Implementation of Best Practices to Ensure Aflatoxin Controlled Chili Production from Post Harvesting to Customer in Developing Country

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Abstract

This project is carried out in one of the leading spice manufacturer of Pakistan located in Karachi. Dundi-cut whole red chilies (Capsicum indicum) are the most revenue-generating commodity of Pakistan. However, the persistence of aflatoxin contamination in chilies at higher levels is raising the health and economic risks. Aflatoxin (AFs), produced by A.spergillus flavus and A. parasilicus Spears, are toxic, carcinogenic and immunosuppressive. Post-harvest practices may play as crucial role to make the red chilies physically damaged that may lead to increase the levels of aflatoxins. In this study good post harvesting technique after plugging of crop was implemented on drying process by which chili is dry on geo sheet instead on sandy soil and analysis of AFs content was performed for verification of true hypothesis. In addition the study also elaborate the level of aflatoxin content in normal, discolored, with pedicle and without pedicle chili samples collected from different field of Sindh province, in order to understand the root cause of high AFs content by result analysis in chili crop. The study was conducted in different chili producing areas of Sindh-Pakistan. The samples of red chili (locally called dandi cut variety) were collected from different chili growing areas in and around Kunri, Mithi, Nagarparkar, Marjhango and Samaro.

Keywords: Aflatoxin Controlled Chili Production, Post Harvesting, Developing Country

JEL Classification: D2, D24

INTRODUCTION

Spices are generally considered important ingredients of food and increase the taste of different recipe. However, there are various biological factors contributed towards phenomena called food poisoning. This research project is particularly focused on production of red chili without aflatoxin. This chapter will provide essential background of the study, objectives behind the research intentions and its significance. The scope of the present study is to evaluate the aflatoxin content in red chili that was grow in different field of Sindh (crop of October 2014), additionally the scope of project is to test and study the aflatoxin content in different pods of red chili. The study can be the pioneer initiative regarding adaptation of post harvesting technique to dry red chili crop on geo sheet instead on sandy soil that reduce aflatoxin level up to acceptable limits and produce aflatoxin controlled chili.

General objectives to draw current struggle was to upscale the production of controlled aflatoxin chili, a major crop of Pakistan, is not only an important ingredient in food but is also used for essence production. Pakistan is in the list of biggest producer of chilies after India, china, Mexico. Chili is an important cash crop of the Sindh province, particularly in Kunri located in Umer Kot District. Production of red chili in the province is 80,000 tons per annum, which accounts for around 86 per cent of the total red chili production of Pakistan. Until fairly recently, this area was known as the chilies capital of the world. Effectively it will be done from grass hood level by giving training to farmers and continuously motivate them to adopt best pre and post harvesting practices to reduce aflatoxin content in red chili, in which drying of chili on geo sheet instead of sandy soil is key to success in long lasting impact, that positively play vital role in health sector but also beneficial in trade dynamics.

Objective to draw current struggle was to upscale the production of controlled aflatoxin chili, a major crop of Pakistan, is not only an important ingredient in food but is also used for essence production. After conclusive results aflatoxin controlled chili will be produced that may increase export volume by meeting international standards with safe nutrient value. The specific purpose of current study was to elaborate the level of aflatoxin content in normal, discolored, with pedicle and without pedicle chili samples by different field of Sindh province, in order to understand the root cause of problem by result analysis tested by approved method. Study also cover that implement of best post harvesting technique by using of geo sheet in drying process gives remarkable reduction in aflatoxin content in dried red chilies. The following research hypothesis has been:

- There is no significant difference evaluated after using the geo sheet in post- harvest drying process

instead on sandy soil for production of Aflatoxin controlled chili and another technique would be more suitable

- There is a significant difference evaluated after using the geo sheet in post- harvest drying process instead on sandy soil for production of Aflatoxin controlled chili

LITERATURE REVIEW

Chilli or pepper vegetable crop and botanically genus named as Capsicum annum L, which is belongs to Solanaceae family and regardless of originated from tropical America 7000 B.C used in Mexico now a days developing countries are also growing chilli being a commercial product in order to fulfill domestic consumption as well as export to international markets (Mazida, Salleh, & Osman, 2005). Particularly, chillies were categorized into two main classes in the agriculture known as sweet pepper and hot peppers. However, in general chillies can be segregated on the basis of their size, pungent types and colour. There are more than 400 types of chillies has been reported all over the world (Ashilenje, 2013). For production of chillies various technical aspects pertains to farming methodology are considered as important factors for quality of optimum yields and these needs to be managed properly by plan the production of red chilli to maximized profit. Chilli plants are very sensitive to the unfavorable climate and plants need suitable cool environment for continuous growth in order to protect blossoms often drop at low humidity (Mansour, 1993) as well as cutting of roots at depth during the cultivation also cause of blossoms drop (Rylski & Spigelman, 1982). This vegetable usually nurture well in tropical areas of the land and 18 °C to 25 °C temperature normally required for more than 4 months where annually about 2000mm rainfall needed to sandy loam type of soil contains pH in between 5.5 to 7 is considered effective for good yield. Consequently, after soil preparation the seeds of the chilli planted during spring season in pots or trays in temperature controlled environment i.e. 20 °C (70 °F) then seeds sowed in outdoor seedbeds frost free environment and seedlings transplantation process will be initiated after buds have 4 to 5 leaves.

