge about aflatoxigenic fungi and aflatoxin contamination in wheat flour. It is necessary to conduct concerted campaigns to create awareness among traders about aflatoxin contamination and its associated problems.

Keywords: Aflatoxin, Awareness, Ethiopia, Knowledge, Wheat Flour

Citation: Guchi, E. and Ibrahim, A. 2023. Awareness and Knowledge of Stakeholders in Wheat Flour Aflatoxins Contamination Zone one Towns, Afar Region, Northeastern Ethiopia. *Daagu International Journal of Basic and Applied Research*, 5(2): 226-239. DOI: https://doi.org/10.20372/DIJBAR41582.V5I2.2023

©*Daagu International Journal of Basic and Applied Research*

1. INTRODUCTION

Wheat (*Triticum aestivum*) is an important food crop worldwide and is a staple food for a large number of African populations and in the world (Manjula *et al*., 2009). Roughly 90 to 95% of the wheat produced in the world, about 600 million tones USDA (1998), is common wheat (*T. aestivum*), which is better known as hard wheat or soft wheat, depending on grain hardness. Wheat is utilized mainly as flour (whole grain or refined) for the production of a large variety of leavened and flat breads, and for the manufacture of a wide variety of other baking products contributing 339 kcal and 13.70 g to energy and protein intake, respectively (Emily & Sherry, 2010). Wheat is milled into flour, which is used for human food in a variety of recipes. In Ethiopia, wheat flour is used for making bread, porridge, cake, cookies, pastries etc. Porridge is eaten by all age groups including 6 months old babies from particularly low-income families (Emily & Sherry, 2010).

During wheat production chain viz., harvest, handling and storage, they are inevitably contaminated with various contaminants including moulds. Ethiopia has a climate that is conducive for fungal growth. Mould growth leads to the production of mycotoxins, which are defined as secondary metabolites of toxigenic moulds (Hejri *et al*., 2013).

Nowadays, over 400 mycotoxins are known, however the most investigated include aflatoxins, trichothecenes, fuminosins, zearaleunone and ochratoxins (Ediage *et al*., 2011). Aflatoxins are produced by *Aspergillus flavus, Aspergillus parasiticus* and *Aspergillus nominus*. These fungal groups contaminate a wide range of agricultural food commodities including beans, sorghum, groundnuts, millet, peas, cassava, rice and wheat, with the latter being the most significantly contaminated by aflatoxins (Kaaya & Warren, 2005; Magan *et al*., 2011). Aflatoxins are categorized into aflatoxins B (B1 and B2) and G (G1 and G2) as result of blue and green fluorescence, respectively on the Thin Layer Chromatography plates under UV light (Sweeney & Dobson, 1998).

Aflatoxins are poisonous. They can cause death and other serious harm to health, when food or feed containing them is eaten by humans and animals. Numerous studies have linked aflatoxins to various diseases, such as cancer of liver and hepatitis B and C. Aflatoxins are acutely and chronically toxic, immunosuppressive, mutagenic, teratogenic and carcinogenic compounds targeting mainly the liver for toxicity and carcinogenicity (Peraica *et al*., 1999). Aflatoxin is a carcinogen and acute aflatoxicosis results in human deaths. Although acute aflatoxin poisoning is

rare, 25% of these cases are fatal. Chronic exposure rates are high especially in developing counties (Williams, 2011). Aflatoxins have a wide range of toxicological and other ill-effects on human life and are of greater public health concern in developing world where need for eating far outweighs other considerations like the safety issues and where in the most of countries, regulation of food is still in developmental stage (Williams, 2011).

In Africa, the consumption of aflatoxins contaminated food may be linked to recent increased liver cancer cases and has even resulted in fatal cases. Indeed, in 2004, in rural Kenya, an Eastern African country, the consumption of aflatoxins contaminated maize resulted in 317 cases of aflatoxicosis, with the death of 125 persons (Lewis *et al*., 2005). Aflatoxins are also believed to be positively correlated to malnutrition disorders like stunting, underweight and decreased level of haemoglobin in children (Bankole & Adebanjo, 2003).

