UNIVERSITI PUTRA MALAYSIA

STAKEHOLDERS' KNOWLEDGE, ATTITUDE, AND PRACTICES IN RELATION TO MINIMIZING AFLATOXINS CONTAMINATION IN PEANUT-BASED PRODUCTS

NUR NAZURAH BINTI MOHD AZAMAN

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By

NUR NAZURAH BINTI MOHD AZAMAN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia in Fulfillment of the Requirements for the Degree of Master of Science

December 2017

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DEDICATION

This thesis is dedicated to my beloved husband Muhammad Syafiq bin Musa, my daughter, my family members and friends, which always besides me through thick or thin during until completed my study.

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Abstract of thesis presented to the Senate Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

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December 2017

Chairperson : Associate Professor Nitty Hirawaty Kamarulzaman, PhD
Faculty : Agriculture

Aflatoxins are carcinogens produced by *Aspergillus flavus* and *A. parasiticus* that commonly found in agricultural commodities particularly peanut and occurring found in human foods and animal feeds. Aflatoxins are one of the food contaminants, which have been the important issues and reported widely in many developing countries such as India and China. However, the issues on aflatoxins are still new among food stakeholders in Malaysia. Health issues that affect to human and animals take place almost every day. Unfortunately, only a few people know about the effects and risks from aflatoxins contamination to human health. Knowledge of the danger of aflatoxins contamination in peanuts-based products is still lacking among food stakeholders. The government of Malaysia concerned on the health issues that have been increasing these days relating to aflatoxins. Therefore, both public and private agencies have taken several steps to increase their surveillance and investigation towards only good quality of imported peanuts will reach to the Malaysian markets. Thus, the objective of this study was to determine the food supply chain stakeholders' knowledge, attitude, and practices (KAP) in relation to minimizing aflatoxins contamination in peanut-based products.

A total of 111 respondents of peanut-based products companies located in selected stated in Peninsular Malaysia were the respondents of this study. Stratified random sampling was used involving importers, large and small-scale manufacturers, and retailers as the main groups of stakeholders. Face-to-face interviews were conducted with the respondents using a structured questionnaire. The data was analysed using descriptive analysis, KAP analysis, analysis of variance (one-way ANOVA), Pearson correlation, factor analysis, and logistic regression analysis.

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Based on the overall results of KAP analysis revealed that 68.5% of peanut stakeholders showed inadequate knowledge about aflatoxins contamination. The knowledge level was determined based on overall score. Among the stakeholders, 84.7% showed favourable attitude toward reducing aflatoxins contamination. The result also indicated that 55.8% of stakeholders had low level of hygiene practices to minimize aflatoxins contamination in peanut-based products.The findings based on the analysis of variance (one-way ANOVA) showed that knowledge and practices levels found differences among four groups of stakeholders. The knowledge level between importers and large-scale manufacturers were showed difference with small-scale manufacturers and retailers. In addition, hygiene practices between importers and large-scale manufacturers were significant difference compared to the other stakeholder groups. However, the hygiene practices indicated no difference between small-scale manufacturers and retailers.The Pearson correlation result showed that the knowledge level and attitude of importers were positively correlated with scores 0.833 on attitude and practices with scores 0.830. The knowledge level and practices of large-scale manufacturers showed positively correlated with the score of 0.635. To add too, the knowledge and attitude of retailers showed positively correlated with the score of 0.563. Meanwhile, the results from factor analysis found that there were three main factors that influenced the hygiene practices level in minimizing aflatoxins contamination namely material handling, distribution and processing, and storage. Finally, the result from logistic regression analysis proved that knowledge about aflatoxins, employee training, material handling, distribution and processing, and storage were identified to be significant variables that influenced stakeholders' hygiene practices in reducing aflatoxins formation in peanut-based products. However, the most influential factor that affecting stakeholder' hygiene practices in relation to minimizing aflatoxins contamination in peanut-based products were on knowledge about aflatoxins.

The result obtained from this study has clearly showed that stakeholders in the peanut-based products supply chain should implement good practices to reduce aflatoxins contamination. They should also be more aware on aflatoxins since peanut can be easily contaminated and it is difficult to see using naked eyes unless by analyzing in the laboratory to check on the existence of aflatoxins in peanut. Besides that, stakeholders should implement continuous hygiene and training programs, education, and attending seminars as these are deemed necessary to educate peanut-based stakeholders. Provided continuous training programs may be improved and revealed to have significant effects on stakeholders' KAP levels as well as their awareness on food safety towards hygiene practices in the workplace.

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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

PENGETAHUAN, SIKAP DAN AMALAN PIHAK BERKEPENTINGAN KE ARAH MENGURANGKAN PENCEMARAN AFLATOKSIN DALAM KACANG TANAH

Oleh

NUR NAZURAH BINTI MOHD AZAMAN

Disember 2017

Pengerusi : Profesor Madya Nitty Hirawaty Kamarulzaman, PhD
Fakulti : Pertanian

Aflatoksin adalah bersifat karsinogen yang dihasilkan oleh kulat *Aspergillus flavus* and *A.parasiticus* yang kebiasaannya ditemui dalam komoditi pertanian teruatamanya di dalam kacang tanah dan sering terjadi di dalam makanan manusia dan makanan ternakan. Kebanyakannya negara-negara membangun seperti India dan China sering melaporkan isu-isu penting secara meluas mengenai aflatoksin kerana ianya merupakan salah satu bahan cemar di dalam makanan. Walaubagaimanapun, isu-isu tentang aflatoksin masih lagi baru di kalangan pihak berkepentingan di Malaysia. Hampir setiap hari sering berlaku isu-isu berkaitan kesihatan. Malangnya, hanya segelintir masyarakat sahaja yang mengetahui tentang kesan dan risiko tentang pencemaran aflatoksin kepada kesihatan manusia. Tahap pengetahuan masih kurang di kalangan pihak berkepentingan mengenai bahaya pencemaran aflatoksin dalam produk berasaskan kacang tanah. Kerajaan Malaysian sangat menitikberatkan tentang peningkatan isu kesihatan yang berkaitan dengan aflatoksin. Oleh itu, agensi awam dan swasta perlu mengambil beberapa langkah dalam meningkatkan pengawasan dan penyiasatan iaitu hanya kualiti kacang tanah yang baik sahaja diimpot ke dalam pasaran Malaysia. Maka, objektif asas kajian ini adalah untuk menentukan tahap pengetahuan, sikap dan amalan pihak yang terlibat dalam rantaian bekalan makanan ke arah mengurangkan pencemaran aflatoksin dalam produk berasaskan kacang tanah.

Seramai 111 responden yang terlibat dalam kajian ini dari negeri-negeri yang terpilih di Semenanjung Malaysia. Persampelan secara rawak strata yang melibatkan kumpulan utama pihak berkepentingan iaitu pengimpot, pengeluar berskala besar dan kecil serta peruncit. Temubual secara bersemuka telah dijalankan bersama responden dengan menggunakan borang kaji selidik berstruktur. Data kemudian dianalisis dengan

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menggunakan analisis deskriptif, analisis varians (satu-hala ANOVA), analisis korelasi Pearson, analisis faktor, dan analisis regresi logistik.

