AFLATOXINS AWARENESS STATUS IN A NIGERIAN UNIVERSITY

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Abstract
A survey was conducted to ascertain theaflatoxin awareness level among employeesofBabcock University, Nigeria, as a baselinestudyfor understanding the level of aflatoxin awareness within the Nigerian University System. Semi-structured self-administered questionnaires were used to collect data on respondents' socio demographics, knowledge abouthealth/economic impacts of aflatoxins, as well as respondents' perception on potential mitigation strategies against aflatoxin contamination. Although all respondents (n=200) had a minimum of Bachelor's degree, only 64%of them had prior knowledge about aflatoxins, with the majority of aflatoxin-aware respondents coming from science/health related faculties of the university. There was no direct correlation between awareness level and the educational qualification of employees. However, the percentage of unawareness was higher among female respondents, indicating a need to increase awareness levels within this populationthatismore involved domestically with food preparation and preservation. Eighty percent of aflatoxin-aware respondents (n=128) correctly attributed aflatoxin contamination to fungal infestation, but 14% of these responded that theywent ahead to consume fungal infested food after removing the mouldy parts. Aggressive public enlightenment is highly recommended for improving aflatoxin awareness levels across Nigeria, through collaborations among local and international governmental and non-governmental agencies.
Keywords: Aflatoxins, community awareness, food safety, fungal contamination, public health.

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1. INTRODUCTION

Aflatoxins are toxic secondary metabolites produced majorly by *Aspergillus flavus* and *Aspergillus parasiticus*, fungal species that grow optimally at 25°C and water activity of 0.75_{aw}(DeRuyck *et al.,* 2015; Hesseltine, 1976). Other aflatoxin-producing fungal species include *Aspergillusnomius, Aspergillus pseudotamarii, Aspergillusparvisclerotigenus*, *Aspergillus bombycis* section *Flavi*, *Aspergillusochraceoroseus*, *Aspergillus rambelli*isection *Ochraceorosei*, *Emericella astellata* and *E.venezuelensis*(Frisvad *et al.*, 2004; IARC,2002). These fungi contaminate alarge fraction of the world's food, majorly maize, rice, sorghum, barley, rye, wheat, peanut,groundnut, soya, cottonseed, and other derivative products, particularly in low-income countries (Caloniand Cortinovis, 2010; Masoero *et al.*, 2007; Rizzi *et al.*, 2003; Saleemullah *et al.*, 2006; Strosnider *etal.*, 2006).

Although aflatoxins, regarded as sanitary contaminants, have been a problemthroughout history, they were undocumented until 1960 when about one hundred thousand turkeys died in England from an acute necrosis ofthe liver and hyperplasia of the bile duct after consuming groundnuts infected with*A. flavus* (Asao *et al.*, 1965; D'Mello, 1997; Strosnider *et al.*, 2006). Williams and co-workers(2004) estimated that aflatoxins are ubiquitous and approximately 4.5 billion peoplewere exposed tothese carcinogens. Factors that contribute to aflatoxin contaminationinclude regional climate, innate crop characteristics, soil type and atmospheric moisture (Strosnider *et al.*, 2006).

One of the most dangerous aflatoxins is the aflatoxin B1 (AFB1), which has been classified by the International Agency for Research on Cancer (IARC), as a group 1 carcinogen due to itscapacity to incite liver cancer in humans. Of all dietary aflatoxins, AFB1 is the most prevalent aflatoxin usually implicated in cases of aflatoxicosis, and is responsible for acute and chronic toxicity, carcinogenicity, teratogenicity, genotoxicity and immunotoxicity(Williams *et al.*, 2004).

The need for enlightenment as an intervention strategy has been emphasized over the years with insignificant follow up.
A University setting, comprising large number of educated personnel is expected to constitute a pool that can teach the rest of the society. To achieve this aim, there was the need to investigate the awareness profile of each personnel and determine their state of compliance to standardsand preparedness to contribute to the overall intervention targeted at the less educated and economically challenged group in the society.Therefore, the aim of this study was to determine the level of aflatoxins awareness in the Nigerian University system, using Babcock University as a reference point.