Approximately 45 cm between plants and approximately 75 cm gap between rows with10 cm mulch (Ashilenje, 2013) added during plantation (Ashrafuzzaman, Halim, Ismail, Shahidullah, & Hossain, 2011). For better yield fertilizers are usually recommended for the growth of red chilli but it is very important to be analyzed the soils chemical properties prior to selection of fertilizer in order to understand the available amount of organic matter in soil, soil pH, Phosphorous, nitrogen and potassium (Han & Lee, 2006). Similarly, irrigation system is pre-requisite because a chilli required approximately 600mm of water at developing stage either it is obtained from rainfall or irrigations (Dalla Costa & Gianquinto, 2002). Although sufficient amount of water required growing chilies plant during flowering and fruit set but due to its sensitivity waterlogging should be avoided, in order to prevent flower drop (Cochran, 1936). In this connection, Furrow and drip irrigations techniques are suggested by experts and applied worldwide (MA et al., 2011). In case of overhead irrigation method applied then it should be scheduled on morning as this system in the evening left the fruit and leaves wet which promote diseases, in this perspective plant should be dried before nightfall (Obradovic et al., 2004). Proper amount of nutrients, water and light and mulches added to control the weeds otherwise herbicides should be used to suppress weeds (Isik, Kaya, Ngouajio, & Mennan, 2009). Similarly, various types of pests i.e. American bollworm, cutworms, aphids, beetles, thrips, nematodes, red spider mites and associated diseases i.e virus, bacterial wilt and powdery mildew are attacked on red chilli crop. In order to counter these issues in addition to chemical treatments, field sanitation, crop rotation and good cultural practices should be applied. Chilies are a warm-climate crop, most Chili cultivars grow well in areas where the average temperature is 30°C for at least four to five months of the year (Ashilenje, 2013).

International Market & Trade Overview

Approximately 2020 thousands hectares area of the world is used for the cultivation of Chilli and about 3762 thousand tons of chilli produced from all over the world. According to 2013 statistics published by Food and Agriculture Organization of the United Nations (FAO), India is largest producer of chilli as 1376% thousand tons of chilli which is 36.57% of the total has been produced by this country, whereas, China 2nd, Thailand 3rd and Pakistan on 4th position in the chilli production, facts and figure revealed that area of production is only 65 hectors and production rate of 150 thousand tons despite of huge area available and production capacity the important cash crop of Sindh has a declining per acre yield production. There are number of reasons for decline in yield but major problems include mal-cultural practices, dieses during post-harvest stages, non-availability of standard seeds etc. Other countries like Vietnam, Myanmar, Bangladesh, Nigeria, Mexico and

Romania also producing chilli dominantly. Table 2.1 shows overall chilli productivity of different countries. From 2005 to 2013 the five year chillies production data , we found that average 1988.40 thousand hectares area of the whole world was used for cultivation of this product and average production was 3432.05 thousand tonnes, where per hectare average production was 1.73 thousand tonnes. Moreover, table 2.2 show that the production trend slightly increased in every year (Geetha & Selvarani, 2017).

Pakistan's Chilies Export and Production Overview

Pakistan is exporting significant quantity of chillies to various countries in the form of powder as well as whole dry chilli. Since last two decades, only in year 2007 -2008 export of chilies was un-economical due to bad crop harvest export. Quality and price of chilli is main factor influence the export of chillies. From 2005-2010 average annual export of red chilli was about 4951 tons. FAO facts and figures as shown above may vary but reflects that Pakistan is increasing its trade capacity in international market. Ministry of national food security and research (MNFSR) published data for the year 2013 to 2014 shows chilli in various forms exported and resultantly, Rs. 429 million (approximately) were added to the country revenue, which was further increased to Rs.569 million in 2014-2015 and this was the 33% increment became only possible due to government facilitations provided for the red chilli sector. Facts and figures show that production of chilli is considered valuable cash crop for country economy development. Most of the chilli exported to the Arab countries particularly Saudi Arabia, Bahrain, Kuwait, Qatar, Emirate, yaman, Oman and other like USA, Mexica, Canada etc. are also included. But aflatoxin ratio is higher than international standards lag behind the international market share because European Union(EU) and Japan banned due to aflatoxin level non-conformance. However, Pakistan has good quality and taste and government establishing some hydro plants as well as technical assistance in harvesting chilli to produce export quality. Table 2.3 and table 2.4 described country wise distribution of chilli powder as well as whole chilli respectively (Dr. Noor Ahmed Memon, 2015).