Conway & Toeniessen (2003) asserted that the safety of food and feed for human and animal consumption should be of top most priority with regards to agricultural and food industries. Those growers involved in farming venture in Sub-Saharan Africa constitute about 70% of the population, and food commodities are the major items of international trade for many African countries. According to Bhat & Vashanti (1999), the quality and safety of food is important so that domestic and foreign markets are not compromised by the sale of low quality or unsafe food. Health risks associated with aflatoxins can be reduced through awareness campaigns (Strosnider *et al*., 2006). In 2005, FAO/WHO argued it is imperative that food safety remains a concern in all situations to derive maximum benefit from even the little available food and strong political will and hence relevant food safety systems are essential from production to consumption. There is also the issue of the level of aflatoxin awareness that negatively influences food safety and food security in developing countries since the level of awareness and knowledge in many developing countries is extremely low or non-existent altogether. According to James *et al*. (2004), poor knowledge of the aflatoxin and its health risks causes consumers to be exposed to acute and chronic toxicity through consumption of poor quality or moulded food products.

According to Williams (2011), 40% of commodities in local African markets exceed permissible levels of aflatoxins in foods. Ephrem *et al*. (2015) found that percent prevalence of total aflatoxin concentration from the positive samples 87% were above 10 ppb and 13% were less than 10 ppb at Trader's at Fedis district, indicating heavy contamination of groundnut by aflatoxin beyond the maximum tolerable level by the CODEX Alimentarius Commission (10 ppb) in

Eastern Ethiopia. In Ethiopia, mycotoxins produced by several fungal species are common in barley, sorghum, wheat, maize and teff (Amare *et al*., 2006). Amare (2010) identified 15 species of fungi from 17 maize grain samples collected from Dire Dawa, Adama, and Ambo. He also detected aflatoxins, fumonisins, deoxynivalenol and nivalenol with varying concentrations. A need therefore exists for a series of research in aflatoxins and other mycotoxins contamination of local and imported food products. Wheat flour is used for food for all age groups of Ethiopia especially Afar region in all their socio-economical classes. Ephrem *et al*. (2014) found that 90% of the actors were unaware of aflatoxin contamination of groundnut seeds and its consequence in Eastern Ethiopia. Therefore, assessment of the gaps in traders' and consumers' awareness and knowledge about aflatoxin contamination problem of wheat flour is required. The present study is, therefore, aimed at to assess awareness and knowledge of stakeholders in wheat flour Aflatoxins contamination Zone one Towns, Afar Region, Northeastern Ethiopia.

2. MATERIAL AND METHODS

2.1. Description of the Study Area

The study was conducted in Logyia-Semera, Dubti and Assaita town, Afar Region, Northeastern Ethiopia. Dubti town is situated at about 600 km northeast of Addis Ababa. Geographically, it is located between 11º 39' to 11º 48'' N Latitudes and 41º 6' to 41º 12'' E Longitudes with an altitude that ranges from 339-381 masl. Based on traditional classification methods using altitude, temperature and rainfall, Dubti area is laid under tropical desert (Bereha) i.e. arid climate categories. Based on meteorological data obtained from Dubti station, the average annual 28 years (1986-2014) rainfall is 222 mm which is characterized by bimodal rainfall pattern, and the major season is "karma", the long rainy season (mid - June to mid - September), while the short rainy season that extends from March to April is "sugum". The rainfall is erratic in nature and is not sufficient for rainfed agriculture. Hence, crop production is practiced based on irrigation. The annual mean minimum and maximum temperatures are 22.6 and 48.8 ^{0}C, respectively with mean annual evapo-transpiration of 2854 mm. Whereas Assaita town is situated at about 630 km northeast of Addis Ababa. Geographically, it is located between 11º 55' to 11º 06'' N Latitudes and 41º43' to 41º63'' E Longitudes. Assaita town has an elevation of 300 meters (980 ft), is 50 km (31 miles) south by unpaved road from Awash-Asseb highway. In Assaita, the average annual temperature is 28.7 °C. About 144 mm of rain fall (precipitation)

falls annually. At an average temperature of 33.4 °C, June is the hottest month of the year. The lowest average temperatures in the year occur in January, when it is around 24.5 °C. Whereas Logyia town is situated at about 570 km northeast of Addis Ababa, the country's capital city. Geographically, it is located between 11º72’11º32’’ N Latitudes and 40º97'40º64’’ E Longitudes. The average annual temperature at Logyia is 28.2 °C. Rainfall (precipitation) here averages 203 mm. The warmest month of the year is June, with an average temperature of 32.5 °C. January is the coldest month, with temperatures averaging 24.3 °C (Afar region Agriculture Bureau, 2019).

