Evaluation of the Population's Health Risk from Aflatoxin in Dried Chillies in Ban Palad Community, Li City, Lamphun Province, Thailand

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Abstract

The occurrence of aflatoxin, a potent carcinogenic toxin produced by the fungi *Aspergillus flavus* and *Aspergillus parasiticus*, in food is a significant public health concern worldwide. Dried chilli is among the most commonly contaminated food items, particularly in tropical and subtropical regions. In Thailand, the consumption of dried chilli is prevalent, and its contamination with aflatoxin has been reported in several regions. One such region is Ban Palad community, located in Li City, Lamphun Province, where the majority of the population relies on agriculture and small-scale food processing for their livelihoods. Despite the potential health risks of aflatoxin exposure through contaminated chilli consumption, no studies have been conducted to assess the exposure and health risks in this community. Therefore, the present study aimed to assess the levels of aflatoxin contamination in dried chilli consumed by the population in Ban Palad community and to estimate the associated health risks. The results of the survey showed that 52% of respondents and 48% of respondents, respectively, had known and unknown mycotoxins. There were 84.67% and 15.33%, respectively, of people who were aware that dried chilli can develop mold when maintained in a moist or humid environment under known and unknowing factors. The percentage of individuals known to have liver cancer caused by the mycotoxin in dried chilli peppers was 16.67% and 83.33%, respectively. This study's findings will provide valuable information for policy-makers and local com-

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munities to develop strategies to reduce aflatoxin contamination and mitigate the associated health risks. In conclusion, the risk assessment of aflatoxin in dried chilli from Risk Ranger program indicates that there is a moderate level of risk associated with consumption. Consumers should be aware of the potential hazards and take necessary precautions to reduce the risk of exposure.

Keywords : Aflatoxin, risk assessment, exposure, Risk Ranger program

Introduction

Aflatoxin, a potent carcinogen generated by the fungi *Aspergillus flavus* and *Aspergillus parasiticus*, is found in food and is a major global public health concern. One of the most frequently contaminated foods is dried chilli, especially in tropical and subtropical areas [1]. The United Nations Food and Agriculture Organization has recognized mold toxins in food as a significant global food processing safety problem. The most common strain is *Aspergillus flavus*, which produces aflatoxins (AFs) [2]. Aflatoxin B1 contaminants found in food are the main dangerous substances that have an effect on public health. Aflatoxin chronic exposure can occur at any age, including in the fetus, and increases with repeated consumption. Aflatoxin exposure at high levels makes acute poisoning fatal [3]. When consumed in high-risk foods, aflatoxins, which are made *Aspergillus flavus* and *Aspergillus paraciticus* and classified as human carcinogens, can withstand heat up to 268 degrees Celsius. Therefore, the poison cannot be rendered harmless by normal cooking [4]. In order to protect consumer health, the amount of aflatoxin contamination in food cannot go above the limits defined by the Codex Alimentarius Commission. Each country thus uses it as a trade barrier and a negotiation tactic when purchasing agricultural products. As a result, the product's market value decreases. The World Commerce Organization has established guidelines for negotiations when problems with global commerce arise. Risk Ranger Program is an effective tool for defining the hazard risk assessment to decide the strategies to control the hazards. The program operates aligned with the information related to the consumption data, frequency of consumption, proportion of population consuming the product and Probability that a serving of raw product is contaminated, these are advantages for assessment the risk to contribute in various size of population [5]. In Thailand, it is unclear how much consumption of chilli paste affects the risk of cancer brought on by exposure to aflatoxin-containing chilli paste that is frequently consumed in Northern of Thailand, a variety of chilli pastes in both homemade and store-bought. Therefore, the objective of this study is to assess the risk involved with consuming chilli paste that can be contaminated with aflatoxin and to investigate the likelihood of chilli paste consumers are exposed to aflatoxin. By offering guidelines to lessen the likelihood of contamination in dried chilli raw materials and food safety management standards for dried chilli manufacture at

both the home and commercial levels, the risk of harm to consumers will be lowered.

Research Objectives

To ascertain the possible dangers of consuming foods that include dried chilli that has been contaminated with aflatoxins.

To identify the most effective techniques for reducing the risk of exposure to aflatoxin contamination in dried chilli.

To introduce the development of a toxin-free dried chilli production technique that fits with the demand for production.

Research Methodology

1 Materials

The purpose of this study is to assess the possibility of aflatoxin exposure among chilli paste inhabitants of Lamphun Province by randomly spreading the area and selecting certain Ban Pha Lat sample populations. Aflatoxin is a fungal toxin that is contaminated in dried chilli. There were 150 volunteers in total. Find out how to manage the threat of aflatoxin in dried chilli. After data collection and before conducting behavioral and dried chilli eating frequency questionnaires, volunteers will be divided into two groups.