Introduction to Aflatoxin

The Greek words "mykes" meaning fungus and toksikon meaning is poison and combination of both refers to mycotoxicon. In 1960 Aspergillus flevus Linkex fries a kind of toxin of fungal origin was a compound named as "Aflatoxin", caused the death of 100,000 poultry birds in Turkey reported first time and initially this disease was termed as mycotoxin (Mohamed E. Zain, 2011). Basically, fungi is contagious item produce mycotoxins which can metabolite the system and this power of metabolite influence helps to create antibiotics in the form of penicillin that is used as a tool against bacterial infection. On the other hand phytotoxins products are harmful to plants due to fungal diseases as toxicity of mycotoxins directly affects the vertebrates and other animals even the amount of toxins found low. Parasitic metabolites of low-sub-atomic weight, for example, ethanol that are dangerous just in high focuses are not considered mycotoxins (Bennett & Klich, 2003). Mycotoxins as metabolic reactions of filamentous fungi or molds usually developed on various foods under the appropriate environmental conditions and their small molecular weight with diverse structure initiating serious jeopardies to human and animal health because variability in secondary metabolites may contain simple monilifomin to complex compounds like phomopsins (Dinis, Lino, & Pena, 2007). Despite more than 300 mycotoxins identified by the scientists and research studies are covered only those have dangerous to human health but it has been found that all molds and secondary metabolites are not toxic, however; aflatoxings(AF), ochratoxins (OT), trichothecenes, zearalenone (ZEN),fumonisins(F), tremorgenic toxins, and ergot alkaloids are considered crucially important for human health because these compounds put impact on human health, animal health and destroy agricultural yield as ecological conditions, storage of foods or feeds and environment being a mycotoxins developing factors often beyond the human control (Hussein & Brasel, 2001). Figure 2.5 shows chemical structure of mycotoxins.

Aflatoxin Contamination in Foods

Aflatoxin contamination of foods and feeds has gained global significance because of its deleterious effects on human as well as animal health. The marketability of food products is adversely affected by atlatoxin contamination. The harmful effects of consuming aflatoxin contaminated food products is well documented. The reported outbreaks of aflatoxicosis in man were due to the consumption of contaminated food. Circumstantial evidence has implicated groundnut meal containing aflatoxin as causing Indian childhood cirrhosis. Studies carried out in Kenya, Swaziland. Mozambique and Thailand have found a positive correlation between hepatocellular carcinoma and aflatoxin ingestion by man. The harmful effects of

consuming contaminated groundnut meal cake have mainly been observed in poultry and milch cattle. The effects in poultry include mortality, feed refusal, slow growth, fertility and reproduction problems. A 3 % live weight loss of poultry in USA representing a total weight loss of over 100 million kg of meat, worth 143 million IJS dollars has been estimated to be due to consumption of feed contaminated with mycotoxins. Aflatoxins have been detected as natural contaminants of many different foods such as corn, peanuts, cottonseed, nuts, almonds. figs, spices and a variety of other foods and feeds. Milk, eggs and meat products are sometimes contaminated because of consumption of aflatoxin contaminated feed by the animals. However, the commodities with the highest risk of aflatoxin contamination are corn, peanuts and cotton seed.

Toxin contamination of foods such as peanuts and cereal grains occur both at pre-harvest and post-harvest stages and during storage as a result of Improper drying or because of subsequent wetting of products not adequately protected from weather. 'This contamination is affected by an interrelationship 3f several factors including climate, geographical location. type of storage container and the mode of commodity handling and transport. Insect and rodent infestations also facilitate mold invasion of some stored commodities. Information with regard to aflatoxin contamination in cereals and oil seeds has been. related in thousands of scientific articles and news reports but comparatively lesser information is available about aflatoxin contamination in spices, which also form an important component of human diet. These spices were found to contain active principles, which are inhibitory to fungal growth and aflatoxin production, but they are quite vulnerable to mould contamination. depending on the climatic conditions under which they are stored (Madhyastha and Bhat 1985). Among the moulds, the species most frequently isolated are A. glaucus, A. restrictus, A, ochraceus and A. Javus, the latter capable of synthesising aflatoxins (Guarino 1973). Aflatoxin contamination also affects the international trade of the food products. To minimise the health risk, legislation has been passed in several countries restricting the level of aflatoxins in food products. Recently, several consignments having huge quantities of chillies, from Guntur in Andhra Pradesh were turned down by the importing countries because these chillies were contaminated with atlatoxins. So. analysis of spices for atlatoxins has become mandatory. Conventional chemical methods for aflatoxin analysis such as thin layer chromatography, Mini column Method, High Pressure Liquid Chromatography, Gas and Mass Spectroscopy are time consuming, laborious, expensive and require extensive sample clean.up. Recently efforts have been made to develop and use Enzyme- Linked Immunosorbent Assay (ELISA) for the determination of aflatoxin in food and feeds. The commercial kits for atlatoxin analysis based on enzyme immune assays are very expensive and many times import of kits becomes a problem.