2. MATERIALS AND METHODS

The study population was 200 selected by systemic sampling techniques. Data collection was by a semi-structured self-administered questionnaire. In total, 200 paper questionnaires were administered to and retrieved from respondents. The general demographic distributions of the respondents are presented in Table 1. A suitable scale was developed to measure the awareness level of each respondent about aflatoxins. The respondents' responses were recorded as either YES or NO against each questionnaire statement about general aflatoxin awareness. A unit score was given to each YES or NO answer. In addition, a number of statements were included in the questionnaire to measure the level of awareness of the respondents, about mold infestation of food products and its consequences. The answers to these statements were recorded on a three-point Likert-scale of 0 = Do not know, 1 = Agree, and 2 = Disagree (Likert, 1932).
Data analysis was by a descriptivestudy design used to determine the knowledge scores of respondents (Williams, 2006). Statistical significance was set at 0.05. Inferential statistics was used to test the p-value whichwas considered not significant when greater than 0.05. Data were based onfrequenciesand percentages of particular answers.

3. RESULTS AND DISCUSSION

Results

Thedemographic characteristics of the respondents are presented in Table 1. The majority (54%) of respondents were male within the age gap of25-35 years. All the respondents had at least a first University degree while 40% were educated up todoctorate level. Of the 144 academic staff interviewed, approximately 33% belonged to the rank of senior lecturer and above, while othersbelonged to lower academic ranks.In addition,approximately 36% of the non-academic staff interviewed (n=56) were professionals, including medical doctors, nurses, medical laboratory scientists, librarians and support staff.There was no significant difference in the distribution of respondents among the faculties (P = 0.950).
The general aflatoxins awareness levels among BU staff is depicted in Table 2. One hundred and twenty-eight (64%) of the respondents indicated that they hadpreviously heard about aflatoxins (aflatoxin-aware respondents), with approximately (ca.) 40% of these respondents stating that they became aware of aflatoxins through scientific journals, while newspaper print, electronic media and workshops accounted for the media of aflatoxin awareness for less than 30% of respondents. Over 50% of the respondents who had previously not heard about aflatoxins (n=72) attributed their unawareness to lack of awareness and disinterest since aflatoxin was not related to their field of work.On food and mouldiness, 61% of the aflatoxin-aware respondentsagreed that they have previously observed moulds on their food items.
In terms of physical manifestation of aflatoxin contamination, >60% of respondents indicated that physical appearance of food items, including discoloration, insect rot, unpleasant odour, softened fruit tissue, mouldy appearance and visible moisture on grains are possible indicators of fungal infestation and possible aflatoxin contamination.Eighty-two percent of these respondents further responded that they

discarded the mouldy foodsout rightly, while about 14% removed the infected parts and went ahead to consume the food.

The general aflatoxin awareness levels according to academic faculties, faculty status and gender of respondents are represented in Table3 and 4 respectively. Four academic faculties including, Computing & Engineering (CE), Law and Security Studies (LSS), Medicine, Public & Allied Health (PAH), and Science and Technology (SAT) had higher awareness percentages among the academic respondents, while the number of academic staff that were aware of aflatoxins was lower than unaware staff in Veronica Adeleke (VA), Education and Humanities (EAH), and Management Faculties (Table3). It was only in the Nursing Science (NS) Faculty, where equal numbers of aware and unaware academic staff were observed. Regarding non-academic staff, five faculties including VA, LSS, Management, NS and EAH had employeeswho were unaware of aflatoxins (Table3). Comparatively, there was no direct correlation between awareness level and the employee status of either academic or non-academic, as both groups comprised employees that were aware and unaware of aflatoxins. In addition, a higher percentage of unawareness was observed among the female respondents than the males (Table4).

