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IMPACT OF BLUE LIGHT FOR THE REDUCTION OF AFLATOXIN LEVEL IN STORED WHEAT

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ABSTRACT

Aflatoxin is the potent mycotoxin and is known as highly carcinogenic. Contamination caused by the aflatoxin during storage can reduces the quality of every cereals. Wheat is the important cereal consumed globally and found heavily contaminated with mycotoxins. Many methods were employed for the decontamination of these deadly aflatoxins from wheat but due to their stability towards temperature and environment mycotoxins cannot be completely eliminate from the wheat but present study has design with the objective of level reduction of aflatoxin up to permissible limits set by FDA (20ng/g). Blue light was used for the decontamination purpose as it bears similarity with UV light with a emitting light diode and production of one oxygen atom, but is not harmful as UV light and does not causes DNA mutation nutrient destruction.Wheat were exposed under simple blue light was and found to reduce aflatoxin level significantly. Blue light irradiation causes aflatoxin reduction from wheat grain when exposed as open grain or grain packed in the sack for specific time duration of 0, 5, 15 and 30 hours. The results revealed that

aflatoxin level were decreases more under long length of time of exposure that is after 30 hours the35 to 50% reduction was observed in open grain moreover 18 t0 39% reduction in level of aflatoxin was recorded in wheat grain packed in sack. Residues remained after blue light irradiation treatment was recorded under maximum residue limit, and also residues level reduced more after the exposure time of 30 hours (open grain 8-14ng/g and grain in sack 11-18ng/g). Therefor it was find from current study that Blue light was one of effective methods in regard of aflatoxin level reduction or decontamination and provide safe wheat for food and feed purpose and supportive for the agricultural countries to compete in the national and international demands.

Key Words: blue light, aflatoxin, decontamination, wheat, godown

INTRODUCTION

Among all cereals wheat is on the 1st rank and is recognised as chief dietary source of Pakistan (1). Wheat can be contaminated by various microscopic fungi during its development and storage that can affect grain quality, chemical properties as well as its rheological characteristics (2). Fungal genera such as *Aspergillus, Penicillum, Fusarium, Altenaria* and *Claviceps* generatevarious secondary metabolites called mycotoxin, whereas the aflatoxin is the type of mycotoxin which is identified in the 1st group of carcinogenicity by agency of research on cancer and produced by *A. parasiticus and A. flavus*(3,4). Aflatoxin contaminate variety of food including more commonly cereals i-e wheat, maize, barley and ricereported by FAO/WHO (5). Hot and humid atmosphere of Pakistan favours the production of mycotoxins that will further colonize during storage due to improper storage conditions (6, 7). Worldwide situation for storing wheat grain is not satisfactory and toxin are not being regulated (8,9) and 40% of the agricultural products lost every year due to aflatoxin contamination in developing countries (10). It is very difficult to eradicate aflatoxin from food commodity due to their thermal and environmental stability (11).Therefore many methods like roasting, gamma rays exposure, UV, sunlight, and microwave heating was examined for aflatoxin level reduction (12,13,14). Scientific study suggest that irradiation sources were mostly used for the decontamination purpose (15). UV-C used as germicidal for aflatoxin and other mycotoxin (16, 17). UV radiation at 365 nm wavelength destroy mycotoxins(18). Bennett *et al.* (1981) found no growth of aflatoxin under light at

temperature 35°C and 40°C, whereas normally growth of aflatoxin was found good at this temperature (19). It was stated that aflatoxin B1 was tainted under UV radiation (Lillard&Lantin, 1970) (20). It was well known that UV light induces cell death by DNA mutation, cellular destruction and creating toxicity and damage in gene, whereas UV light bears similarities with simple blue light in the emitting light diode with production of one oxygen, so using UV as decontaminate source found little problematic and periloushence current study has been conceptualized to observe the effects of simple blue light as decontaminate source under the shade of many modern literature.This simple and cost effective method has ensure to retain the nutritive value and have been employed for the decontamination purpose that can be easily applied for the bulk quantity of wheat during storage at godowns the common wheat store houses.