Aflatoxin estimation by ELISA method is very simple, specific, fast and cost effective also. In addition to this large number of samples can be analysed within a short period. As aflatoxins are considered as unavoidable contaminants of our food supply, efforts have been directed towards detoxification of aflatoxin contaminated food. The application of physical methods, gamma irradiation, microwave treatment (Straton 1980 and Pluyer et al.,1987) and chemical methods (treating with chlorinating agents, oxidising agents and hydrolytic agents) alone or in combination provide varying effective means of aflatoxin degradation. Such treatment procedures are expected to be cost effective but their applicability is restricted by safety problems that may arise from chemical residues. (Samarajeewa et 01, 1990). So, physical detoxification by homescale cooking methods like roasting, boiling, fermentation, frying, baking, steaming etc was extensively investigated. (Farah e/ a/., 1983, Reddy 1984, Pluyer el UI., 1987, Mahjoab 1988 and Maria el u/,1 988). These normal food processing and preparation methods appear to cause an average of 60% degradation under laboratory conditions. However, all aflntoxins do not react equally to heating, for example aflatoxin 1-31 is heat stable, while aflatoxin GI can bc destroyed by heat (Reegner 1967). Also, the sensitivity of aflatoxins to heat is governed by environmental conditions. On one hand, the presence of moisture in roods may enhance degradation by hydrolising lactone ring at critical moisture and temperature levels. On the other hand, aflatoxins, may be protected in foods in part by their binding or association with proteins and other constituents. Aflatoxins are considered a major public health problem worldwide, especially in developing countries where facilities for long term storage of food and food products are often inadequate, and high temperature and high humidity encourage the growth of molds. Aflatoxins are toxic and carcinogenic to Inan and animals. Some groundnut producing countries are losing export earnings because they are not able to achieve the

permissible limits of aflatoxin set by importing countries (Gowda and Ramakrishna, 1997). Aflatoxin contamination is a major problem in many groundnut producing countries. Thus, the presence of aflatoxins in groundnut products has attracted the attention of the research investigators all over the world owing to a serious health problem caused by these mycotoxins. Aflatoxin formation in certain products before or after crop harvest cannot be prevented in any known practical way, but it can sometimes be reduced by appropriate management practices (Bhatnagar el al., 1998).

RESEARCH METHODOLOGY

The design of this study is quantitative in nature. In this study qualitative attributes of the red chilli i.e their taste, colour, shape and smell will not analyzed. However, quantitative variable is aflatoxin which is often found in different amount subjected to be investigated depend upon the independent variable geo sheet. Geo sheet is although main part of experimental design but its qualitative and quantitative attributes like weave, weight, area, thickness, nature of dyes, chemical treatment, material of sheet either synthetic or natural are not correlated except it is used for growth of the red chilli crop in order to estimate aflatoxin variability either reduced or increased. There are many other aspects pertains to production of red chilli are also considered constant therefore environmental temperature used for growing the red chilli, watering the plants and pesticides used etc. This experimental quantitative study has comparative methodology which further defines design in detail as geo sheets are effective treatment for controlling the aflatoxing level in the red chilli or not.

This study has been conducted in two phases for estimation of aflatoxins in red chilli. Basically, district Umerkot of Sindh province of Pakistan was selected for sampling / experiment due to its high production records available in previous research studies. The samples of red chili (locally called dandi cut variety) were collected from five chilies growing lands in and around Kunri, which was sown in late February to early March, and picked in the second week of September in the same year. There were five distinct areas Kunri, Mithi, Nagarparkar, Marjhango and Samro coded as A,B,C,D and E from which sample of 500 gm was collected randomly from different lots and whole experiment performed in two distinguished phases as shown in table 3.1.

For estimation and calculation of total aflatoxins the quantitative analysis of total aflatoxins underwent evaluation by the United States Department of Agriculture, Grain Inspection, Packers and Stockyards Administration (USDA-GIPSA). Under the authority of the United States Grain Standards Act, this test kit was found to meet or exceed all design and test performance criteria as defined in “Design Criteria and Test Performance Specifications for Quantitative Aflatoxin Test kits, September 2010 version”. This test kit is cited in the AOAC® Official Methods Program, as official method 991.31 applicable for the determination of aflatoxin B1, B2, G1 and G2 both by fluorometry and HPLC analysis. All statistical analyses were performed by using SPSS software (SPSS version 20, Inc., USA). With assistance of QI Macros for Excel, the statistics package for creating valuable charts and graphs.