2.2. Sampling

For the study, a total of 90 respondents were selected purposively based on population group and type of trade traded by traders. That is, the study covers 30 traders, both whole sellers and vendors. In addition, 30 consumers were randomly taken (from farmers, traders, employee, etc) and included in as key informants. Among supporters 30 respondents were randomly taken (from Samara University Biology and Plant Science Students, Instructors, Health and Agriculture Experts, Ethiopian Commodity Exchange and Developmental Agent) and included as key informants purposively.

2.3. Study Methodology and Procedure

Primary data on stakeholders’ awareness and knowledge was gathered using a key informant interview. A pre-tested apt questionnaire was used in data collection. Where applicable, the questionnaire survey was conducted at the time of sample collection and stakeholders who provided wheat flour samples were served as key informants in the interview. The questionnaire was developed after pre-testing through conducting a focused group discussion and interview involving farmers, traders, supporters, village elders, some community leaders and provincial administration staff. The results of the discussion was used to formulate the survey questions and respondents who aware and perceived the situations were selected purposively. These were the criteria we used in inclusion and exclusion of respondents. The questions were designed in a way that each element of the question represented a statement the respondents would have made if asked a question. This was done to minimize respondent bias (Ajzen, 1991).

2.4. Data Analysis

Data that was collected from the questionnaires including socio-demographic characteristics of respondents, awareness of aflatoxin contamination of wheat flour, knowledge on aflatoxigenic fungi and aflatoxin contamination of wheat flour and associated factors were summarized and analyzed using Statistical Package for Social Sciences (SPSS) version 22 for windows. Descriptive statistics in the form of means and percentages were used to analyze the data. Moreover, a Chi-square test was also used to explore associations at 5% level of significance.

2.5. Ethical Consideration

Informed consent was obtained from the concerned offices and community leaders before implementing the actual study. Sampling of wheat flour was carried out with full consent of stakeholders in northeastern Ethiopia. Before each sampling, the study objectives were clearly explained to the stakeholders, that the aim of the study is neither to evaluate the performance of the individual nor to blame anyone for weakness, but to gather information that might lead to eventual improvement in the situation. Each stakeholder is assured that the information provided would be confidential and used only for the purpose of research.

3. RESULTS AND DISCUSSION

3.1. Socio-Demographic Characteristics of Respondents

The socio-demographic characteristics of respondents in the study areas is presented in Table 1. It was observed that from the respondents traders were 22 (73.3%) of male headed households, while consumers were 13 (43.3%). Also, the majority of respondents, particularly traders 12 (40.0%) and supporters 16 (53.3%) were between the ages of 35 and 50 years. A number of traders 11 (36.7%) were below 35 years of age. Most of the respondents were married, particularly supporters 15 (50.0%) and consumers 15 (50.0%). However, almost 15 (50.0%) supporters and 14 (46.7%) consumers were single or unmarried. A large number of respondents had no formal education (i.e. they were illiterate). In contrast, 11 (36.7%) of traders and more than 10 (33.3%) of consumers attended primary education, 18 (60%) of supporters had secondary and 12 (40%) had tertiary education. With regard to household incomes, 15 (50.0%) traders earned above ETB 10,000 per month. Consumers had the lowest income with 4 (13.3%) earning less than ETB 3,000 per month. With regard to years of experiences, 16 (53.3%) of

supporters had 5 to 10 years of experience, whereas most traders 11 (36.7%) had more than 10 years of experience.