MATERIAL AND METHODS

Wheat sampling

Wheat was sampled from the government godowns of Hyderabad division namely Bolhari, Hali road, Fatah chowk, Hala city, Matiyaari, Thatta, Tandpallhyaar, Dadu, KhairpurNathan Shah, Sehwan and Aarazi. Temperature and humidity was the major factor for colonization of mycotoxins therefore these both parameters were consider in the studyand 37-52°C of temperature and 40-70% of humidity were recorded in each godowns during all visits. Wheat was taken from the upper, central and bottom sack of one selected specific stack of wheat.

Mycological Study

Agar plate method was used for the determination of Mycofloradescribed by Mathur*et al*. (2003) (21). Calculation of relative isolation frequency (Fq.) of *Aspergillus parasiticus and Aspargillusflavus* (aflatoxin producing fungi) was done by the method ofFatmaBensassi*et al*.,2011 (22).

Decontamination by Blue light

Commercially available source for blue light was used (Sky light 25watt made in China). Emitting blue light of visible range were used for the decontamination of aflatoxin.Under the blue light wheat wereplaced openly and packed in the common packaging material used for wheat grain at godowns and time exposure for the both (open grain and packed grain) were 0, 5, 15, 30 hours.

Sample Preparation

After irradiation wheat samples was ground and 25ml of 70% methanol was added and shake for three minutes by hand or mechanical shaker then filter through

whatman no.1 filter paper and filtrate was collected and saved for the analysis.

Sample analysis

Collected filtrate was used for the analysis by Enzyme linked immunosorbent assay (ELISA) technique and commercially immunoassay kit i-e Neogen ELISA Kit (Veratox , Product no. 8030) was used, the kit was based on competitive direct enzyme linked immunosorbent assay format. Concentration was calculated by ELISA 'state fax 2100' (Awareness technology).

Data Analysis

All the experiments had three replicates. Data was analyzed for one-way analysis of variance followed by Student-Newman-Keuls multiple test at 0.05 level using compare means procedure of SPSS 16 (18)

RESULTS AND DISCUSSION

The table-1 shows wheat grain were treated with blue light under different time exposure of 5, 15 and 30 hours and observed the wavelength dependent reduction of aflatoxin and high decontamination were observed in blue light after 30 hour time duration exposure among both samples of open grain (35 to 50%) wheat and wheat grain closed in sacks (18 t0 39%) and residues were also under the permissible limits after 15 and 30 hour divulgement.

Table 1:Reduction percentage (%) of Aflatoxin after Blue light Irradiation treatment

	Hours (0)	Hours (5)	Hours (15)	Hours (30)
Godowns	**Open Grain**			
Bolhari	**0**	**5^{a}**	**10^{a}**	**36^{a}**
Hali road	**0**	**6^{a}**	**14^{ab}**	**42^{ab}**
Fateh Chowk	**0**	**5^{a}**	**16^{ab}**	**38^{ab}**
Hala city	**0**	**5^{a}**	**22^{ab}**	**44^{ab}**
Matiari	**0**	**6^{a}**	**22^{ab}**	**47^{ab}**
Thatta	**0**	**5^{a}**	**18^{ab}**	**43^{ab}**
TandoAllahyar	**0**	**7^{a}**	**23^{b}**	**38^{ab}**
Dadu	**0**	**9^{a}**	**25^{ab}**	**40^{ab}**
Khairpur Nathan Shah	**0**	**6^{a}**	**17^{ab}**	**43^{ab}**
Sehwan	**0**	**10^{a}**	**14^{ab}**	**47^{b}**
Aarazi	**0**	**6^{a}**	**26^{ab}**	**50^{ab}**
F-Statistics at df = 32		**2.8**	**2.4**	**2.9**
Grain in sacks				
Bolhari	**0**	**2^{a}**	**7^{a}**	**18^{a}**
Hali road	**0**	**0^{ab}**	**7^{a}**	**21^{ab}**
Fateh Chowk	**0**	**1^{ab}**	**10^{a}**	**27^{ab}**
Hala city	**0**	**3^{ab}**	**6^{a}**	**33^{ab}**
Matiari	**0**	**3^{ab}**	**7^{a}**	**26^{ab}**
Thatta	**0**	**2^{ab}**	**10^{a}**	**31^{ab}**
TandoAllahyar	**0**	**3^{ab}**	**7^{a}**	**23^{a}**
Dadu	**0**	**4^{ab}**	**10^{a}**	**22^{ab}**
Khairpur Nathan Shah	**0**	**3^{ab}**	**8^{a}**	**34^{ab}**
Sehwan	**0**	**4^{b}**	**3^{a}**	**26^{ab}**
Aarazi	**0**	**4^{ab}**	**5^{a}**	**39^{b}**
F-Statistics at df = 32		**2.5**	**0.9**	**2.4**

Values followed by the same letter are not significantly different at 0.05 level Student-Newman-Keuls test.