Phase-I Pilot Study Methodology

The picked chilies were transferred to open-air drying fields, where the harvest was spread over sandy soil. To investigate the comparative occurrence of aflatoxin in defective and normal pods, separate samples were collected on completion of sun drying and categorized into following sub-samples each of 500gm true representative sample randomly. All the samples were collected in cotton bags and quickly transported to the laboratory and kept in sterile glass jars. The jars were kept in a refrigerator at 4°C. All samples were analyzed within a week for aflatoxin estimation.

- Normal Chilies
- Moldy Chilies
- Chilies with cap (with dandi cover)
- Chilies without cap (without dandi cover)

Phase-II Methodology

Total 120 samples from various suppliers are selected for investigating the difference of aflatoxin between red chili dried on sandy soil and geo textile, initially. Geo textile sheet were distributed among all supplier with training of good practices of sorting, lining and segregation of damaged / discolor and abnormal chili from whole crop to take best result. Dundi-cut whole red chili samples were collected from listed agricultural farms and send to laboratory with same sampling, estimation and testing protocol as discussed above in first phase Aflatest fluorometer procedure for red chili discuss under following scheme.

Scientific investigations for improvement of any product’s quality directly or indirectly access specific type of research instruments for data collection in order to ensure valid analysis and conclusions of the resultant

data. Detection of aflatoxin usually based on electronic equipment equipped with advance systems for precision and accuracy of the data. In this study affinity chromatography VICAM series 4 and 4EX fluorometer is used for research analysis of red chilli. Chromatographic technique for analysis of aflatoxin detection is widely used and acceptable by food industry around the world. Generally, research studies based on primary source of data and secondary source of data. Although primary data is collected by researcher from experiments or surveys according to the nature of study, but secondary data has critical importance because on the basis of secondary data researcher enables to find research gap. Secondary data is frequently cited from books, research journals, newspapers and internet sources. Collection of data is time consuming and difficult process. However, being a researcher of this project all efforts were made to achieve objectives of this research project and continuously focused on every stage of data collection. This research project is consists of both secondary and primary data. In order to gather relevant data from secondary sources different research work evaluated especially with the help of internet accessibility to the relevant literature is more convenient than conventional way of secondary data review. For primary data samples of red chilli collected from different five areas A,B,C,D and E of district Umerkot and samples were tested on chromatographic equipment, equipment after testing provided primary data for necessary evaluation and comparisons of aflatoxin detection with and without Geo sheets for drying red chillies.

DATA ANALYSIS & INTERPRETATION OF RESULTS

Total twenty number of observations has been taken from four distinct sorted categories known as chilies with dundi cap and without dundi cap, chilies considered normal with respect to its color and discolor chilies and being a pilot study only one sample of each grade four grades were collected from five distinguished areas of Sindh as A, B, C, D and E. Detail of case summary is shown in table 4.1 and table 4.2.

Experiment Analysis

Experiment performed in location C, total 12 number of samples evaluated as six samples of chili taken from batch produced without geo sheet and similarly six samples taken from batch produced with geo sheet. Mean value of Aflatoxin found in chili produced without geo sheet is 29.1 PPB whereas by using geo sheet the rate of aflatoxin dramatically reduced to 8.8 PPB. This shows the quality of chili towards improvement. Minimum value aflatoxin value observed in this experiment was 5.90 PPB and same is mode of the data explaining its repeatability. For this reason second experiment was performed to ensure reproducibility of the results may occur or not. However, summary of this experiment shown in table 4.34, statistical details as mentioned in table 4.35 to 4.38. Moreover table 4.39 and table 4.40 shows the correlation between the values observed with and without geo sheet. Figure 4.4 shows comparison of aflatoxin value observed.

Case Processing Summary – All Batches						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Chilie Category * Aflatoxin PPB	120	100.0%	0	0.0%	120	100.0%

Cumulative Statistics with and without Geo Sheet– All Batches		
Aflatoxin PPB		
N	Valid	120
	Missing	0
Mean		18.0542
Std. Error of Mean		.91518
Median		15.2500
Mode		7.90[a]
Std. Deviation		10.02524
Variance		100.506
Skewness		.294
Std. Error of Skewness		.221
Kurtosis		-1.422
Std. Error of Kurtosis		.438
Range		33.50
Minimum		5.90
Maximum		39.40
Sum		2166.50
a. Multiple modes exist. The smallest value is shown		