Table 1. Socio-demographic characteristics of respondents (n=90) in Afar region in 2019

Variables		Traders		Supporters		Consumers	
		N	%	N	%	N	%
Sex group	Male	22	73.3	19	63.3	13	43.3
	Female	8	26.7	11	36.7	17	56.7
Age group	< 35 years old	11	36.7	9	30.0	11	36.7
	35-50 years old	12	40.0	16	53.3	11	36.7
	>50 years old	7	23.3	5	16.7	8	26.7
Marital status	Single	11	36.7	15	50.0	14	46.7
	Married	12	40.0	15	50.0	15	50.0
	Divorced	6	20.0	0	0.0	1	3.3
	Widowed	1	3.3	0	0.0	0	0.0
Educational level	No formal education	9	30.0	0	0.0	6	20.0
	Primary education	11	36.7	0	0.0	10	33.3
	Secondary education	10	33.3	18	60.0	14	46.7
	Teritery education	0	0.0	12	40.0	0	20.0
Household income per month (*ETB)	< 3000	5	16.7	11	36.7	4	13.3
	3000-10000	10	33.3	10	33.3	15	50.0
	>10000	15	50.0	9	30.0	11	36.7
Years of experience	< 5 years	8	26.7	10	33.3	11	36.7
	5-10 years	11	36.7	16	53.3	11	36.7
	> 10 years	11	36.7	4	13.3	8	26.7

*ETB (Ethiopian Birr)

3.2. Stakeholders 'Awareness about Aflatoxin and Associated Problems

Awareness about aflatoxin was low among respondents of wheat flour actors (Table 2). The result revealed that 57.5% of respondents, i.e., 83.7% traders, 27.2% supporters and 61.7% consumers were unaware of aflatoxin and its consequences. However, more than 73% of supporters and 40% of consumers responded that they know aflatoxin before. This is due to highest literacy levels of supporter respondents. Lack of awareness of respondents was due mainly to lack of visual symptoms of aflatoxin contamination on wheat and maize flour. Awuah *et al.* (2009) reported that from interviewed farmers, traders, and consumers 90% were not aware of aflatoxin, while 92% of farmers in Ghana had never heard of aflatoxin (Jolly *et al*., 2006).

The survey results also revealed that traders (69.9%) were not aware of the health effects of aflatoxin to human and animal. This could be attributed to lack of symptoms on the flour as the major factor for their being unaware about aflatoxin contamination. According to Kaaya and Warren (2005) large number of traders and consumers were unaware of aflatoxin contaminated food. In the present study, almost all of the interviewed traders were not aware of any health

effects of consuming "too much flour paste." When respondents were asked about the criteria used to identify aflatoxin contaminated flour, some of them pointed out that they could identify spoiled or contaminated crops by the color or the shape. According to the study by Selestin *et al*. (2016) in Tanzania, 82% of the parents were unaware of aflatoxin contamination in children's foods and their health effects.

Table 2. Awareness of respondents (n=90) about aflatoxin in Afar region in 2019

Questions	Traders		Supporters		Consumers	
	Not sure	Sure	Not sure	Sure	Not sure	Sure
1. Have you noticed the word aflatoxins before?	29(96.7)	1(3.3)	5(16.7)	25(83.3)	14(46.7)	16(53.3)
2. Are you aware of what produces aflatoxins?	27(90.0)	3(10.0)	8(26.7)	22(73.3)	20(66.7)	10(33.3)
3. Are you aware of aflatoxin contamination in wheat?	24(80.0)	6(20.0)	6(20.1)	24(79.9)	21(70.0)	9(30.0)
4. Have you heard of the health effects of aflatoxin on humans & animals before?	21(69.9)	9(30.1)	7(23.4)	23(76.6)	15(50.0)	15(50.0)
5. Are you aware of as chronic aflatoxin causes liver cancer?	23(76.6)	7(23.4)	11(36.7)	19(63.3)	21(70.0)	9(30.0)
6. Are you aware of as acute aflatoxin cause hepatic necrosis?	28(93.3)	2(6.7)	9(30.1)	21(69.9)	20(66.7)	10(33.3)
7. Are you aware of as aflatoxin depressed immunity on humans & animals?	22(73.3)	8(26.7)	10(33.4)	20(66.6)	18(60.0)	12(40.0)
8. Are you aware of teratogenic effect of aflatoxin on humans & animals?	27(90.0)	3(10.0)	9(30.1)	21(69.9)	19(63.3)	11(36.7)