Berdasarkan keputusan bagi jumlah keseluruhan analisis KAP menunjukkan bahawa 68.5% responden berpengetahuan tentang pencemaran aflatoksin. Tahap pengetahuan telah ditentukan berdasarkan markah keseluruhan. Antara responden, seramai 84.7% menunjukkan sikap yang baik ke arah mengurangkan aflatoksin. Hasil kajian juga menunjukkan bahawa 55.8% responden mempunyai tahap rendah bagi amalan kebersihan dalam mengurangkan pencemaran aflatoksin dalam kacang tanah. Hasil kajian berdasarkan analisis varians (satu-hala ANOVA) menunjukkan bahawa tahap pengetahuan dan amalan menunjukkan perbezaan antara empat kumpulan pihak berkepentingan. Antara pengimpot dan pengeluar berskala besar menunjukkan tahap pengetahuan yang berbeza dengan pengeluar berskala kecil dan peruncit. Di samping itu, antara pengimpot dan pengeluar berskala besar menunjukkan perbezaan tahap amalan kebersihan berbanding dengan kumpulan responden yang lain. Walaubagaimanapun, tahap amalan kebersihan menunjukkan tiada perbezaan antara pengeluar kecil dan peruncit. Hasil kajian dari analisis korelasi Pearson menunjukkan bahawa tahap pengetahuan dan sikap pengimpot adalah positif dengan skor 0.833, dan tahap sikap dan amalan dengan skor 0.830. Bagi tahap pengetahuan dan amalan pengeluar berskala besar menunjukkan positif dengan skor 0.635. Bagi tahap pengetahuan dan sikap peruncit menunjukkan positif dengan skor 0.563. Selain itu, keputusan bagi analisis faktor mendapati terdapat tiga faktor utama yang mempengaruhi tahap amalan kebersihan dalam mengurangkan aflatoksin iaitu pengurusan bahan, pengedaran dan pemprosesan, serta penyimpanan. Akhir sekali, hasil daripada analisis regresi logistik membuktikan bahawa tahap pengetahuan tentang aflatoksin, latihan kepada pekerja, pengendalian bahan, pengedaran dan pemprosesan, serta penyimpanan dikenalpasti sebagai pemboleh ubah yang penting dalam mempengaruhi amalan kebersihan responden mengurangkan pembentukan aflatoksin dalam produk kacang tanah. Walaubagaimanapun, faktor yang paling mempengaruhi menunjukkan tahap pengetahuan tentang aflatoksin membantu dalam mengurangkan aflatoksin dalam kacang tanah.

Keputusan yang diperoleh daripada kajian ini jelas menunjukkan bahawa pihak yang berkepentingan dalam rantaian bekalan berasaskan kacang tanah harus melaksanakan amalan baik dalam mengurangkan aflatoksin di dalam kacang tanah. Mereka juga haruslah lebih sedar bahawa aflatoksin dalam kacang tanah boleh dicemari dan sukar untuk dilihat dengan mata kasar melainkan dengan menjalani proses analisis di makmal untuk memeriksa kewujudan aflatoksin dalam kacang tanah. Di samping itu, pihak berkepentingan digalakkan untuk melaksanakan program kebersihan dan latihan yang berterusan, pendidikan serta menghadiri seminar yang dianggap perlu untuk meningkatkan pengetahuan terhadap pencemaran aflatoksin. Secara tidak langsung, program latihan yang berterusan dapat dipertingkatkan dan ini dapat membuktikan memberi kesan yang signifikan terhadap tahap KAP pihak berkepentingan serta kesedaran tentang keselamatan makanan terhadap amalan kebersihan di tempat kerja.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of Supervisory Committee were as follows:

Nitty Hirawaty Kamarulzaman, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Datuk Mad Nasir Shamsudin, Professor PhD
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Jinap Selamat, Professor PhD
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Member)

_____
ROBIAH BINTI YUNUS, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

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Name of Chairman of
Supervisory Committee: Nitty Hirawaty Kamarulzaman

Signature: _____
Name of Member of
Supervisory Committee: Mad Nasir Shamsudin

Signature: _____
Name of Member of
Supervisory Committee: Jinap Selamat

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LIST OF ABBREVIATIONS

AFB_1	Aflatoxin B_1
AF_s	Total Aflatoxins
ANOVA	Analysis of Variance
DOA	Department of Agriculture
EFA	Exploratory Factor Analysis
FAO	Food and Agriculture Organization
GAP	Good Agriculture Practice
GMP	Good Manufacturing Practice
IARC	International Agency for Research on Cancer
KMO	Kaiser-Mayer-Oklin
MOH	Ministry of Health
SD	Standard Deviation
SPS	Sanitary and Phytosanitary
SPSS	Statistical Package for the Social Science
WHO	World Health Organization

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CHAPTER 1

INTRODUCTION

The discussion in this chapter includes an introduction on peanut food industry, problem statement, research questions, and objectives of the study. An introduction to food crop industry, food contamination in peanut and its effect on the human and animal are discussed in this section. The problem occurs in the peanut consumption is explained in the problem statement. The research questions become the parameter for creating the objectives of this study. The significance of the study is debated to show the impact of the study to the related entities.

1.1 World Peanut Industry

Legumes is in the third rank of the world crop production in which the major constraint to crop productivity is attributed to biological (biotic) and environment (abiotic). Peanut which is also known as groundnut (*Arachishypogaea* L.) is a major oilseed crop in the world, for both oil and function as one of the source of protein. A study argued that peanut plant has become one among the most beneficial crops and principal oilseeds in the world (Sunkara, Bhatnagar-Mathur, & Sharma, 2014). It is also an annual soil enriching, a nitrogen-fixing legume, adapted to a diversity of soils and temperature zone around the world. Generally, peanut is known as nature's masterpiece of food value and most of the people enjoy the pleasant aroma, irresistible nutty flavor and smooth crisp texture of roasted peanuts. To add more, peanuts are sold fresh in a form of vegetable, canned food, roasted in shell, salted and has been used in more than 50 confections.

The world peanut production showed a good record as the groundnut is ranked the 13th most important food crop of the world. It has been recorded as the 4thmost important source of edible oil and the 3rd most important source of vegetable protein the world. In 2004, the groundnut was grown on 24 million hectares worldwide with a total production of 36 million metric tons. It is estimated that about 65% of the crop produced in the world is crushed to extract groundnut oil and the remaining is used in making other edible products (Pound & Phiri, 2010). The main world producers of groundnut are China, India and the USA, although in terms of exports China and Argentina are ranked the 1st and the 2nd. Meanwhile, the European Union (EU), Canada and Japan are the main importers of groundnut (Pound & Phiri, 2010).

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According to the latest data from Nuts and Dried Fruits Global Statistical Review (2016), global peanut production has been estimated at almost 39.5 million MT in 2015/16, which increased by 15% compared with 2005/6. China was the major producer of peanut in the last decade, registering 16.7 million MT only in the 2015/16crops. Table 1.1 shows the world peanut production in-shell basis for ten (10) years in metric tons (MT) from the year 2006 – 2015.