Aflatoxin PPB (All Batches with and without Geo Sheet)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5.90	2	1.7	1.7	1.7
	6.00	1	.8	.8	2.5
	6.40	2	1.7	1.7	4.2
	6.80	1	.8	.8	5.0
	6.90	1	.8	.8	5.8
	7.20	1	.8	.8	6.7
	7.30	2	1.7	1.7	8.3
	7.40	1	.8	.8	9.2
	7.50	2	1.7	1.7	10.8
	7.60	1	.8	.8	11.7
	7.80	2	1.7	1.7	13.3
	7.90	7	5.8	5.8	19.2
	8.00	2	1.7	1.7	20.8
	8.10	6	5.0	5.0	25.8
	8.20	2	1.7	1.7	27.5
	8.30	4	3.3	3.3	30.8
	8.50	1	.8	.8	31.7
	8.60	4	3.3	3.3	35.0
	8.70	1	.8	.8	35.8
	8.80	1	.8	.8	36.7
	9.20	1	.8	.8	37.5
	9.80	1	.8	.8	38.3

	9.90	1	.8	.8	39.2
	10.10	1	.8	.8	40.0
	10.20	1	.8	.8	40.8
	10.60	1	.8	.8	41.7
	11.10	1	.8	.8	42.5
	11.50	2	1.7	1.7	44.2
	12.30	2	1.7	1.7	45.8
	12.40	1	.8	.8	46.7
	12.70	1	.8	.8	47.5
	13.10	1	.8	.8	48.3
	13.40	1	.8	.8	49.2
	13.60	1	.8	.8	50.0
	16.90	1	.8	.8	50.8
	17.50	1	.8	.8	51.7
	18.40	1	.8	.8	52.5
	19.80	1	.8	.8	53.3
	19.90	1	.8	.8	54.2
	21.90	1	.8	.8	55.0
	22.00	1	.8	.8	55.8
	22.30	1	.8	.8	56.7
	22.40	1	.8	.8	57.5
	22.80	1	.8	.8	58.3
	23.00	2	1.7	1.7	60.0
	24.00	1	.8	.8	60.8
	24.10	1	.8	.8	61.7
	24.60	1	.8	.8	62.5
	24.90	1	.8	.8	63.3
	25.00	1	.8	.8	64.2
	25.60	1	.8	.8	65.0
	25.80	1	.8	.8	65.8
	25.90	1	.8	.8	66.7
	26.00	5	4.2	4.2	70.8
	26.30	1	.8	.8	71.7
	26.50	1	.8	.8	72.5
	27.00	3	2.5	2.5	75.0
	28.00	7	5.8	5.8	80.8
	28.10	1	.8	.8	81.7
	28.30	1	.8	.8	82.5
	29.00	7	5.8	5.8	88.3
	30.00	1	.8	.8	89.2
	30.10	1	.8	.8	90.0
	30.50	1	.8	.8	90.8
	31.00	2	1.7	1.7	92.5
	31.20	1	.8	.8	93.3
	33.00	1	.8	.8	94.2
	33.50	1	.8	.8	95.0
	34.20	1	.8	.8	95.8
	34.30	1	.8	.8	96.7
	37.00	1	.8	.8	97.5
	38.00	1	.8	.8	98.3
	39.00	1	.8	.8	99.2
	39.40	1	.8	.8	100.0
	Total	120	100.0	100.0	

Table 4.79 Chi-Square Tests– All Batches

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	120.000[a]	73	.000
Likelihood Ratio	166.355	73	.000
Linear-by-Linear Association	103.247	1	.000
N of Valid Cases	120		

a. 148 cells (100.0%) have expected count less than 5. The minimum expected count is .50.

Table 4.80 Symmetric Measures– All Batches

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Interval by Interval	Pearson's R	.931	.012	27.810	.000[c]
Ordinal by Ordinal	Spearman Correlation	.866	.000	18.851	.000[c]
N of Valid Cases		120			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

Discussion

The three main challenges faced by chili farmers are the use of low yielding seeds, lack of access to modern farming practices and techniques, and the high levels of aflatoxin in locally dried chili, which don't meet international export standards. Aflatoxin is naturally occurring toxins produced by molds in chilies. High levels are carcinogenic and can cause cancer. Aflatoxin levels in chilies are regulated in many countries and international standards restrict producers in Pakistan from exporting to the international market. Traditional practices by Pakistani producers of drying chilies on the ground can result in the produce being infested with high levels of aflatoxin. Chilli or pepper vegetable crop and botanically genus named as Capsicum annum L, which is belongs to Solanaceae family and regardless of originated from tropical America 7000 B.C used in Mexico. Chillies can be segregated on the basis of their size, pungent types and colour. There are more than 400 types of chillies has been reported all over the world. Chilli plants are very environment for continuous growth and usually nurture well in tropical areas of the land and 18 °C to 25 °C temperature normally required for more than 4 months where annually about 2000mm rainfall needed to sandy loam type of soil contains pH in between 5.5 to 7 is considered effective for good yield. Temperature controlled environment i.e. 20 °C (70 °F) and 45 cm between plants and approximately 75 cm gap between rows with10 cm mulch with suitable fertilizers are usually recommended.