3.3. Stakeholders' Knowledge on Aflatoxin Problem

Table 3 below showed that respondents' knowledge on aflatoxin problem. The result revealed that 73.3% of traders responded that pre-harvest and post-harvest practices were unimportant in reducing moldiness and aflatoxin. There was also 96.7% of traders responded that knowledge of long-term exposure to fungi and aflatoxin could not be as such harmful to health. However, 76.6% of supporters responded that the importance of whether pre-harvest and post-harvest practices reduced moldiness and aflatoxin and long-term exposure to fungi and aflatoxin could be harmful to the health.

Table 3. Knowledge of respondents about aflatoxin problem (n=90) in Afar region in 2019

Questions	Traders		Supporters		Consumers	
	Not important	Important	Not important	Important	Not importnt	Important
1.Timing of planting of wheat to reduce moldiness	22(73.3)	8(26.7)	7(23.4)	23(76.6)	15(50.0)	15(50.0)
2. Timely harvesting to control moldiness of wheat in storage	20(66.7)	10(33.3)	9(30.1)	21(69.9)	19(63.3)	11(36.7)
3.Cultural practices to control moldiness	18(60.0)	12(40.0)	6(20.1)	24(79.9)	21(70.0)	9(30.0)
4. Drying flour to reduce moldiness	21(70.0)	9(30.0)	8(26.7)	22(73.3)	16(53.3)	14(46.7)
5. Thorough sorting	22(73.3)	8(26.7)	10(33.4)	20(66.6)	18(60.0)	12(40.0)
6. Proper storage to reduce AF	29(96.7)	1(3.3)	5(16.7)	25(83.3)	12(40.0)	18(60.0)
7. Use of pesticides to reduce moldiness in storage	20(66.7)	10(33.3)	7(23.4)	23(76.6)	17(56.7)	13(43.3)
8. Long term exposure to fungi and aflatoxin can be harmful to the health	29(96.7)	1(3.3)	6(20.1)	24(79.9)	15(50.0)	15(50.0)

3.4. Socio-demographic Factors with Knowledge about Fungi and Aflatoxin

The socio-demographic factors affecting the knowledge about fungi and aflatoxin contamination in wheat flour have been depicted in a cross-tabulation (Table 4). Being married, educational levels and also household income were the major factors significantly ($\chi 2 == 13.461$, $\chi 2 = 14.217$ and $\chi 2 = 13.750$, $p \leq 0.05$) associated with knowledge about fungi and aflatoxin contamination in wheat flour. However, gender disparity, age and years of experiences did not affect respondents on the level of knowledge about fungi and aflatoxin contamination in wheat flour. Thus, males (12.1%) and females (12.1%) knew equally about fungi and aflatoxin contamination in wheat flour. There was no significant difference in the levels of knowledge about fungi and aflatoxin among the three age groups; those individuals with less than 35 years old (6.7%), those persons between 35 and 50 years (9.7%) and those older ones than 50 years (7.9%) knew about fungi and aflatoxin contamination in wheat flour. Moreover, respondents with less than 5 years of experiences (3.0%), those individuals with experiences between 5 and 10 years (13.9%), and those ones with more than 10 years of experiences (7.3%) knew about fungi and aflatoxin contamination in wheat flour.

In general, it can be assumed that the respondents had low level of knowledge about fungal and aflatoxin contamination in wheat flour. When analyzed according to factors, respondents who were married, with secondary educational level and with yearly household income level between

ETB 3,000 and 10,000 had significantly high total score of knowledge on fungal and aflatoxin contamination in wheat flour.

Indeed, similar studies have shown the influence of marital status on health promotion and disease prevention. For instance, being divorced resulted in higher odds for poor self-rated health (Kawada & Suzuki, 2011). Besides, a recent study showed that unmarried migrant women were vulnerable to sexual and reproductive health problems due to lower level of knowledge than the married ones (Lu *et al*., 2012). Although the importance of knowledge in these examples is indirectly explained for health promotion and disease prevention, it could be said that knowledge would be easily accessible through the supports and communications between and among partners.