The perception of theaflatoxin-aware respondents (n = 128)about the health and economic implications of aflatoxin in foods, as well as potential remedial strategies is presented in Table 5. Over 60% of the respondents agreed that cereals and peanut based foods are most susceptible to aflatoxin commination, which may negatively impact international trade of these products, especially if contamination levels exceed the acceptable limits of the importing countries.Regarding health implications of aflatoxins, > 40% of the 128 aflatoxin-aware respondents agreed that aflatoxins cause toxic-shock syndrome or aflatoxicoses, leading to a variety of symptoms in the consumers, including death. More than 64% of these respondents also agreed that, among other measures, preventing fungal contamination is crucialto the mitigation of aflatoxin contamination in food products.Lastly, the majority of the aflatoxin-aware respondents (>83%) agreed that farmers and public health enlightenment, as well as improvements in agricultural and industrial practices, are important strategies for reducing aflatoxin contamination to safeguard public health and improve agricultural trade (Table 5).

Discussion

Aflatoxin poses concerns on health and international trade from the standpoint of economically challenged nations.Globally, the importance of food safety cannot be overemphasized, as aflatoxins, which are toxic secondary metabolites of some fungal *Aspergillus* species, constitute a serious challenge to food safety and quality, as well as international trade. Consequently, several strategies have been proposed and are currently being implemented to reduce to acceptable levels, the aflatoxin contamination of crops and food products. However, critical to the successful implementation of these intervention strategies is the awareness of the exposed human population about the aflatoxin problem itself.

More than half of the respondents in this study who had no previous knowledge about aflatoxins agreed that they were very much interested in human and animal health issues, but attributed their ignoranceto lack of awareness campaigns and to the fact their disciplines had no relationship with aflatoxin-related issues. Awareness campaigns are expected to be a continuous strategy in the crusade for food safety. Of note is the higher percentage of ignorance among female respondents. This is a source of scare because they are more at home in handling preparation and storage. Therefore, not being adequately equipped in food safety ingredients means that awareness should be an attraction to relevant government regulatory and extension agencies.

Although 80% of the respondents identified fungi as the producersof aflatoxins 11.5% simply washed off the mouldy parts and then consumed the food. This is a risky practice

because fungal toxins may be present even in unmouldy parts of the food. Many respondents identified candidate crops as maize, rice, sorghum, barley, rye and wheat, peanut, groundnut, soybean, cottonseed, and their derivatives as susceptible food items as confirmed in earlier studies (Caloni and Cortinovis, 2010; Gimeno, 2004; Masoero *et al.*, 2007; Saleemullah *et al.*, 2006; Wild and Gong, 2010).

Aflatoxin B1, a major dietary aflatoxin, has the capacity to incite liver cancer in humans, thereby earning the placement of Group 1 carcinogen according to the International Agency for Research on Cancer (Chen *et al.*, 2001; Henry *et al.*, 2002; Omer *et al.*, 2004; Qian *et al.*, 1994; Wang *et.al.*, 1996).

Regarding food protection against aflatoxins, more than 50% of the respondents agreed that packaging food in air tight containers, sun drying food items or storing foods in moist or cold environment may discourage fungal infestation and subsequent aflatoxin contamination. More than 80% of the respondents also agreed that increasing public awareness and enlightening farmers about aflatoxins and fungi that produce them, as well as improving agricultural and industrial processes involved in food production and preservation, are important steps to be taken to mitigate the public health and economic problems that may be associated with aflatoxins in food.

Moreover, this outcome may not be representative of the society outside the university campus, as it was expected that the university employees were the educated elites of the society. However, although, thefocus of this study is one of the few known centers of interest in mycotoxin studies, this report can be adopted in constructing an awareness map on aflatoxin in Nigeria's higher institution. It is recommended that sufficient resources be committed to improving aflatoxin awareness levels across the Nigeria, through public enlightenment campaigns. This can be jointly promoted by local and international NGOs, regional bodies and other stakeholders.