1.1 Primary producers (farmers who grow chillies for their own consumption) must continuously planted and processed dried chillies for domestic consumption by farmers who grow them for their own purpose (Preliminary Producer Representative).

1.2 Customers who buy dried peppers to consume (consumer representatives) by gathering information on distribution points, storage locations, and dried chilli product specifics.

2. Methods

This study has been certified of research human ethics by Associated Medical Sciences, Chaing Mai University, Chiangmai, Thailand.

2.1 Research prevention strategies for aflatoxin in dried chilli.

The populations of this study were Participatory Action Research: PAR random by using purposive sampling [6]. Information gathering: to carry out this study volunteer in Ban Palad Community, Li City, Lamphun Province. The subject criteria are people age 18 and above with the consumption of dried chilli, extensive surveys and interviews were conducted. They were divided into two groups. 1) Farmers who grow chilli for their own consumption (Preliminary producer representative): there must be continuous planting and processing of dried chilli for household consumption. By gathering data on the processes used by farmers to produce dried chilli, the growing season, drying techniques like sun drying or smoking, storage, and processing used by farmers in the area, and summarizing all the data to get an overall picture. Integration of production and processing processes (to be studied in the risk assessment process to suggest ways to improve the production management process of dried chilli from the actual situation in Ban Palad community. 2) Consumers that purchase dried chilli for consumption (consumer representatives) by gathering data on distribution hubs, storage facilities, and dried chilli product details.

2.2 The questionnaire study in the population

The questionnaire was divided into 3 parts, which were multiple-choice questions as follows:

Part 1: Ask about the general information of the respondents, including sex, age, education level, occupation, and earnings.

Part 2: Inquired about consumer behavior towards dried chilli products. Ask about the qualities and origins of dried chilli peppers that are commonly consumed (processing, storage).

Part 3: The frequency of consumption of foods containing dried chilli was the subject of Part 3's investigation. This is done in order to research how the locals make dried chilli. Including knowledge, management and practise tests.

2.3 The probabilistic risk of dietary exposure

The probabilistic risk of dietary exposure of assessment of health risk from aflatoxin in dried chilli of population. The risk estimation of aflatoxin in dried chilli were analyzed using the Risk Ranger program to determine the likelihood of daily illness [5]. According to the consumer concerned, the combined forecast of illness per day per consumer of interest total predicted illnesses/annum in population of interest. The risk rating (0 to 100). Exposure to the food will depend on how much is consumed by the population of interest, how frequently they consume the food and the size of the exposed population. Probability of exposure to an infectious dose will depend on: 11 questions

Question 1: Hazard severity

Question 2: Susceptibility of the population in which you are interested

Question 3: Frequency of consumption

Question 4: Proportion of population consuming the product

Question 5: Size of consuming population

Question 6: Probability that a serving of raw product is contaminated

Question 7: Effect of processing

Question 8: Potential for recontamination after processing

Question 9: How effective is post-processing control?

Question 10: What level of increase is needed to cause illness

Question 11: Effect of meal preparation

Figure 1: The questionnaire surveying of this research in Ban Palad Community, Li City, Lamphun Province, Thailand

Results

1. Research prevention strategies for aflatoxin in dried chilli.

The questionnaire surveying of this research, the evaluation of the population's health risk from aflatoxin in dried chilli, was conducted in Ban Palad Community, Li City, Lamphun Province, as shown in figure 1.

In Table 1: General Information of the Population, it was presented that the gender of males was 37% and that of females was 63%. The average age range between 18–35, 36–60, and more than 60 was 5.33%, 66.67%, and 28%, respectively. The occupations of the subjects are farmer merchant, government employee, and others: 75.33%, 5.33%, 10.00%, and 9.33%, respectively.

2. The questionnaire study in the population

Based on Table 2, the consumption habits of dried chilli were analyzed and separated into five factors. The first factor was cultivation, which showed that the highest percentage of dried chilli was cultivated during April-June, accounting for 62.75%. The second factor was processing and storage methods, which revealed that smoking or grilling over fire was the most common processing method, accounting for 66.67%, while storing dried chilli in plastic bags was the most popular storage method, accounting for 72.55%. The third factor was retailing, which showed that neighborhood stores were the most common retailers for dried chilli, accounting for 5.88%. The fourth factor was the keeping period, which showed that dried chilli was usually kept for six months, accounting for 50.98%.

The knowledge of mycotoxin in foods is presented in Table 3. The percentages of people who had known and unknown mycotoxins were 52% and 48%, respectively. The percentage of people who recognized that mold can grow up on the dried chilli when kept in a humid or wet condition with known and unknown conditions was 84.67% and 15.33%, respectively. The percentage of individuals known to have liver cancer caused by the mycotoxin in dried chilli was 16.67% and 83.33%, respectively.