Table 1.1: World Peanut Production In-shell Basis from 2006 – 2015

Year	Production (metric tons)
2006	33,407,356
2007	31,736,990
2008	34,559,800
2009	30,757,000
2010	33,548,000
2011	35,796,300
2012	37,170,000
2013	39,833,000
2014	38,892,000
2015	39,449,000

Source: Nuts and Dried Fruits Global Statistical Review (2016)

India was the leading exporting country of peanut in 2014. Vietnam was clearly as the top destination of India's peanut, which roughly around 45% of the total. The second largest exporter was United States of America, in which they have been shipped more than 269,483 MT of shelled peanut. Table 1.2 represents the world peanut export (shelled) in metric tons (MT) for nine (9) years from the year 2004 – 2014.

Table 1.2: World Peanut Export Shelled from 2004 – 2014

Year	Export (metric tons)
2004	1,432,687
2005	1,716,767
2006	1,501,580
2007	1,558,804
2008	1,528,781
2009	1,309,364
2010	1,257,325
2011	1,625,377
2012	1,395,446
2013	1,521,562
2014	1,651,043

Source: Nuts and Dried Fruits Global Statistical Review (2016)

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Table 1.3 designates the world peanut imports grew year by year started from 2005 to 2014. Table 1.3 marks Indonesia at the highest rank among others with the amount of 205,031 MT in 2014. Netherland was the largest peanut import in 2014, which was roughly around 180,147 MT and followed by Vietnam 168,599 MT. Other leading peanut importer countries were Mexico, Germany, Canada and Malaysia. However, in the data given showing that Malaysia was placed in the seventh largest peanut imports, which has shown a steady increase year by year.

Table 1.4 shows the world peanut consumption has increased from the year 2010 to year 2014. The world leading peanut consumption was China amounted for 16,636,003 MT and followed by India, which amounted for 4,247,948 MT in 2014. Other leading peanut consumptions were Nigeria, Unites States of America, Indonesia, and Vietnam. Based on Table 1.4, Malaysia peanut consumption was about 70,390 MT in 2014 after Germany and South Africa.

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Table 1.3: World Peanut Imports for 2005-2014 (metric tons)

Country	Imports (metric tons)									
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Indonesia	113,605	146,998	153,404	145,366	133,681	216,273	280,231	161,035	208,082	205,031
Netherlands*	271,284	248,894	265,642	273,279	244,298	154,346	156,494	135,722	171,769	180,147
Vietnam	7,461	10,247	1,197	2,692	1,564	2,102	149,310	259,703	130,212	168,599
Mexico	87,886	88,756	106,100	67,893	95,246	83,740	107,079	93,720	95,967	109,787
Germany	63,082	47,763	50,381	51,951	31,051	41,295	65,787	83,512	96,545	92,024
Canada	74,838	78,711	75,782	115,405	83,388	73,929	87,221	74,326	83,369	87,595
Malaysia	58,077	40,086	49,087	48,352	47,711	93,477	99,836	76,303	58,365	72,336
Russian Fed.	107,410	82,971	72,634	54,712	69,672	61,084	73,750	47,998	66,059	71,198
Philippines	52,020	56,162	56,602	35,444	42,424	57,760	54,273	58,043	57,764	70,390
UK	122,869	107,950	106,639	71,059	71,294	57,820	76,726	47,560	71,772	69,123
Algeria	40,641	35,090	29,705	23,202	44,898	23,370	30,607	15,375	41,177	40,354
China	1,139	6,586	7,672	15,963	7,582	16,854	49,607	17,628	20,435	36,848
Thailand	15,926	16,708	23,696	27,866	25,874	31,790	36,547	25,915	29,536	36,235
Japan	42,280	43,843	36,137	38,513	28,962	27,626	29,203	13,030	25,912	29,087
Poland	52,098	37,404	34,869	28,788	30,649	16,096	20,339	24,829	31,139	28,810
Ukraine	41,315	29,826	30,683	23,484	15,585	25,273	25,583	12,958	21,090	14,903
Kenya	560	453	1,506	3,721	5,033	7,318	9,356	3,178	18,142	14,607
Spain	34,885	30,139	29,717	30,428	14,910	8,657	11,230	12,472	16,326	11,396
South Africa	14,899	25,487	21,836	11,729	11,869	1,878	8,305	5,232	18,214	8,450
Others	431,168	335,561	383,269	355,380	270,772	245,211	253,893	204,929	259,686	304,122
Total	**1,633,443**	**1,469,635**	**1,536,558**	**1,425,227**	**1,276,463**	**1,245,899**	**1,625,377**	**1,373,468**	**1,521,562**	**1,651,043**

*Transit country

*Total consumption expressed in kg per person. Based on UN Statistics Division (UNSD) population census.

Source: Nuts and Dried Fruits Global Statistical Review (2016)

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Table 1.4: World Peanut Consumption for 2010-2014 (metric tons)

Country	2010		2011		2012		2013		2014	
	Consumption (MT)	Consumption/cap/kg/year*	Consumption (MT)	Consumption/cap/kg/year*	Consumption (MT)	Consumption/cap/kg/year*	Consumption (MT)	Consumption/cap/kg/year*	Consumption (MT)	Consumption/cap/kg/year*
China	14,491,284	10.88	15,934,643	11.96	16,462,347	12.36	16,421,641	12.28	16,636,003	12.14
India	5,941,258	5.24	5,293,941	4.67	4,339,061	3.83	5,096,543	4.31	4,247,948	3.35
Nigeria	1,550,029	11.59	1,550,104	11.59	1,550,930	11.60	3,000,000	21.43	2,999,992	16.81
USA	1,875,125	6.22	1,760,026	5.84	2,116,879	7.02	1,992,756	6.45	2,213,881	6.94
Indonesia	1,466,273	6.50	1,526,649	6.77	1,272,932	5.64	1,365,917	5.83	1,367,024	5.41
Vietnam	552,102	6.48	568,310	6.67	743,703	8.73	667,212	7.68	648,599	7.19
Brazil	213,348	1.14	229,780	1.23	226,410	1.21	279,472	1.45	287,614	1.42
Mexico	265,390	2.51	179,345	1.70	159,546	1.51	204,399	1.90	212,601	1.72
Nicaragua	53,838	9.62	46,568	8.32	42,975	7.68	59,594	0.46	70,986	0.50
Canada	73,858	2.24	87,086	2.64	74,326	2.25	83,350	1.05	82,574	1.02
Germany	38,573	0.47	60,749	0.74	74,481	0.91	85,616	2.44	87,543	2.48
South Africa	35,679	0.74	91,649	1.90	107,880	2.23	103,879	10.25	115,852	18.78
Malaysia	91,364	3.36	97,375	3.58	74,780	2.75	58,020	0.61	70,390	0.70
Russia	60,938	0.43	73,547	0.52	47,819	0.34	66,059	2.05	72,182	2.39
Philippines	57,760	0.65	54,273	0.61	58,043	0.65	57,764	1.14	68,396	1.07
UK	56,110	0.92	75,288	1.24	46,782	0.77	71,103	2.08	78,697	1.50
Algeria	23,370	0.69	30,607	0.90	15,375	0.45	41,177	1.14	40,354	1.01
Thailand	31,323	0.47	35,947	0.54	25,867	0.39	29,491	0.20	29,070	0.23
Japan	27,544	0.22	29,120	0.23	13,030	0.10	25,903	0.81	28,276	0.74
Poland	15,257	0.40	19,729	0.52	24,590	0.65	30,763	0.44	36,192	0.54
World Total	**33,766,565**	**4.90**	**36,230,900**	**5.25**	**35,990,518**	**5.22**	**35,990,513**	**5.78**	**39,144,000**	**5.43**

*Total consumption expressed in kg per person. Based on UN Statistics Division (UNSD) population census.

