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STORAGE SUITABILITY FOR ELABORATION OF AFLATOXIN IN CEREALS[1]

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ABSTRACT

67 composite samples of cereals (paddy, wheat, maize and barley) made out of 170 samples obtained from different storage systems of Bihar were analysed for quantitative elaboration of aflatoxins in them. Sotrge systems have been found to be specific for particular cereals in supporting synthesis for higher amount of toxins. Toxigenicity of *Aspergillus flavus* isolates (124) obtained from these samples were also tested. 35% of the isolates were toxigenic. These aspects have been discussed in relation to the available conducive conditions in the storage systems.

INTRODUCTION

Aflatoxins are known to contaminate a wide range of consumable substrates including various types of food and feed. Substantial literature is available regarding aflatoxin contamination in cereals (Hesseltine, 1974; Krishnamachari *et al.* 1975; Sreenivasamurthy, 1975; Bilgrami *et al.* 1981 and Bilgrami 1984). Reports regarding their contamination in relation to storage practices are however scanty. After harvest cereal grains are stored for varying length of time. 82% grains are stored in traditional storage structures, out of which 20% of grains are reported to get damaged due to mould contamination and toxin elaboration. It was, therefore considered desirable to study the impact of storage systems on quantitative elaboration of aflatoxins in stored grains.

The different types of storage systems commonly used by the farmers of Bihar are (1) Kothi (2) Mora (3) Bukhari (4) Chatka (5) Earthen pot (6) Gunny bag (7) Iron bin. Kothi is a vertical and cylindrical structure made of mud and paddy husk, having an inlet and an outlet. Mora is made of paddy hay ropes in form of a container. Bukhari is made of bamboo or arhar sticks. Grains kept in it are packed by paddy husks both at top and bottom. Chatka is also a cylindrical structure made up of woven bamboo strips.

MATERIAL AND METHOD

170 samples of cereals viz. paddy wheat, maize and barley were collected from different parts of Bihar from various storage structures. 67 composite samples were prepared on the basis of various collections. Isolation of mycoflora associated with different samples was done by the standard blotter and agar plate methods (ISTA, 1966).

Extraction of aflatoxin from the samples was done by modified Seitz and Mohr method (1977). Qualitative and