Figure 1a and 1b showing positive correlation among exposure time and reduction of aflatoxin level. The decontamination rate increases with increase in exposure time therefore the samples exposed for 30 hours under open sun rays was showed more reduction in aflatoxin percentage in open grain and same results was noted for the wheat grain packed in sack.

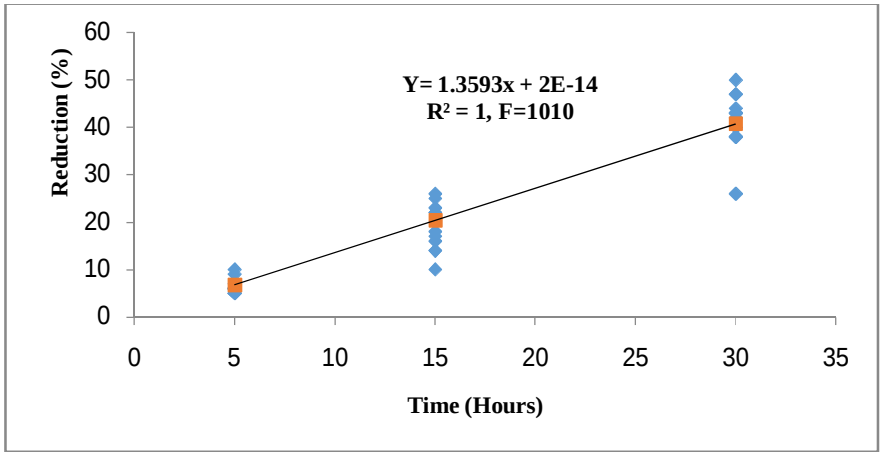

Figure 1a: Regression curve of Aflatoxin reduction (%) in relation with Blue light exposure time of open wheat grain

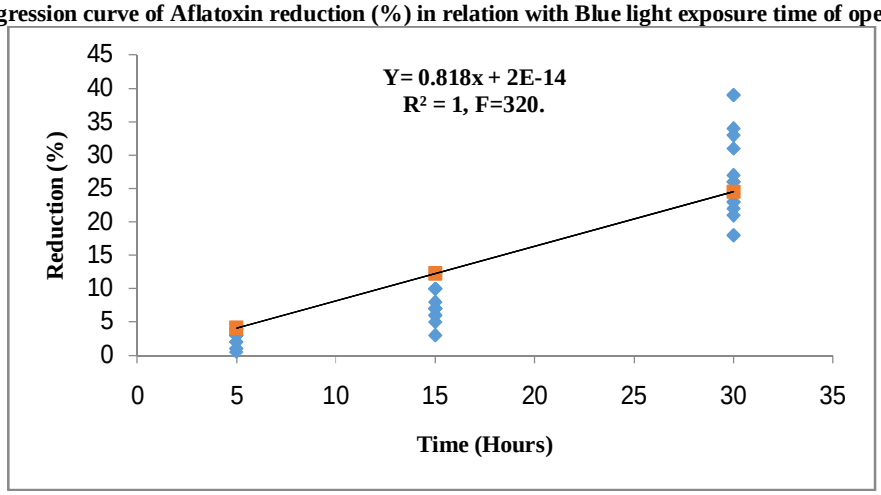

Figure 1b: Regression curve of Aflatoxin reduction (%) in relation with Blue light exposure time of wheat grain packed in sacks

Data in table 2 shows the aflatoxin residues remaining after solar irradiation, residues was observed within the permissible range of aflatoxin (20 ng/g) set by FDA. After 30hours exposure residues become under the permissible ranges in open grain (8-14ng/g) and grain packed in sack (11-18ng/g).