Source: Nuts and Dried Fruits Global Statistical Review (2016)

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1.2 Peanut Industry in Malaysia

Grain legumes play an important role in human nutrition as one of the sources of protein, vitamins, and minerals. In a nutritional point of view, chickpea, pigeon pea, soybean and peanut are the most vital legumes for million people in semiarid and tropical regions of the world (Singh & Singh, 1992). Nevertheless, peanut has become as one of the significant source of protein and fat in the developing country, for instance is Malaysia. To add more, peanut can also be used for different purposes such as food (raw, roasted or boiled seeds, cooking oil), animal feed (pressings, seeds, green material, straw) and industrial raw material (soap, detergent, cosmetics). Peanut seed comprises 40% – 50% of fat, 20% – 50% of protein, and 10% – 20% of carbohydrate (Maiti, Satya, Rajkumar, & Ramaswamy, 2012). The peanut seed acquires a high nutritional and commercial value due to the existence of the protein, carbohydrates, fatty acids, fibers, vitamins, calcium, and phosphorus (Friedman, 1996).

Peanut is not the primary food in Malaysia, yet it always comes in a form of snack, side dish, a part of the local cuisine and it has been consumed in a large portion quantity per individual. Hashim, Mohd Din, Karim, Md. Yusof, and Mohd Ngadikin (2006) and Azrandeh, Selamat, and Lioe (2010) reported that the estimated mean of peanut intake by Malaysia is 56.90 g of peanut per day. The same study also noted that demand and consumption for peanuts are increasing progressively over the years. Thus, it is proven to the extent that Malaysians are susceptible to the risks effects from aflatoxins due to the ready availability of peanuts and peanut-based products throughout the country's retail markets and supermarkets.

Peanuts have also been used in a variety of popular Malaysian dishes such as satay (beef or chicken with peanut sauce) and rempeyek (traditional cracker) (Sulaiman, Chye, Hamid, & Yatim, 2007).Data statistics from the Department of Agriculture (DOA) Malaysia in Table 1.5 indicates the Malaysia's Groundnut Import and Export from year 2014to year 2016 in metric tons. Data statistics showed that Malaysia have imported and exported groundnut rapidly increased year by year, as to reach the demand and consumption from Malaysia population. Thus, this data statistics revealed that majority of population in Malaysia have consumed peanuts in a high rate over the years.

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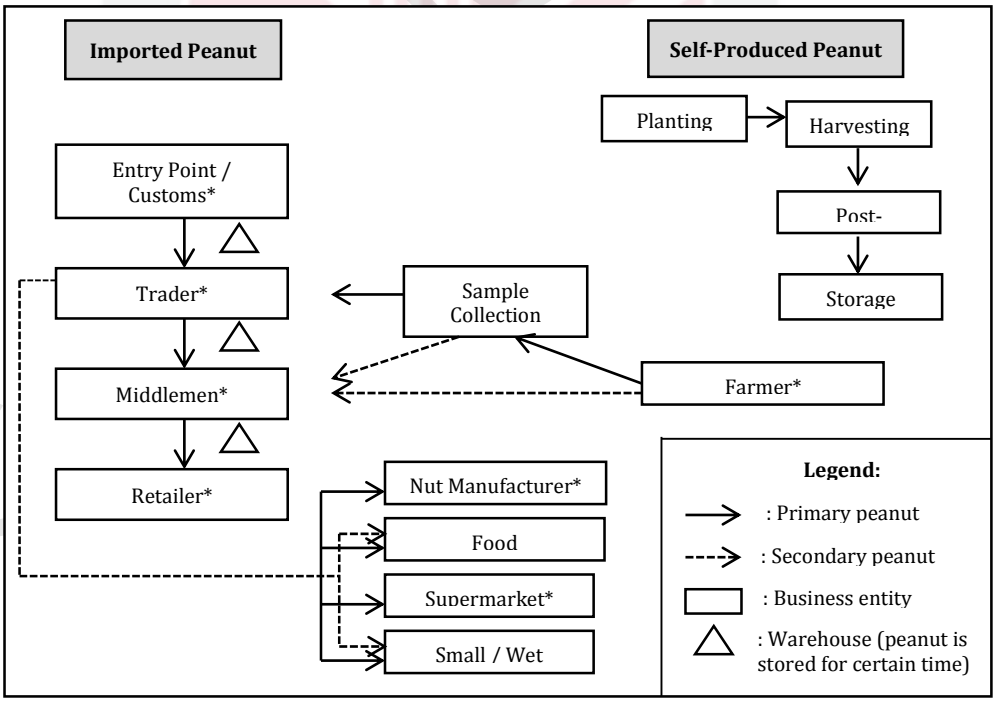
Table 1.5: Malaysia Groundnuts Import and Export in 2014 – 2016 (metric tons)

Groundnut (Shelled)	2014	2015	2016
Groundnuts Import not roasted or otherwise cooked, whether or not broken	54,283,591	146,311,649	175,624,660
Groundnuts Export not roasted or otherwise cooked, whether or not broken	597,331	3,542,646	2,674,165

Source: Department of Agriculture, Malaysia (2017)

1.3 Flow of Peanut Chain in Malaysia Industry

Food supply chain usually is basically referring to the nourishment from farm to end consumers. Besides, food supply chain also involves many different types of processes and procedures including food manufacturers, processing, distribution, transportation, packaging, and retail stores before reaching to the consumers (Levinson, 2010). Today's peanut is cultivated on a large-scale production and the greatest peanut producers are China, India, and Africa.



Source: Norlia, et al. (2017)

Figure 1.1: Supply Chain of Peanut in Malaysia

Figure 1.1 shows the two types of peanut supply chain in Malaysia for domestic market, namely imported peanut and self-produced peanut (Norlia et al., 2017). Most of the peanut supplies are imported from countries such as China, India and Vietnam (MOH, 2014). Besides, data from the Agricultural and Processed Food Products Export Development Authority (APEDA) showed that India groundnut's export has increased by 39% during 2014 - 2015 (Jha, 2016). Figure 1.1 also shows that from the entry point, the imported peanuts started with the collection of raw peanut and followed by screening process as the requirement for laboratory samples to test the existent of fungi for human consumption. In addition, the self-produced peanut is basically starting from planting, harvesting, post harvesting, and storage. Usually, the sample of raw peanut will be separated and run for laboratory testing. The same process goes to the imported peanuts before collected and traded to the producers or manufacturers.