3. The preliminary risk assessment of exposure to aflatoxin in dried chilli

The probability of illness per day per consumer of interest was 2.35E-6, and total predicted illnesses per annum in the population of interest was 7.51E-4. The risk rating (0 to 100) was 67. The probabilistic risk of dietary exposure to dried chilli was shown in Table 4.

Table 1: The concentration ratio of palmitic acid (A) combination with lauric acid (B) by using the experimental plan of 62 Factorial designs in Completely Randomized Design (CRD).

Variables	Frequency (n)	Percent (%)
Sex		
Male	55	37.00
Female	95	63.00
Age		
18-35	8	5.33
36-60	100	66.67
> 60	42	28.00
Caregiver educational level		
Illiterate	4	2.67
Grade 1–6	114	76.00
Grade 7–9	9	6.00
Grade 10–12	13	8.67
Tertiary education	4	2.67
Earnings per month		
< 10,000 Baht.	105	70.00
10,000 – 14,999 Baht.	35	23.33
15,000 – 19,999 Baht.	7	4.67
> 20,000 Baht.	3	2.00
Marital status		
Married	138	92.00
Single	2	1.33
Divorced/and or separated	10	6.67
Occupation		
Farmer	113	75.33
Merchant	8	5.33
Government employee	15	10.00
Other (such as day laborer, etc.)	14	9.33

Table 2: Consumption habits of dried chilli

Variables	Frequency (n)	Percent (%)
Grown ourselves	51	34.00
cultivate		
April-June	32	62.75
July-September	17	33.33
October-December	3	5.88
Processing		
Sun exposure	18	35.29
Smoked (grilled over the fire)	34	66.67
Drying	0	0.00
storage methods		
plastic bag	37	72.55
Bottles/jars	15	29.41
baskets/sacks	0	0.00
available		
Merchant	0	0.00
Factory/Company	0	0.00
Neighborhood	3	5.88
Keeping		
1 month	13	25.49
3 month	4	7.84
6 month	26	50.98
1 year	4	7.84
>1 year	5	9.80

According to the risk criteria in Aflatoxin in dried chilli, the hazard severity is considered severe as it can cause death to most susceptibles. The susceptibility of the population is general, which includes all members of the population. The frequency of consumption is 18 liters per year, which is equivalent to 4.87 kilograms per year, and the proportion of consumers is most at 75%. The size of the population is 1.17 million. The probability of raw product contamination is 3.03%, but the effect of processing usually eliminates hazards by 99%. There is no possibility of recontamination,

Table 3: knowledge of mycotoxins

Variables	Frequency (n)	Percent (%)
number of persons knowledge of mycotoxins		
known	78	52.00
Unknown	72	48.00
number of persons knowledge of Mold can grow on dried chilli when they are kept in humid environments.		
known	127	84.67
Unknown	23	15.33
number of individuals known that the mycotoxins in dried chilli can cause liver cancer in humans.		
known	25	16.67
Unknown	125	83.33

and post-process control is controlled. The increase to infective dose is 5.17 illnesses per 66,511,700, and further cooking before eating is effective in reducing the hazard by 99%. Based on these risk criteria, the predicted annual illness in the population is 2.35E-6, and the probability of illness per day per consumer of interest (Pinf x Pexp) is 7.51E-4. The risk ranking on a scale of 0 to 100 is 67, which indicates a moderate level of risk [6,7]. Therefore, it is recommended that consumers take precautions when consuming dried chilli to minimize the risk of exposure to aflatoxins.

Discussion

1. Regarding consumer behavior in this study, community stores were the most common place for purchasing dried chilli, accounting for 80.81%, followed by fresh markets (12.12%) and shopping malls (7.07%). The period of consumption was found to be more than four weeks, 2-3 weeks, 2-3 days, and 1 week, with a percentage of 78.79, 21.21, 10.10, and 9.09, respectively. The quantities of dried chilli consumed were about one kilogramme, 500 grammes, and 250 grammes, accounting for 50.51, 20.20, and 8.08%, respectively.

2. According to a number of studies on mycotoxins in foods, the general population's knowledge and awareness of these harmful substances remain low, which corresponds to the research work of Viang et al., 2014 [8] which found that agriculture has been placed chilli on the roof or at sidewalk of street. From research work of Liu and Wu. 2010 [9], Risk Assessment Global burden of Aflatoxin-

Table 4: The probabilistic risk of dietary exposure of dried chilli

Risk criteria	Aflatoxin in dried chilli
Dose and severity	
1.Hazard severity	SEVERE hazard-causes death to most victims
2.Susceptibility	GENERAL-all members of the population
Probability of exposure	
3.Frequency of consumption 18 liters per year	4.87 kilogram per year
4.Proportion consuming	Most 75%
5.Size of population	1.17 million
Probability of contamination	
6.Probability of raw product contaminated	3.03 %
7.Effect of processing	Us usually eliminates hazads (99 %)
8.Possibility of recontamination	No
9.Post-process control	Controlled
10.Increase to infective dose	5.17 illnesses per 66,511,700
11.Further cooking before eating	Effective in reducing 99% hazard
Predicted annual illness in the population considered	2.35E-6
Probability of illness per day per consumer of interest (Pinf x Pexp)	7.51E-4
Risk ranking (0-100)	67