Table 1. Surveillance study on aflatoxin awareness among respondents

Parameter	**Category**	**Frequency: N=200**	**Percentage %**
Sex:	Male	108	54.0
	Female	92	46.0
Age:	25-35 years	85	42.5
	36-45 years	57	28.5
	46-60 years	45	22.5
	61-80 years	13	6.5
Qualifications:	B.Sc.	51	25.5
	M.Sc.	55	27.5
	Ph.D.	80	40.0
	MBBS	8	4.0
	L.L.B	4	2.0
	L.L.M	2	1.0
Status			
	Teaching staff	144	72.0
	Non-teaching staff	56	28.0
Academic Staff	**Rank**		
	Assistant lecturer	35	17.5
	Lecturer 2	40	20.0
	Lecturer 1	22	11.0
	Senior Lecturer	21	10.5
	Associate professor	11	5.5
	Professor	15	7.5

Non-teaching Staff	**Designation**		
	Secretary	11	5.5
	Research Assistant	3	1.5
	Office Assistant	7	3.5
	Administrative staff	15	7.5
	Librarian	1	0.5
	Med lab technologist	8	4
	Nurses	3	1.5
	Doctor	6	3
	Registrar	1	0.5
	Driver	1	0.5
Faculty:	Education and Humanities	24	12
	Management and Science	21	10.5
	Science and Technology	21	10.5
	Public and Allied health	22	11
	Nursing Sciences	15	7.5
	Law and Security Studies	24	12
	School of Medicine	24	12
	Computing and Engineering school	24	12
	Veronika Adeleke School	23	11.5

P = 0.950 Statistical significance = 0.05 $P_A > P$

Table 2. Response pattern of the respondents on aflatoxin awareness

	Questions	YES	NO
1	**Have you ever heard about aflatoxins? (fungi/moulds)**	128(64.0%)	72(36.0%)
2	**If yes, how did you hear about it?**		***N*=128**
	• *Scientific journals*	50(39.1%)	78(60.9%)
	• *Electronic media*	28(21.9%)	100(78.1%)
	• *Workshop*	32(25.0%)	96(75.0%)
	• *Newspaper*	20(15.6%)	108(84.4%)
	• *Other means- School*	33(25.8%)	95(74.2%)
3	**If No, why the lack of knowledge until this time?**		***N*=72**
	Reasons for lack of knowledge	**Yes**	**No**
	• *No awareness campaigns*	53(75.0%)	18(25.0%)
	• *Not interested in animal and human health*	4(5.6%)	68(94.4%)
	• *Not in my field so less bothered*	61(84.7%)	11(15.3%)
			***N*=128**
4	**Aflatoxins are produced by fungi/moulds**	**Yes**	**No**
		102(79.7%)	26(20.3%)
5	**Have you ever observed moulds on your food items?**	**Yes**	**No**
		122(61.0%)	78(39.0%)
6	**If yes, what did you do to with the food?**		***N*=122(%)**
		Yes	**NO**
	• *Discarded it*	100(82.0%)	22(18.0%)

	• *Washed and then ate it*	14(11.5%)	107(88.5%)
	• *Gave it to children*	2(1.6%)	120(98.4%)
	• *Gave it to animals*	9(7.4%)	113(92.6%)
	• *Sorted out infected parts and then consumed it*	14(11.5%)	108(88.5%)