Basically, the imported raw peanut and self-produced peanut are compulsory for a screening process for importers or traders. At this stage, the Ministry of Health (MOH) Malaysia will take the raw peanut as a representative sample for further analysis before the consignment can be released to other entities such as food manufacturers, middlemen, and retailers. However, the peanut sample tested must be under the Malaysia maximum permitted limits of aflatoxins, which is 10 μg/kg for total aflatoxins in peanut products and 15 μg/kg for total aflatoxins in raw peanut (Food Act, 1983). A study from Kamika and Tekere (2016) revealed that the occurrence of aflatoxins contamination in maize samples in Democratic Republic of Congo, where all the collected maize samples were found to contain 300% higher than the maximum limit of 10 μg/kg as established by the World Health Organization (WHO).

After the screening process is done, the raw peanut consignments are distributed to the food manufacturers. Next stage is some of the peanut entities such as traders, middlemen, food manufacturers, and retailers (including nut and food manufacturers, small/ wet store, and supermarket) usually stored the peanut in the warehouse for a certain period of time. At this point, most aflatoxins can be produced during storage stage. Improper storage condition such as leaky roof and unprotected floor because of unsuitable ventilation in the warehouse and high moisture foreign material associated with stored peanuts can make the groundnut become wet and favor to mould growth and aflatoxins production. Therefore, a good supply chain management of agricultural commodities like peanut is highly regarded since these commodities are very susceptible to fungal invasion and lead to aflatoxins contamination if exposed to the favorable condition.

Figure 1.2 indicates the peanut supply chain in Malaysia, in which dominated by three (3) main stakeholders namely importers, manufacturers (including large-scale and small-scale), and retailers. The first main stakeholder in the supply chain is the importer. In this study, importers are defined as "a person or organization that brings goods or services into the country from abroad for sale" (Oxford Dictionary, 2017, p. 201). Besides, importers too play a vital link between producers and processors. For

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instance, they import the raw peanuts commodity and act as suppliers to the food processors.

The second main of stakeholder is the manufacturer. Manufacturers are defined as "a person or company that make good for sale" (Oxford Dictionary, 2017, p. 248). In other word, manufacturers are an aggregator or marketer who provide the input for the processing facilities (Dani & Deep, 2010). This entity also produces products or goods through a process involving raw materials, components, or assemblies, usually on a large scale with different operations divided among different workers. This group is also producing a variety of peanut-based products such as peanut butter, roasted nuts, peanut candy, and oil intermediaries who interface with the end users who are the consumers. Majority of the peanut manufacturers have the capacity to buy the groundnuts from the importer. Then, the value of peanuts-based products is added for exporting and selling purposes within the country. In addition, this group is mainly concerned with aflatoxins. However, there are also a small-scale manufacturer produces a low volume of sales due to a small number of workers.

Retailer is the third main stakeholder in this supply chain. They are defined as "a person or business that sells goods to the public in relatively small quantities for use or consumption rather than for resale" (Oxford Dictionary, 2017, p. 344).Usually, this group provides a major market for intermediaries and farmers, as they service the needs of the consumers. Sometimes, retailers refer to a business or a person that sells products or goods to the consumers (Dani & Deep, 2010).

1.4 Overview of Mycotoxins

Nowadays, safety and security have generally remained as the basic human needs in today's changing world including Malaysia. Ensuring the safety of food is a major focus of international and national action over the last few years. Both microbiological and chemical hazards are the critical concern among the people around the world. This issue arises when grains and other field crops are found to contain unsafe chemicals, additives or other contaminants.

Consuming grains or other foods contaminated with certain mycotoxins can cause fatal if the toxins were present at very high level. Long-term exposure to mycotoxins can increase the risk of cancer and suppress the immune system between other health problems. Among chemical hazards, the contamination of food and feed by mycotoxins (toxic metabolites of fungi), fishery products by phycotoxins (toxins produced by algae) and edible plant species by their plant toxins have been recently characterized by the World Health Organization (WHO) as the significant sources of food-borne illnesses (WHO, 2002). Among these three categories of natural toxins, the focus

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attention has been directed to mycotoxins and it is currently represented a major food safety issue.

The word mycotoxin was derived from mycotoxicosis which was the term first used in 1955 to describe diseases of animals caused by toxics metabolic by-products of certain fungi (Herrman, Trigo-Stockli, & Pedersen, 2002) which includes mushrooms, moulds, and yeast. Mycotoxins appear in the food chain due to fungal infection of crops, either by being eaten directly by human or being used as livestock feed. Mycotoxins are a group of natural occurring poisonous chemical compounds produced by certain fungal species. The most important fungal species of mycotoxins produced viz. *Aspergillus*, *Penicillium*, and *Fusarium* species. Bhat, Rai, and Karim (2010) stated that *Aspergillus* and *Penicilliums*species can grow well at lower water activity and higher temperature compared to *Fusarium* species.

Setting mycotoxin regulations is a complex activity, which involves several factors and interested parties. The first limits for mycotoxins were set in the late 1960s for the aflatoxins (Van Egmond & Jonker, 2004). By the end of 2003, approximately 100 countries had developed specific limits for mycotoxins in foodstuffs and feedstuffs, and the number continuously growing. Even though people has to face health risks stemming from the contamination of grains with other natural occurring substances, mycotoxins are unique in a way that they produce naturally on the grain and their presence is usually associated with uncontrollable factors such as climatic conditions.

The significance of different food contaminants to human health varies on whether acute or chronic effects are being considered. Microbiological contamination and consequent food poisoning rank as the primary concern in all societies. Based on the risk assessment consideration, Kuiper-Goodman (1999) has suggested for acute hazards, mycotoxins might be ranked below phycotoxins yet above food additives and pesticide residues.

Mycotoxins are the most concern issue in food safety perspective which have five broad groups namely aflatoxin, trichothecenes (T-2 toxin and deoxynivalenol), ochratoxins A, fumonisin and zearalenone, are commonly found in food and feed (Miller, 1998). These five groups of mycotoxins all present health concerns and subject to SPS or other regulatory measures. Mycotoxins commonly grow on agricultural commodities in human food and feed ingredients, for instance maize, peanuts, wheat, barley, sorghum, other legumes and oilseeds that are suspected to lead some effects on human and animal health (Miller, 1998). Table 1.6 presents the main agricultural commodities that contaminated with general groups of mycotoxins.

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Table 1.6: Main Agricultural Commodities Contaminated with Mycotoxins

Mycotoxins	Agricultural Commodities
Aflatoxins (AFs)	Peanuts, maize, wheat, cereals, palm kernels, cocoa, coffee beans
Ochratoxin A (OTA)	Cereal grain (wheat, barley, maize, oats), dry beans, mouldy peanuts, cheese, coffee, raisins, dried fruits, cocoa
Fumonisin (FMN)	Maize, Sorghum
Zearalenone (ZEN)	Maize, mouldy hay, pelleted commercial feed
Trichothecenes (DON and T-2 toxins)	Maize, wheat, barley, oats, commercial cattle feed

Source: FAO (1997)

Mycotoxins are the secondary metabolite toxic produced and vastly suit under chemical, biological and physiological condition. Besides that, mycotoxins can easily be influenced by some ecological and environmental factors such as moisture content, temperature, relative humidity, physical damage by insects, type of substrate, fungicides implementation, occurrence with other fungi and water activity (a_w), as well as storage condition (Zöllner & Mayer-Helm, 2006). Additional factors that can also influence fungal growth and increase the risk of mycotoxins production are poor harvesting practices, improper processing, packaging, drying procedure, and transportation activities (Bhat et al., 2010). Moreover, the climate condition is also one of the important factors that affect mycotoxins production of foods and feedstuff (Paterson & Lima, 2010).