Education is positively related to awareness, knowledge and perceived benefits (Jolly *et al*., 2009). It is understood that people with higher education level are likely to be better informed and, therefore, may be better aware of some types of risk of food additives or pesticides in foods than those with less educational levels (Dosman *et al*., 2001). Additionally, Baker (2003) stated that those with highest levels of education were more willing to pay for food safety. In this study, we found that respondents with higher education status had significantly higher level of knowledge on the occurrence of fungal infections in the diets than those with lower education status. This observation clearly depicted that education is an important mode to disperse information and knowledge to the public. In other words, when respondents knew about fungal contamination in wheat flour, they were more likely to have knowledge or heard about fungi and/or aflatoxin contamination and its health risk.

The respondents with higher income were more knowledgeable than those with lower income respondents. Inevitably, money appears to matter because it is a marker of something else (Marmot, 2002). For example, Marmot (2002) explained that money and technical knowledge have allowed the community to invest in conditions that favor an alleviation of the conditions that lead to high infant mortality. Besides, income is related to an individual's ability to seek for a better health support as evidences showed that the richer ones are always getting healthier relative to the poor people (Shankardass *et al*., 2012). In the case of the effects of aflatoxin on human health, those who had better income are more likely to have more access to knowledge than those with lower income status.

Furthermore, fear of lack of information and knowledge about the adverse effects of aflatoxin allows the people to try to access knowledge about food safety from the available experts, who can be expensive or costly. To some extent, the option might be unbearable for individuals with low-income status. One of the reasons is the transaction cost in the search for knowledge would increase when the symptoms of the problem are not obvious and not well known, and the experts and professionals themselves are not totally committed to the problem (Jolly *et al*., 2009).

Table 4. Cross-tabulation of socio-demographic factors with knowledge about fungi and aflatoxin contamination in wheat flour (n= 90) in Afar region in 2019

Variables		**Do you know fungal and aflatoxin contamination in wheat flour?**		**χ2**
		Yes	**No**	
1. Sex group	Male	20 (22.1)	34 (37.0)	0.556
	Female	20 (22.1)	16 (17.7)	
2. Age group	< 35 years old	10 (11.1)	20 (22.1)	1.190
	35-50 years old	16 (17.7)	14 (15.5)	
	>50 years old	14 (15.5)	16 (17.7)	
3.Marital Status	Single	20 (22.1)	10 (11.1)	13.461
	Married	30 (33.3)*	5 (5.5)*	
	Divorced	10 (11.1)	5 (5.5)	
	Widowed	5 (5.5)	5 (5.5)	
4.Educational Level	No formal education	20 (22.1)	10 (11.1)	14.217
	Primary education	5 (5.5)	10 (11.1)	
	Secondary education	30 (33.3)*	5 (5.5)*	
	Teritery education	5 (5.5)	5 (5.5)	
5.Household income per month	< 3000 birr	5 (5.5)	20 (22.1)	13.750
	3000-10000 birr	35 (38.8)*	5 (5.5)*	
	>10000 birr	20 (22.1)	5 (5.5)	
6.Years of practice**	< 5 years	5 (5.5)	25 (27.7)	2.690
	5-10 years	30 (33.3)	10 (11.1)	
	>10 years	5 (5.5)	15 (16.6)	

*Factors significant at $p \leq 0.05$

**Trader-Trading; Supporter-Teaching; Consumer-use of flour in the diet

4. CONCLUSION

In this study, it was observed that awareness about aflatoxin was low among traders. Traders was also responded that knowledge of long-term exposure to fungi and aflatoxin contamination to be not harmful to the human health. Being married, educational levels and also household income were factors associated with knowledge on fungi and aflatoxin contamination in wheat flour. Gender disparity, age and years of experience did not affect respondents on the level of knowledge on fungi and aflatoxin contamination in wheat flour.

5.1.Recommendations

There is a need for launching a concerted campaign to augment awareness among the traders, consumers and similar end-users about aflatoxigenic fungi development, aflatoxin generation, contamination and management and quality maintenance in wheat flour production and marketing. So, it is important to create awareness among stockholders' about aflatoxin contamination and its associated problems in order to promote aflatoxin management interventions and practices by scholars in this field.