Approximately 2020 thousands hectares area of the world is used for the cultivation of Chilli and about 3762 thousand tons of chilli produced from all over the world. According to 2013 statistics published by Food and Agriculture Organization of the United Nations (FAO), Pakistan on 4th position in the chilli production, facts and figure revealed that area of production is only 65 hectors and production rate of 150 thousand tons despite of huge area available and production capacity the important cash crop of Sindh has a declining per acre yield production. There are number of reasons for decline in yield but major problems include mal-cultural practices, dieses during post-harvest stages, non-availability of standard seeds etc. Since last two decades, only in year 2007 -2008 export of chilies was un-economical due to bad crop harvest export. Quality and price of chilli is main factor influence the export of chillies. From 2005-2010 average annual export of red

chilli was about 4951 tons. MNFSR published data for the year 2013 to 2014 shows chilli in various forms exported and resultantly, Rs. 429 million (approximately) were added to the country revenue, which was further increased to Rs.569 million in 2014-2015 and this was the 33% increment. But aflatoxin ratio is higher than international standards lag behind the international market share because European Union(EU) and Japan banned due to aflatoxin level non-conformance. Mainly, Pakistan cultivated two species C.annum and C. frutescens for export and domestic consumption. Sind Board of Investment (SBI) reports year 2010 describing the red chilli production was 90,000 tons whereas it was 188,827 tonnes in 2009-10, which was increased to 147,664 tonnes in 2013-14 s close to the 150,000 tonnes figured by FAO 2013. Sindh province of Pakistan is growing chillies dominantly higher than as compare to other provinces of Pakistan. More than 85% of total production contributes with 1.7 tons per hectare on 40 thousand hectares produced by Sindh province, lead to 53.7 thousand tons of chilies and this is approximately 1.5% towards GDP. Greek words "mykes" meaning fungus and toksikon meaning is poison and combination of both refers to mycotoxicon. In 1960 Aspergillus flevus Linkex fries a kind of toxin of fungal origin was a compound named as “Aflatoxin”, caused the death of 100,000 poultry birds in Turkey reported first time and initially this disease was termed as mycotoxin. More than 300 mycotoxins identified by the scientists and research studies are covered only those have dangerous to human health but it has been found that all molds and secondary metabolites are not toxic, however; aflatoxings(AF), ochratoxins (OT), trichothecenes, zearalenone (ZEN),fumonisins(F), tremorgenic toxins, and ergot alkaloids are considered crucially important for human health. Out of 300 mycotoxins, currently 18 different types of aflatoxins have been identified related to difuranocoumarins group fromed by Aspergillus jlavus and A.spergillus purusiliclr.s in greenish colour. Most important types of Aflatoxins are B1, B2, G1 and G2, identified by their light emitting wave lengths like UV and distinct colour, whereas M1 and M2 are metabolites of B1 and B2 after hydroxylation. The reported outbreaks of aflatoxicosis in man were due to the consumption of contaminated food. Aflatoxins have been detected as natural contaminants of many different foods such as corn, peanuts, cottonseed, nuts, almonds. figs, spices and a variety of other foods and feeds. Milk, eggs and meat products are sometimes contaminated because of consumption of aflatoxin contaminated feed by the animals. However, the commodities with the highest risk of aflatoxin contamination are corn, peanuts and cotton seed. Aflatoxin contamination also affects the international trade of the food products. To minimise the health risk, legislation has been passed in several countries restricting the level of aflatoxins in food products. Conventional chemical methods for aflatoxin analysis such as thin layer chromatography, Mini column Method, High Pressure Liquid Chromatography, Gas and Mass Spectroscopy are time consuming, laborious, expensive and require extensive sample clean.up. Recently efforts have been made to develop and use Enzyme- Linked Immunosorbent Assay (ELISA) for the determination of aflatoxin in food and feeds.

CONCLUSION AND RECOMMENDATIONS

Essentially, ten experiments were performed and at least two experiments were performed on each location respectively. It is also mentioned that previous sections shows correlation is not significant due to less size of sample representing each experiments despite statistical results shows after use of geo sheet Aflatoxin level drastically decreased. Improper post-harvest handling practices at farm level played important role to increase the contamination of aflatoxin in chilies. The aflatoxin in Moldy pods was found to be highest amongst other types of pods. It is therefore suggested to separate the Moldy and opened viscera pods from the lot that may decrease the risk of further increase in the level of aflatoxin contamination. This type of practice may help the chili growers to maintain the required standards of quality of their produce and capable to supply aflatoxin free chili to the processors. Consequently, the availability of safe chili for domestic population and export will be a step forward to combat the food safety issues and to support the economic affairs of Pakistan.