However, agriculture crops in tropical and subtropical regions are more susceptible to cross-contamination compared to temperate areas, as the high temperature and humidity that fostered by a suitable condition for fungal infestation (Thomson & Henke, 2000). Miller et al. (1993) argued that countries particularly in tropical and subtropical countries have poorly developed infrastructures such as processing facilities, transportation, skilled workers and storage, which can influence the formation of mycotoxins.

Mycotoxins can cause a variety of adverse effects in human that cause to sickness, lower performance or death in both human and animal. Consuming food that contains mycotoxins is a worldwide problem as it is the main health risk for both humans and animals can cause significantly economic losses in both developed and developing countries. The consequence of ingesting mycotoxins-contaminated food or feed is called as mycotoxicosis (Binder, Tan, Chin, Handl, & Richard, 2007). Among variety groups of mycotoxins, the most widely recognized risk comes from aflatoxins (Jarvis & Miller, 2005).

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1.5 Overview of Aflatoxins

Aflatoxins are a group of chemical substances that is produced mainly by certain fungi known as *Aspergillus* genus such as *Aspergillus flavus* and *Aspergillus parasiticus*, which is recognized to cause both acute and chronic toxicity in human and animals. Aflatoxins are known as highly toxic, extremely potent carcinogenic, teratogenic, and mutagenic compounds (Aycicek, Aksoy & Saygi, 2005; Bhat et al., 2010). There are roughly 18 different types of aflatoxins have been identified in nature. However, aflatoxins B_1, B_2, G_1, and G_2 are the main aflatoxins found naturally in foods, showed in Figure 1.2. These fungi usually present in soil and plant material causing the deterioration of stored grain and food. To add more, varieties of fungi can contaminate the peanut shell and seed since peanuts grow in the soil.

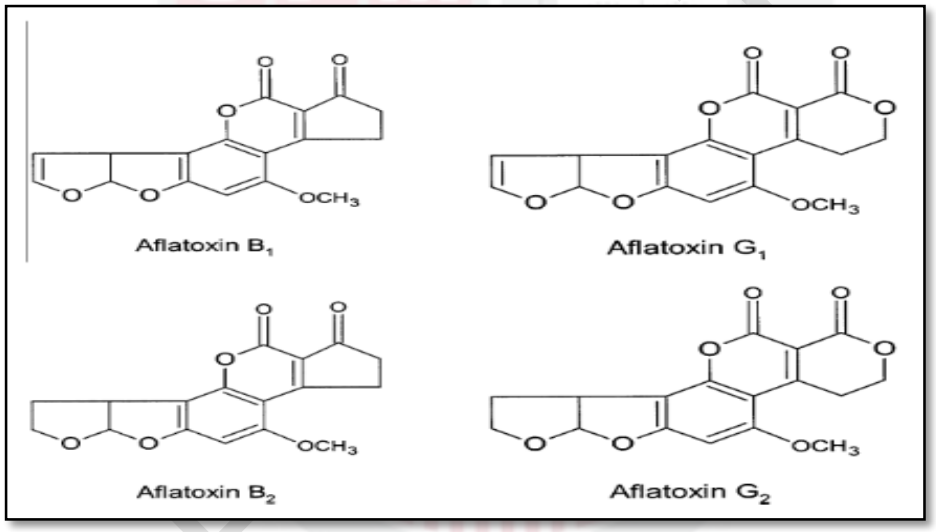

Figure 1.2: Structures of the Major Aflatoxins; AFB_1, AFB_2, AFG_1, AFG_2

Aflatoxins occur naturally in most of the food commodities which are mostly consumed by both human and animal such as corn, soybean, peanut, wheat, barley, other legumes and they are suspected to threaten both human and animal health. Among the food commodities, Fardiaz (1995) found that peanuts and maize showed the most significantly susceptible commodities to contaminate from aflatoxins and easily growing in climatic condition that stimulates aflatoxins-causing agents to breed. Nonetheless, animal products such as milk, cheese, as well as cottonseed and spices are also susceptible to aflatoxins contamination. A study done by Johanna Lindahl, an epidemiologist at International Livestock Research Institute (ILRI) reported that there are still very few people and less exposure to the harm of aflatoxins to human and

animals including animal food products, which can be contaminated with aflatoxins as well (Walke et al., 2014).

Aflatoxin contamination is most commonly happened in African, Asian, and South American countries due to the existence of warm and humid climates but also occurs in temperate areas of North America and Europe. Aflatoxins contamination is fostered by hot and humid conditions in that favor fungi growth, (Azrandeh et al., 2010; Liu & Wu, 2010; Leong, Rosma, Latiff, & Ahmad, 2011). In Malaysia, high production of aflatoxins can be expected due to high temperature and humidity weather in tropical and subtropical regions. The high temperature and high relative humidity in Malaysia falls in the range of 70% - 80% during wet season and 50% - 60% during dry season, and thus the hot and humid weather conditions may provide ideal growth conditions for *Aspergillus flavus* and increase production of aflatoxins (Bhat & Vasanthi, 2003; Leong et al., 2011).

In addition, any chemical damage and improper condition during harvesting, drying, transporting, as well as storage activities might increase the fungal growth and increase the risk of aflatoxins contamination (Bhat & Vasanthi, 2003; Azrandeh et al., 2010). If the peanut commodities drying was delayed and storage condition was not appropriately handled, the effects of producing aflatoxins can be greater. The fungi that produces aflatoxins in the food crops are rendered to unsafe for both human and livestock consumption. Besides, the effects are also together with the insect and rodent infestations, facilitating the invasion of stored products with fungal contamination.

1.6 Aflatoxins Regulation

Several countries in this world have enacted legal regulation to control aflatoxins in food in relation to minimizing human exposure to aflatoxins due to high economic cost among handlers, producers, processors and crops marketers. *A.flavus* and *A.parasiticus* are thoroughly studied in both developed and developing countries due to the nature of their toxicity and carcinogenicity.

Agreeing to Juan, Zinedine, Molto, Idrissi, and Manes (2008), there are currently20 aflatoxins including aflatoxin B1 and B2, which occur naturally, and they are significant contaminants of a wide variety of foods and feeds. In Malaysia, approximately around 65% of peanut-based products were identified as being contaminated with aflatoxins at a mean level of 50μg/kg (Ali et al., 1999), even though the worldwide permitted limit for aflatoxin B_1 (AFB_1) was from 0-30μg/kg and the total aflatoxins was from 0-50μg/kg (Creppy, 2002). Therefore, these toxins have been considered unavoidable contaminants in food chain. The European Commission Regulations in 2010 established the current limits for AFB_1 and total aflatoxins in groundnuts, dried fruit, nuts, and cereals, as not more than 2 μg/kg and 4 μg/kg,

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respectively (Commission Regulation, 2010). In Malaysia, according to the section 34 of *Food Act 1983*, *Food (Amendment) (No.3) Regulations*, the maximum permitted level of total aflatoxins in peanut-based products is 15 μg/kg. Table 1.7 indicates the maximum permitted limit of aflatoxins in Malaysia.