Conflict of interest

The author declares that there is no conflict of interest.

Acknowledgments

We would like to thank Research and Community Service office, Samara University, Ethiopia for financing this study. We also thank Logia, Semera, Dubti and Assaita town administrative offices for their assistance they gave us during data collection.

REFERENCES

Ajzen, I. (1991). The theory of planned behavior. Organized Behaviour of Human Procedia, 50, 179–211.

Amare, A., Fehrmann, H., Lepschy, J., Beck, R. & Dawit, A. (2006). Natural occurrence of mycotoxins in staple cereals from Ethiopia. Mycopathologia, 162**,** 57-63.

Amare, A. (2010). Mycotoxins and surface and internal fungi of maize from Ethiopia. African Journal of Food, Agriculture, Nutrition and Development, 10(9), 4109-4123.

Awuah, R. T., Fialor, S. C., Kagochi, A. D. J. & Jolly, C. M. (2009). Factors influencing marketing participants' decisions to sort groundnuts along the marketing chain in Ghana. Peanut Science, 36 (1), 68–76.

Baker, G. A. (2003). Food safety and fear: Factors affecting consumer response to food safety risk. International Journal of Food and Agribussiness Management, Rev, 6, 1.

Bankole, S. and& Adebanjo, A. (2003). Mycotoxins in Food in Wes Africa: Current situation and possibilities of controlling it. African Journal of Botechnology, 2, 254-263. https:doi.org//10.5897/AJB2003.000-1053.

Bhat, R. V. & Vashanti, S. (1999). Occurrence of aflatoxins and its economic impact on human nutrition and animal feed. The New Regulation Agricultural Development Jounal, 23- 50.

Conway, G. M. & Toenniiessen, G. (2003). Agriculture Science for African Food Security. Science, 299-1187.

Dosman, D. M., Adamowiez, W. L. & Hrudey, S. E. (2001). Socioeconomic determinants of health and food-safety related risk perceptions. Risk Anal, 21, 307-317.

Ediage, E.N, Di Mavungu, J.D., Monbaliu, S., Van Peteghem, C. & De Saeger, S. (2011). A validated multianalyte LC-MS/MS method for quantifcation of 25 mycotoxins in cassava flour, peanut cake and maize samples. Journal of Agriculture and Food Chemistry, 59, 5173–5180

Emily, T. N. & Sherry A. T. (2010). Maize: A paramount staple crop in the context of global nutrition. Comprehensive Reviews in Food Science and Food Safety, 9, 417-436.

Ephrem G., Amare, A., Mashilla D., Mengitu K., Belachew A., & Chemeda F. (2014). Occurrence of *Aspergillus* species in Groundnut (*Arachis hypogaea* L.) along the Value Chain in Different Agro-

Ecological Zones of Eastern Ethiopia. Journal of Applied & Environmental Microbiology, 2(6), 309-317.

Ephrem. G. (2015). Stakeholders' perception about aflatoxin contamination in groundnut (arachis hypogaea L.) along the value chain actors in eastern Ethiopia. International Journal of Food Contamination, 2, 10.

Food and Agriculture Organization and World Health Organization. (2005). National food safety systems in Africa–situation analysis. Paper prepared by FAO Regional Office for Africa, Accra, Ghana. Regional Conference on Food Safety for Africa P 1 Harare, Zimbabwe.

Hejri, L. A. Jinap, S., Hajeb, P., Radu, S. & Shakibazadeh, S. (2013). A review on mycotoxins in food and feed: Malaysia case study. Comprehensive reviews in Food Science, 12, 629-651.

James, B., Adda, C., Cardwell, K., Annang, D.M., Hell, K., Korie, S., Edorh, M., Gbeassor F., Nagatey, K. & Houenou, G. (2004). Public information campaign on aflatoxin contamination of maize grains in market stores in Benin, Ghana and Togo. Taylor and Francis, London.