N = number of respondents that answered particular questions

Table 3: Responsepattern of respondents

				N=128
	Statement	**AGREE**	**DISAGREE**	**DON'T KNOW**
1	Foods items mostly affected by aflatoxins are cereals and peanut based foods	74 (57.8%)	26 (20.3%)	28 (21.9%)
2	Economically, Aflatoxin contamination of food produce may negatively impact international trade	94 (73.4%)	6(4.7%)	28(21.9%)
3	Countries have acceptable limits for aflatoxins in imported and exported food items/ food produce	78(60.9%)	13(10.2%)	37(28.9%)
4	Physical appearance of food items is a possible indicator of fungal infestation and possible Aflatoxin contamination	99(77.3%)	4(3.1%)	25(19.5%)
5	**The following physical attributes of food/food item may indicate fungal infestation and possible aflatoxin contamination**			
	• *Discoloration*	108(84.3%)	1(0.8%)	19(14.8%)
	• *Insect rot (insect activity)*	88(68.5%)	12(9.4%)	28(21.9%)
	• *Unpleasant odour*	104(81.2%)	7(5.5%)	17(13.3%)
	• *Softening of fruit tissue e.g orange rind*	108(84.3%)	4(3.1%)	16(12.5%)
	• *Mouldly appearance on food surface*	108(84.3%)	4(3.1%)	16(12.5%)
	• *Visible water vapour on grains*	95(74.2%)	5(3.9%)	28(21.9%)
6	**Aflatoxin is the cause of a toxic syndrome known as aflatoxicosis**	78(60.9%)	5(3.9%)	45(35.2%)
7	**The symptoms of aflatoxicosis may include**			
	• *Anorexia (loss of appetite)*	65(50.8%)	5(3.9%)	58(45.3%)
	• *Malaise (depression)*	57(44.5%)	8(6.3%)	63(49.2%)
	• *Low-grade fever*	61(47.7%)	9(7.0%)	58(45.3%)
	• *Jaundice (yellowing of th eskin)*	57(44.5%)	8(6.3%)	63(49.2%)
	• *Fulminant hepatic failure (sudden liver failure)*	54(42.2%)	6(4.7%)	68(53.1%)
	• *Cancer*	50(39.1%)	11(8.6%)	67(52.3%)
	• *Immunologic suppression*	54(41.4%)	8(6.3%)	67(52.3%)
	• *Impaired growth*	57(44.5%)	6(4.7%)	65(50.8%)
	• *Nutritional interference (hindrance)*	64(50.0%)	5(3.9%)	59(46.1%)
	• *Death*	71(55.5%)	5(3.9%)	52(40.6%)
8	Fungal contamination is perquisite for aflatoxin contamination i.e. without fungi there will be no aflatoxins in food	83(64.9%)	4(3.1%)	41(32.0%)
9	By preventing fungal infestation, we also prevent aflatoxin contamination of food products	90(70.3%)	5(3.9%)	33(25.8%)
10	**How much do you agree that the following methods of storing food items influence fungal infestation and subsequent aflatoxin contamination?**			
	• *Packaging food in airtight containers*	83(64.8%)	17(13.3%)	28(21.9%)
	• *Inadequate Sun drying food items*	84(65.6%)	17(13.3%)	27(21.0%)
	• *Keeping food in moist or cold environment*	88(68.8%)	11(8.6%)	29(22.6%)
	• Inadequate storage of food items	88(68.8%)	11(8.6%)	29(22.6%)

11	**How much do you agree that the under listed measures will help mitigate the public health challenges associated with aflatoxins in food**			
	• *Increasing public awareness*	107(83.6%)	1(0.8%)	20(15.6%)
	• *Farmer' enlightenment about Aflatoxins and fungi that produce them*	108(84.4%)	1(0.8%)	19(14.8%)
	• *Improvement of agricultural and industrial processes involved in food production and preservation*	109(85.2%)	2(1.6%)	17(13.3%)