Table 1.7: Maximum Permitted Limit of Aflatoxins

Food	Mycological contaminant	Maximum permitted proportion in microgram per kilogram (μg/kg)
Groundnuts, almonds, hazel nuts and pistachios for further processing	Aflatoxins (Sum of B1, B2, G1 and G2)	15
Groundnuts, almonds, hazel nuts and pistachios ready-to-eat	Aflatoxins (Sum of B1, B2, G1 and G2)	10
Others	Aflatoxins (Sum of B1, B2, G1 and G2)	5

Source: Food Act (1983)

1.7 Incidences of Human Aflatoxicosis

Aflatoxins B_1, B_2, G_1, and G_2 are the major aflatoxins that found naturally in food and commodities. However, among those four aflatoxins, aflatoxin B1 (AFB_1) is generally recognized as the most poisonous compared to other types of aflatoxins (Squire, 1981; Moss, 1998). Based on several epidemiological studies, AFB_1 is classified as category Group 1 carcinogens by the International Agency for Research on Cancer (IARC, 1993; JECFA, 1998). Furthermore, these aflatoxins are also related to acute hepatitis (Li, Yoshizawa, Kawamura, Luo, & Li, 2001; Park, Kim, & Kim, 2004) and Hepatocellular carcinoma (HCC) known as liver cancer (Goeger, Hsie, & Anderson, 1999). The incidence of aflatoxins continues to increase significantly in Africa and Asian countries such as Philippines and China.

The first incidence has successfully catch people's eyes and has been identified in United Kingdom on early 1960s, causing deaths of more than 100,000 young turkeys on a poultry farm in England, which called as a Turkey X disease. The common factor in the outbreaks was the high level of peanut meal contained groundnut (*Arachis hypogaea*) meal as a feed ingredient imported from Brazil (Blount, 1961; Sargeant, Sheridan, O'kelly, & Carnaghan1961). Studies in United Kingdom found that the disease was caused by toxins produced by strains of *Aspergillus flavus* fungi when growing on the meal.

With a reference to Scott (2003), the number of incidence increased and it was relating to the food-borne diseases including aflatoxins in both developed and developing

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countries. The United Nation World Health Organization (WHO) estimated that more than 4.5 billion people in the developing world are chronically exposed to uncontrolled aflatoxins (Health News, 2013; William et al., 2004). For example, over 123 reported deaths in Kenya resulted from aflatoxins (CDC, 2004). Aflatoxins contamination in Africa is the most widespread, in which it is a major cause of losses of post-harvest and leads to constitute a significant threat to food security and livelihoods. Other than that, some notable outbreaks including the deaths of 3 Taiwanese in 1967 and the deaths of more than 100 people in Northwest India in the year 1974. Both outbreaks were attributed to aflatoxin contamination of rice in Taiwan and maize in India.

In October 1988, a few cases came up regarding the food poisoning in the northwestern state of Perak in Peninsular Malaysia. The outbreaks were attributable to aflatoxins and boric acid. Fatal cases were reported for 13 Chinese children who died due to acute hepatic encephalopathy and renal failure. Based on the epidemiologic investigation, it described that the children had eaten a Chinese noodle called as "loh see fun" a few hours before death. The case was geographically scattered in six towns, located in two districts along the route of distribution of the noodle supplied by one of the factories in Kampar town. Aflatoxins were confirmed in the postmortem sample received from patients. This outbreak has become an important public health implication for many developing countries (Lye, Ghazali, Mohan, Alwin, & Nair, 1995). Hence, freedom from aflatoxins is regarded as the most important quality factor by some importing countries.

These occurrence and outbreaks comprises some important implications to public health in many developing countries and this can be noted that aflatoxins may increase the level of stress susceptibility and as well as negative affect of kids' growth efficiency (Chao, Maxwell, & Wong, 1991; Lye et al., 1995).The clinical signs of aflatoxicosis are extremely varied. Signs of acute aflatoxicosis include depression, nervousness, abdominal pain, diarrhea and death (Herrman et al., 2002). Consuming foods that contain high level of certain mycotoxins can also cause a rapid onset of mycotoxicosis, a severe illness characterized by vomiting, abdominal pain, pulmonary edema, convulsions, coma, and in rare cases, death (Williams et al., 2004; Wild & Gong, 2009). Although lethal cases are uncommon, acute illnesses from mycotoxins, particularly aflatoxins (aflatoxicosis) have been reported from various countries in the world, usually in the developing countries.

1.8 Food Hygiene Practices

Malaysia established sanitary and phytosanitary (SPS) regulations to protect consumers from aflatoxins contamination risks and seeking them to balance health benefits with the potential trade disruptions, economic losses, and market uncertainties that regulations can cause. Aflatoxins can contaminate many agriculture commodities that affect the agriculture sector output and human dietary staples food such as maize,

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groundnuts, rice, wheat, and barley. By adopting food hygiene practices, the aflatoxins contaminated food can be reduced. For consumer, food safety concern is a potential exposure to mycotoxins through consumption of food from contaminated crops, which can produce acute and/or long-term health problems.

According to Rohr, Luddecke, Drusch, Muller, & Alvensleben (2005) food hygiene come from hygienic surrounding including condition of foods, food additives, food containers, packaging, food manufacturing, processing, blending, storage, displaying, transportation, selling, dining and places as well as free from toxic. Hazardous substances, pollutant, food poisoning and foodborne diseases are also included. Additionally, it is relating to the advertising and hygiene education. To meet the sanitation and hygienic condition, food is required in a safe and reliable at various stages of food processing until final products for human consumption. Hence, food hygiene is the most basic and important part of food supply chain yet often overlooked by consumers and food producers.

Food producers play an important role in ensuring the safety of the food throughout the supply chain including processing, production, storage, and food preparation for human consumption (Hedberg, MacDonald, & Osterholm, 1994). There are a number of quality assurance certification such as Good Agriculture Practices (GAP), Good Manufacturing Practices (GMP), Hazard Analysis and Critical Control Points (HACCP*)*, Malaysia's Best, *Makanan Selamat Tanggungjawab Industri (MeSTI)*, International Organization for Standardization (ISO) and HALAL certificate that may lead the stakeholders as well as food producers to produce peanut products in a safe way. In addition, it is important for stakeholders, food producers and processors to understand that Good Agriculture Practices (GAP) is the baseline of protection against aflatoxins contamination of peanuts. This is also followed by implementation of Good Manufacturing Practices (GMP) and Good Storage Practices (GSP), which are important to take part during handling, processing, storage and distribution process of peanuts for human consumption. Therefore, by conducting effective food hygiene practices with qualified certification at all stages from farm until the food processing could help to control fungi formation to produce excellent quality and safe peanut-based products be assured to consumers.