Jolly, C. M., Bayard, B., Awuah, R. T., Fialor, S. C. & Williams, J. T. (2009). Examining the structure of awareness and perceptions of groundnuts aflatoxin among Ghanaian health and agricultural professionals and its influence on their actions. Journal of Socioeconomics, 38, 280-287.

Jolly, C. M., Jiang, Y., Ellis, W., Awuah, R., Ninedu, O., Phillips, T., Wang, J. S., Afriyie-Gyawu, A., Tang, E. L., Person, S., Williams, J. & Jolly, C.(2006). Determinants of Aflatoxin Levels in Ghanaians: Sociodemographic Factors, Knowledge of Aflatoxin and Food Handling and Consumption Practices. International Journal of Hygiene and Environmental Health, 209 (4), 345–358.

Kaaya, A. N. & Warren, T. R. (2005). Aflatoxin contamination of peanut at farmers and traders in Ghana. Mycopatologia, 21, 85-90.

Kawada, T. & Suzuki, S. (2011). Marital status and self-rated health in rural inhabitants in Japan: A cross-sectional study. Journal of Divorce and Remarriage, 52, 48-54.

Lewis, L., Onsongo, M., Njapau, H., Schurz-Rodgers, H., Luber, G., Kieszak, S., Nyamongo, J., Backer, L., Dahiye, A. M., Misore, A., DeCock, K., Rubin, C. & the Kenya Aflatoxicosis Investigation Group. (2005). Aflatoxin Contamination of Commercial Maize Products during an Outbreak of Acute Aflatoxicosis in Eastern and Central Kenya. Environmental Health Perspectives, 113(12), 1763-1767.

Lu, C., Xu, L., Wu, J., Wang, Z., Decat, P. & Zhang, W. H. (2012). Sexual and reproductive health status and related knowledge among female migrant workers in Guangzhou: a cross-sectional survey. Europian Journal of Obstetrics Gynecology Reproductive Biology, 160, 60-65.

Magan, N., Medina, A. & Aldred, D. (2011). Possible climate change effects on mycotoxin contamination of food crops pre and postharvest. Plant Pathology, 60(1), 150-163.

Manjula, K., Hell, K., Fandohan, P., Abass, A. & Bandyopadhyay, R. (2009). Aflatoxin and fumonisin contamination of cassava products and maize grain from markets in Tanzania and Republic of Congo. Toxin Reviews, 28(2–3), 63–69.

Marmot, M. (2002). The influence of income on health: Views of an epidemiologist. Health Affairs, 21, 31-46.

Peraica, M., Radic, B., Lucic, A. & Pavlovic, M. (1999). Diseases caused by molds in humans. Bulletins of the World Health Organization. (http://www.mold survivor.com/diseases_caused_by_molds_in_huma.html).

Selestin, N., Bendantukuka, T., Dismas, M. & Martin, K. (2016). Awareness of Aflatoxin Health Risks Among Parents with Children Aged Between 6-23 Months in Central Tanzania. International Journal of Nutrition and Food Sciences, 5(6), 429-436. doi: 10.11648/j.ijnfs.20160506.19.

Strosnider, H., AzzizBaumgartner, E., Marianne, B., Bhat, R. V., Breiman, R. & Brune. M. N. (2006). Public health strategies for reducing aflatoxin exposure in developing countries. Environmental Health Perspective, 114, 1898–903.

Sweeney, M. J. & Dobson, A. D. W. (1998). Mycotoxin production by *Aspergillus*, *Fusarium* and *Penicillium* species. International Journal of Food Microbiology, 43, 141–158.

Shankardass, K., Lofters, A., Kirts, M. & Quinonez, C. (2012). Public awareness of income-related health inequalities in Ontario, Canada. International Journal of Equity Health, 11, 26.
USDA. (1998). Wheat production up sharply, global stocks building in 1997/98. In: Wheat Yearbook, Economic Research Service/USDA, p. 1415, Mar. 1998.
Williams, J. H. (2011). Aflatoxin as a public health factor in developing countries and its Influence on HIV and other diseases. Peanut Collaborative Research Support Program, University of Georgia, World Bank Report #60371-AFR, 1–95.

Publisher's Note

Daagu International Journal of Basic and Applied Research remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.