N = number of respondents that answered particular questions

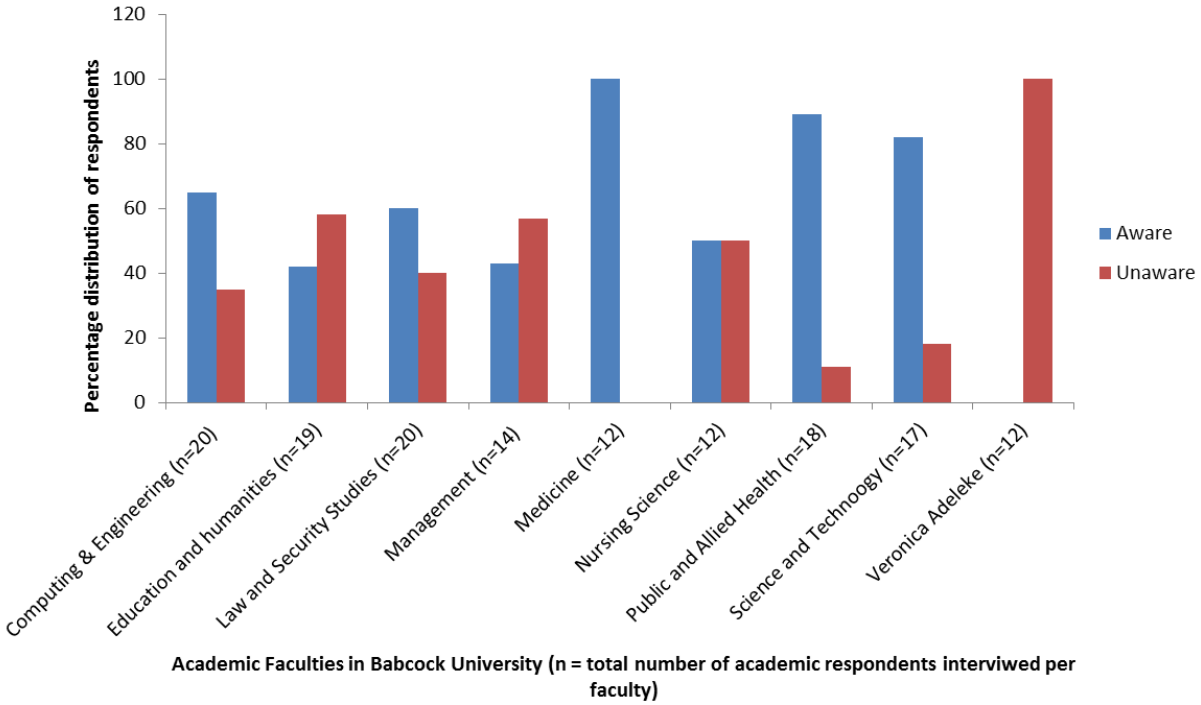

Fig. 1 Aflatoxin awareness profile among academic staff

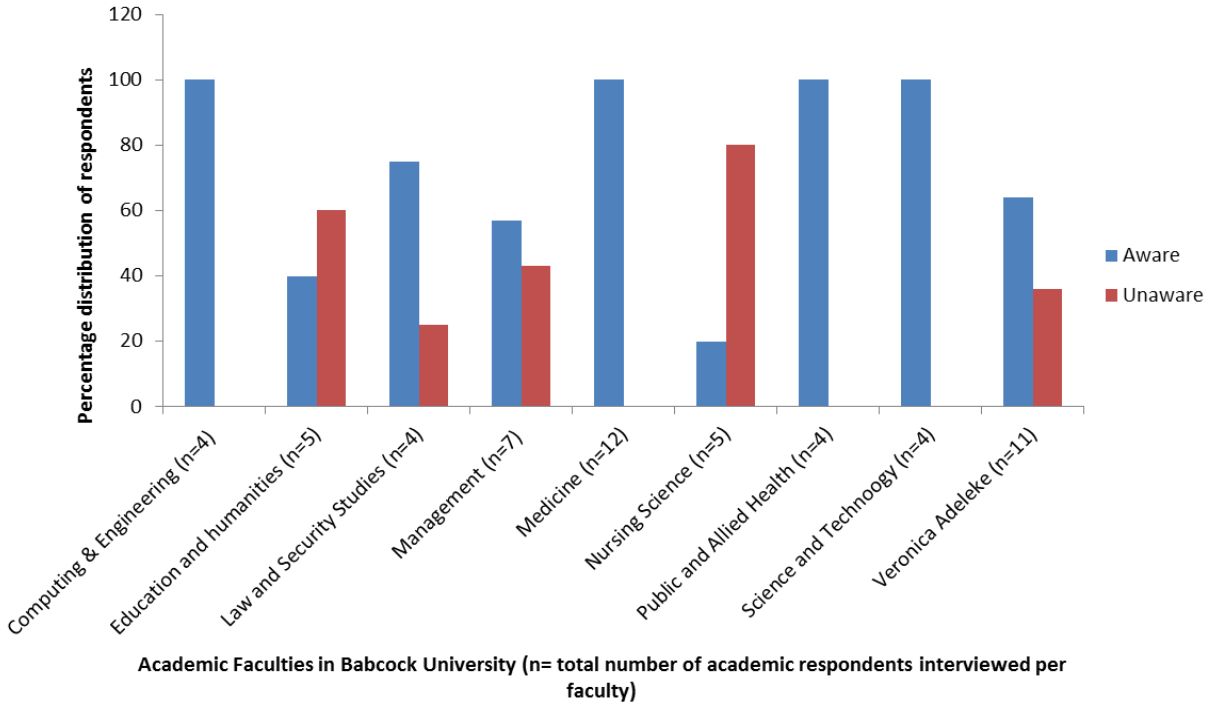