Geo sheet is recommended for better control of aflatoxin level to meet the international standards.

REFERENCES

Ashilenje, D. S. (2013). *Learn how to grow peppers. 1ra ed. Nairobi (Kenya).* Phoenix Publishers Limited.

Ashrafuzzaman, M., Halim, M. A., Ismail, M. R., Shahidullah, S. M., & Hossain, M. A. (2011). Effect of plastic mulch on growth and yield of chilli (Capsicum annuum L.). *Brazilian Archives of Biology and Technology, 54*(2), 321–330.

Bennett, J. W., & Klich, M. (2003). Mycotoxins Clin Microbiol Rev 2003; 16: 497–516. *CrossRef*| *PubMed*| *CAS*| *Web of Science® Times Cited, 428*.

Cochran, H. L. (1936). *Some factors influencing growth and fruit-setting in the pepper (Capsicum frutescens L.)*: The University; New York.

Cserhati, M., Kriszt, B., Krifaton, C., Szoboszlay, S., Hahn, J., Tóth, S., . . . Kukolya, J. (2013). Mycotoxin-degradation profile of Rhodococcus strains, *166,* 176–185.

Dalla Costa, L., & Gianquinto, G. (2002). Water stress and watertable depth influence yield, water use efficiency, and nitrogen recovery in bell pepper: lysimeter studies. *Australian journal of agricultural research, 53*(2), 201–210.

Diener, U. L., & Davis, N. D. (1969). Production of aflatoxin on peanuts under controlled environments. *Journal of Stored Products Research, 5*(3), 251–258.

Dinis, A. M., Lino, C. M., & Pena, A. S. (2007). Ochratoxin A in nephropathic patients from two cities of central zone in Portugal. *Journal of pharmaceutical and biomedical analysis, 44*(2), 553–557.

Dr. Noor Ahmed Memon. (2015). Export of Red Chilli decreased from Pakistan due to ban by EU and Japan. Retrieved from foodjournal.pk/2015/September-October-2015/PDF…/Exclusive-on-Chillies.pdf

Geetha, R., & Selvarani, K. (2017). A STUDY OF CHILLI PRODUCTION AND EXPORT FROM INDIA. *Romania, 51*(2.56), 47.725.

Han, H.-S., & Lee, K. D. (2006). Effect of co-inoculation with phosphate and potassium solubilizing bacteria on mineral uptake and growth of pepper and cucumber. *Plant soil and Environment, 52*(3), 130.

http://www.cfs.gov.hk. (2001). Risk Assessment Studies Report No. 5: Chemical Hazards Evaluation Aflatoxin in Foods. Retrieved from http://www.cfs.gov.hk

Hussein, H. S., & Brasel, J. M. (2001). Toxicity, metabolism, and impact of mycotoxins on humans and animals. *Toxicology, 167*(2), 101–134.

Isik, D., Kaya, E., Ngouajio, M., & Mennan, H. (2009). Weed suppression in organic pepper (Capsicum annuum L.) with winter cover crops. *Crop Protection, 28*(4), 356–363.

Kiran Maye, D. (1999). *Incidence of aflatoxin contamination in selected spice samples in Andhra Pradesh.* Acharya NG Ranga Agricutlrual University.

MA, S.-l., WANG, T.-l., ZHANG, Y.-l., LI, B., ZHAO, Y., & SUN, J. (2011). Experimental Research on the Lower Limit of the Most Appropriate Soil Moisture Content for Green Pepper Irrigation under Drip Irrigation in Greenhouse [J]. *China Rural Water and Hydropower, 2,* 20.

Mansour, N. S. (1993). *Grow your own peppers.*

Mazida, M. M., Salleh, M. M., & Osman, H. (2005). Analysis of volatile aroma compounds of fresh chilli (Capsicum annuum) during stages of maturity using solid phase microextraction (SPME). *Journal of Food Composition and Analysis, 18*(5), 427–437.

Mohamed E. Zain. (2011). Impact of mycotoxins on humans and animals. *Journal of Saudi Chemical Society, 15*(2), 129–144. doi:10.1016/j.jscs.2010.06.006

Obradovic, A., Mavridis, A., Rudolph, K., Janse, J. D., Arsenijevic, M., Jones, J. B., . . . Wang, J.-F. (2004). Characterization and PCR-based typing of Xanthomonas campestris pv. vesicatoria from peppers and tomatoes in Serbia. *European Journal of Plant Pathology, 110*(3), 285–292.

Rylski, I., & Spigelman, M. (1982). Effects of different diurnal temperature combinations on fruit set of sweet pepper. *Scientia Horticulturae, 17*(2), 101–106.

SBI (Ed.). *Red Chilli De-Hydration Plant – Kunri, Sindh*: Sindh Board if Investment.