1.9 Problem Statement

Malaysia has lower level of peanut supply and import is aimed to cover the increasing of peanut consumption. As reported in Nuts and Dried Fruits Global Statistical Review (2016), Malaysia is ranked 13thin the world in terms of peanut consumptions and ranked 7thof world peanut import. With reference to the Department of Agriculture (DOA) Malaysia, almost 90% of peanuts in Malaysia are imported from foreign countries particularly China, India and Vietnam. However, aflatoxins have been

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detected mostly from the imported peanuts. China, India, and Kenya were experienced the serious economic challenges with aflatoxins in peanuts (Wu, 2004).

Other than that, post-import stage is also an important problem in which the level of aflatoxins in imported groundnuts or peanuts need to be tested before they are released to the peanuts stakeholders. As per Jha (2016) found that Indonesia has sought testing for aflatoxin and pesticide residues in groundnut consignments from India. Vietnam raised their concerns over the quality of groundnut shipment from India due to discovery of aflatoxins. To control this problem, importing countries enforce the strict control on the permitted levels of aflatoxins. At the early stage of intervention at post-import point also important such as taking samples at every consignment for laboratory testing before distributed to the other peanuts supply chain. These serious issues along the supply chain are important to the public implications due to consumers lacked information, which probably have been affected by aflatoxins. Thus, every country needs authorities to seek certification and samples of consignments for more laboratories testing as earlier prevention before distribute to the other peanut supply chain channels.

Aflatoxins are potent carcinogens and it does have many adverse health effects to human body. The contaminated food by aflatoxins may be perceived as safe if there is no sign of defects or contamination. However, the characteristics of aflatoxins are odorless, tasteless, and invisible through human naked eye and the aflatoxins itself are difficult to be removed. Because of that, there are increasing incidences or outbreaks in global as well as in Malaysia relating food-borne diseases have become serious issues regarding aflatoxins contamination that affect to human health. Less implementation in best practices can enhance the growth of fungi and may lead to chance of aflatoxins production. Low level of awareness, knowledge, poor in practices, and improper handling particularly occurrence of aflatoxins contamination in peanuts-based products is a result of poor education level among food handlers and workers. If low practicing in proper storage, material handling as well as hygiene and sanitation, thus it can boost the aflatoxins production in peanuts. Therefore, studies relating to the stakeholders' knowledge level towards aflatoxins exposure are significant aspects of food safety and hygiene sanitation that need an attention.

In the light of the above discussions, all issues raised are related to the external aspects that can influence aflatoxins contamination. Awareness, knowledge, education about aflatoxins contamination, and training regarding food safety are driven to the fundamental knowledge about aflatoxins and its prevention among stakeholders in Malaysia. Thus, there are need to understand the stakeholders' hygiene practices and their knowledge and awareness handling the peanut products. Therefore, peanuts stakeholders should be improved in attitudes towards food safety and hygiene practices that are driven from the fundamental knowledge about aflatoxins and its prevention that need to be investigated with regard to their knowledge, attitude, and practices.

1.10 Research Questions

In this study, four specific research questions are addressed. The entire research questions are developed based on stakeholders' knowledge, attitude, and practices (KAP) levels towards aflatoxins contamination in peanut-based products. The research questions are as follows: -

1. What are the knowledge, attitude and practices levels of stakeholders towards aflatoxins contamination in peanut-based products?
2. Are there any differences between knowledge, attitude and practices and stakeholders towards aflatoxins contamination in peanut-based products?
3. What are the relationships between stakeholders' knowledge, attitude and practices levels and peanut-based stakeholders?
4. What are the most influential factors that influenced hygiene practices towards aflatoxins contamination in peanut-based products?

1.11 Objectives of the Study

The general objective of this study is to determine the supply chain of peanuts in stakeholders' knowledge, attitude and practices towards aflatoxins contamination in peanut-based products. The specific objectives of this study are as follows: -

1. To examine the knowledge, attitude, and practices levels of stakeholders in relation to minimizing aflatoxins contamination in peanut-based products.
2. To determine the differences between knowledge, attitude and practices and peanut-based stakeholders in relation to minimizing aflatoxins contamination.
3. To identify the relationship between stakeholders' knowledge, attitude and practices levels and peanut-based stakeholders.
4. To determine the most influential factors that influence hygiene practices in relation to minimizing aflatoxins contamination in peanut-based products.

1.12 Significance of the Study

The aim of this study is to expand knowledge and information regarding aflatoxins contamination in peanut-based products. In addition, this will also help the industry players such as importers, manufacturers, retailers and farmers to improve their level of awareness and to understand the effects of the aflatoxins contamination which can be threaten to both human and animals' health. Besides that, the new idea of exploring the level of knowledge among peanut-based stakeholders will provide some information on the extent to which these stakeholders have moved towards food safety activities as well as their efforts in improving food production in Malaysia. Besides, this is also to disseminate information on factors that influence hygiene practices in relation to minimizing aflatoxins contamination among food workers including stakeholders in

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Malaysia. The findings from this study will help to provide necessary information for authority bodies of various ministries such as the Ministry of Health (MOH) Malaysia and the Ministry of Agriculture and Agro-based Industry (MOA) Malaysia as to improve their services in industry and to improve food safety policy and standards in the future.

1.13 Organization of the Thesis

This thesis is divided into five chapters. Chapter one briefly explains on the background of the research topics; discussing the problems faced in the industry, research questions and objectives of the study. Chapter two summarizes previous literature and findings related to the knowledge and attitude among stakeholders as well as factors that influence hygiene practices towards aflatoxins contaminations. Chapter three explains the conceptual framework, research methodology and analysis methods used in this study. Chapter four provides the analysis of data and discusses the result of the study. Finally, chapter five summarizes the findings of this study, conclusions, recommendations and limitation while conducting this study as well as recommendation for the future research.

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BIODATA OF STUDENT

The student, Nur Nazurah binti Mohd Azaman was born on 9th June 1989 in Kuala Lumpur, Malaysia. She attended her primary school at Sekolah Kebangsaan Gombak Setia, Selangor from year 1996 until 2001. She did her secondary school at Sekolah Menengah Kebangsaan (SMK) Gombak Setia, Selangor from year 2002 until 2004 and then continues from year 2005 until 2006 at Sekolah Menengah Teknik (SMT) Sepang, Selangor. After she finished her secondary school, she further study at Universiti Putra Malaysia Bintulu (UPMKB), Campus Sarawak for 3 years in Diploma studies. After that, she continues study at Degree level at Universiti Putra Malaysia (UPM) Serdang for her Bachelor Science in Agribusiness, which completed in 2013. Then, she continues her study for Master Degree in Agribusiness at Universiti Putra Malaysia. She got the scholarship from Ministry of Education for her study under MyBrain scheme. Her research also funded under Institut Putra Berkumpulan (IPB) Grant, Vot number 9425402 with project title "Improving Food Security and Public Health through Aflatoxins Sustainable Risk Management in Penaut Value Chain Industry".

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