Induced Hepatocellular carcinoma (HCC) found that agricultural regions in Africa and Asia are located in climatic zones favorable to the propagation of A. flavus and A. parasiticus. Inappropriate field practices and poor drying/storage conditions make crops vulnerable to A. flavus and A. parasiticus. Fungal infection and aflatoxin accumulation increase exposure to aflatoxin even in the same country. The risk of aflatoxin-induced HCC can vary significantly. Rural populations generally have higher levels of aflatoxin exposure than urban residents in developing countries. This is because urban populations tend to consume more variety of food than rural populations. And there may be foods that control contaminants better. Only 52% of participants in our study were aware of mycotoxins in foods, while 48% were unaware. However, there was a higher awareness of mold contamination in crops, with 84.67% of people recognizing that mold can grow on dried chilli in wet or wet

conditions with suggested from research of Jalili, Jinap, 2011 [10]. In general, spices are susceptible to fungal contamination since they are usually produced under non-sanitary conditions, especially during drying. For example, chilli is usually sun-dried for 3–7 days, and its final moisture content will nevertheless be around 30%. These conditions are conducive to the growth of mycotoxigenic fungi and subsequent mycotoxin production. Furthermore, the high incidence and levels of aflatoxins (AFs) and ochratoxin A (OTA) contamination in dried chilli samples are frequent by countries located in tropical and sub-tropical areas. Such environments offer desirable conditions for mold growth and mycotoxin production.

This study found that AFs in samples purchased from open markets were significantly higher ($p < 0.05$) than the corresponding levels detected in the samples obtained from supermarkets; this may be due to the fact that dried chilli sold in the open market is usually stored and/or displayed in improper conditions and is accordingly exposed to dust and other sources of environmental pollution. Long storage and improper storage conditions can lead to increased mold growth and mycotoxin production. This is an important finding, as dried chilli are a common food item in many cultures and can contain high levels of mycotoxins if not properly stored and processed. Another key finding of the study was that only 16.67% of individuals who were aware of mycotoxins in dried chilli knew that these substances can cause liver cancer, while 83.33% were unaware of this health risk. This is concerning, as liver cancer is a serious and potentially fatal disease that can be caused by prolonged exposure to mycotoxins [11] and its contamination was involved in liver diseases and proved to be hepatotoxic. Aflatoxin B1 was believed to have a role in causing hepatic and extrahepatic carcinogenesis in humans by causing single and double DNA breaks. The bioactivation of Aflatoxin B1 will produce its epoxide metabolite, which will bind to DNA molecules and eventually cause a neoplastic transformation of the cells. Another study confirmed the carcinogenic effect of AFB1, which was indicated in 2002 to belong to Group 1 of the cancerogens because it induces the formation of DNA adducts that contribute to liver cancer [12].

3. The preliminary risk assessment of exposure to aflatoxin in dried chilli

According to a recent study, the risk of exposure to aflatoxins through consumption of dried chilli is moderate. The study found that the increase in infective dose is 5.17 illnesses per 66,511,700, and that further cooking before eating is effective in reducing the hazard by 99%. Based on these risk criteria, the predicted annual illness in the population is 2.35E-6, and the probability of illness per day per consumer of interest (Pinf x Pexp) is 7.51E-4. The risk ranking on a scale of 0 to 100 is 67, which indicates a moderate level of risk [7]. Therefore, it is recommended that consumers take precautions when consuming dried chilli to minimize the risk of exposure to aflatoxins. These precautions may

include thoroughly washing the chilli before use, cooking the chilli at a high temperature for an extended period, and avoiding the consumption of moldy or discolored chilli. It is important to note that aflatoxins are a type of mycotoxin produced by certain strains of fungi, and can have harmful effects on human health. Aflatoxins have been linked to liver cancer, hepatitis, and other health problems [13].

Conclusion

Overall, these results highlight the need for greater education and awareness about mycotoxins and their health risks, particularly among populations that consume high levels of dried chilli and other potentially contaminated foods. By increasing knowledge and promoting safe food storage and processing practices, we can help reduce the incidence of mycotoxin-related illnesses and improve public health. In conclusion, the risk of exposure to aflatoxins through consumption of dried chilli is moderate, and consumers should take precautions to minimize their risk of exposure. By taking these precautions, consumers can enjoy the flavor and benefits of dried chilli while minimizing their risk of exposure to harmful toxins.

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