Table 2: Residues (ng/g) remaining after Blue light Irradiation treatment

	Hour (0)	Hours (5)	Hours (15)	Hours (30)
Godown	Open Grain			
Bolhari	22[a]	20.7[a]	19.6[a]	14[a]
Hali road	19[a]	17.8[a]	16.3[a]	11[a]
Fateh Chowk	18[a]	17[a]	15[a]	11[a]

Hala city	**18** [a]	**17** [a]	**14** [a]	**10** [a]
Matiari	**15** [a]	**14** [a]	**11.7** [a]	**7.9** [a]
Thatta	**16** [a]	**15.1** [a]	**13** [a]	**9** [a]
TandoAllahyar	**13** [a]	**12** [a]	**10** [a]	**8** [a]
Dadu	**22** [a]	**20** [a]	**16.3** [a]	**13** [a]
Khairpur Nathan Shah	**23** [a]	**21.6** [a]	**19** [a]	**13** [a]
Sehwan	**23** [a]	**20.6** [a]	**19.6** [a]	**12** [a]
Aarazi	**22** [a]	**20.6** [a]	**16.1** [a]	**10.8** [a]
F-Statistics atdf = 32	**1.2**	**1.1**	**1.2**	**1.4**
Grain in sacks				
Bolhari	**22** [a]	**21.4** [a]	**20.4** [a]	**18** [a]
Hali road	**19** [a]	**19** [a]	**17.5** [a]	**15** [a]
Fateh Chowk	**18** [a]	**17.7** [a]	**16.2** [a]	**13** [a]
Hala city	**18** [a]	**17.3** [a]	**16.9** [a]	**12** [a]
Matiari	**15** [a]	**14.5** [a]	**13.9** [a]	**11** [a]
Thatta	**16** [a]	**15.6** [a]	**14.3** [a]	**11** [a]
TandoAllahyar	**13** [a]	**12.6** [a]	**12** [a]	**10** [a]
Dadu	**22** [a]	**21** [a]	**19.7** [a]	**17** [a]
Khairpur Nathan Shah	**23** [a]	**22.1** [a]	**21** [a]	**15** [a]
Sehwan	**23** [a]	**22** [a]	**22.3** [a]	**17** [a]
Aarazi	**22** [a]	**21** [a]	**20.8** [a]	**13.3** [a]
F-Statistics atdf = 32	**0.8**	**0.8**	**0.8**	**1.1**

Values followed by the same letter are not significantly different at 0.05 level Student-Newman-Keuls test.

DISCUSSION

The present study were supported by Luuca*et al.* (2102) that only Blue light significantly reduced bacterial and FG possibility. Blue light is has lethal effect against bacteria and filamentous fungi but purity of light is the 1st priority in its effectiveness (24). Staphylococcus were found to loose activity under high-strength light of visible region, and, further specifically, it was found that inactivation of S. aureus occurs upon exposure to blue light of wavelengths between 400 and 420nm, with maximum inactivation occurring at 405 - +5nm (25). The results also consistent with Seung*et al.* (2012) that LED having antifungal effect against Malassezia species. UV light bears similarities with blue light in the emitting light diode with production of one oxygen (26).

It was well known that UV light induces cell death by DNA mutation, cellular destruction and creating toxicity and damage in gene. In present study the way was found wavelength dependent antifungal light which induced the intracellular and extracellular production without DNA damage (27, 28). Solar radiations also showed positive correlation between the time and aflatoxin level reduction in stored wheat (31).

Residues after 160 minutes under UV radiation treatment were lessen the level of aflatoxin in wheat samples taken from storage houses of Hyderabad division and residues were found within permissible limit set by FDA (20ng/g) (12). Trombete *et al.* (2014) assessed highest contamination of aflatoxin found in whole wheat grain whereas the overall average was 0.69 µg/kg which was under the limit of Brazilian

legislation (5 µg/kg) only one sample exceeding this limit. Aflatoxin concentration was found reported within permissible limit in summer and winter wheat (30).

CONCLUSION

It was sum up from the present study that aflatoxin level reduction rate increase with increase in exposure time and residues were noted in the range of permissible level. More aflatoxin reduction was observed in wheat after 30 hours exposure in both open grain and in wheat grain packed in sack as well, therefore wheat can be protected from the contamination by exposing the wheat to direct blue light at the godowns which reduces the moisture content of grain and provide conditions unsuitable for growth of aflatoxin producing fungi and wheat can be stored for maximum period of time with lowest contamination ratio.

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