Fig. 2 Aflatoxin awareness profile among non-academic staff

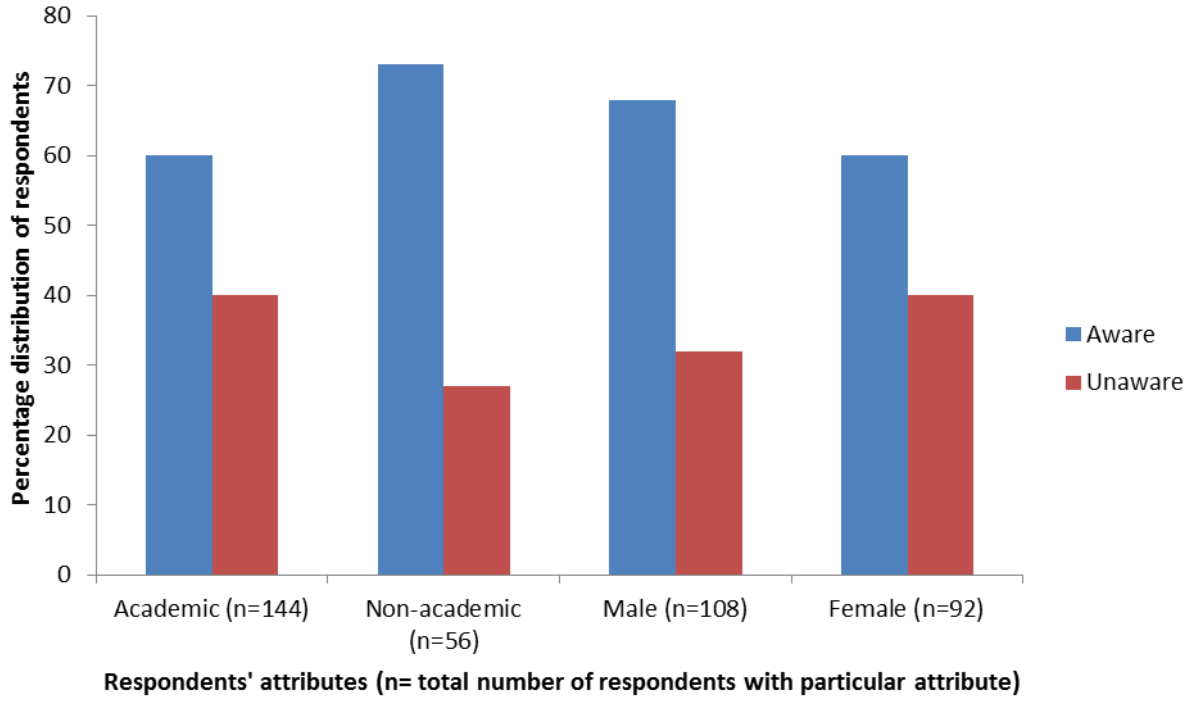

Fig. 3 Aflatoxin awareness profile according to staff status and gender

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