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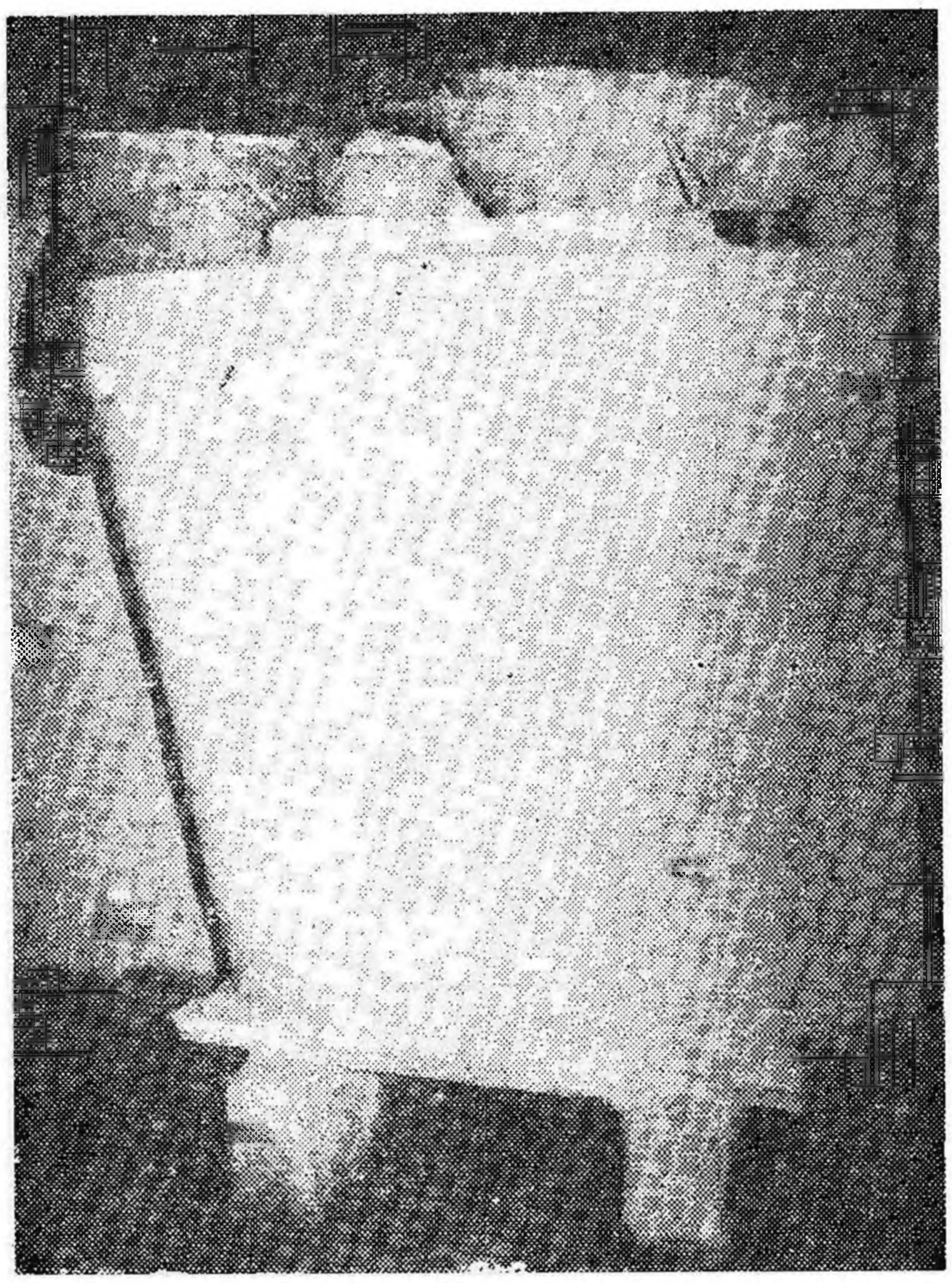
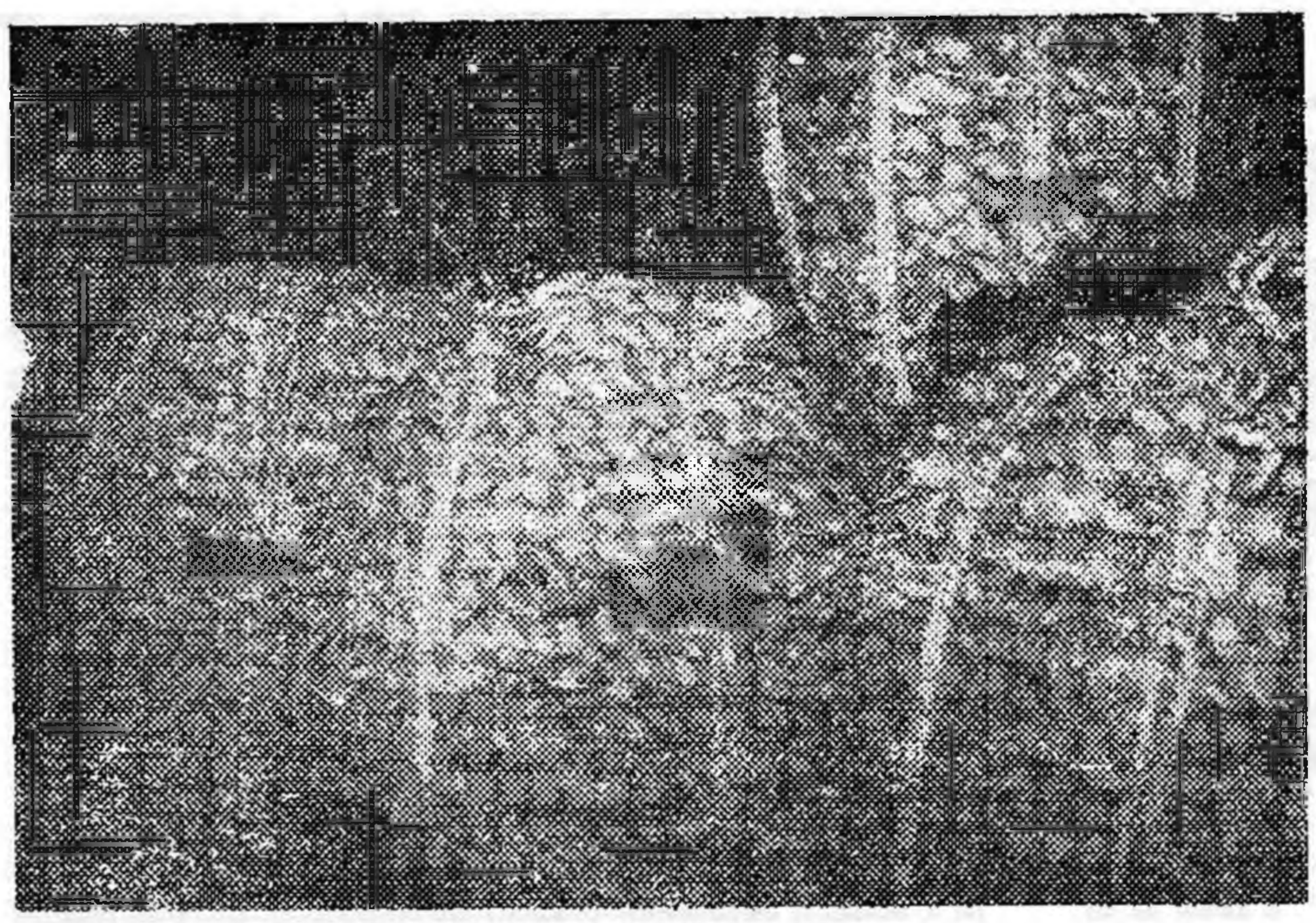
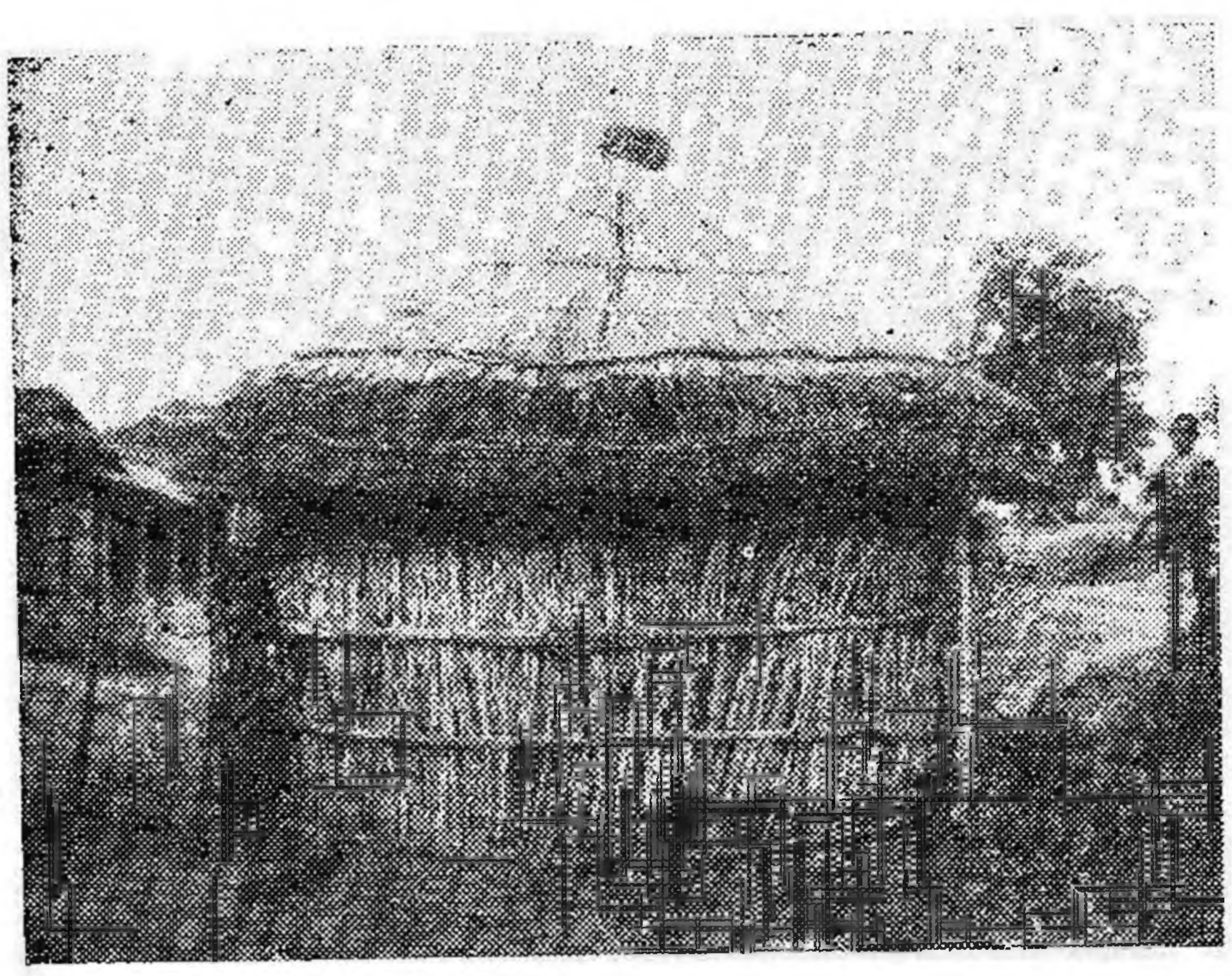
quantitative analyses of aflatoxins was done by the method of Reddy *et al.* (1970) and Nabney and Nesbitt, (1965) respectively. Identity of aflatoxin was confirmed chemically by trifluoroacetic acid (Stack & Pohland, 1975). The aflatoxin producing potential of *Aspergillus flavus* isolate was tested in SMKY liquid medium (Diener and Danis, 1966).



KOTHI



MORA



BUKHARI

RESULT AND DISCUSSION

Altogether 19 fungal species were isolated from different cereals obtained from various storage systems (Table I) of which *Aspergillus flavus* was found to be dominant.

Maximum natural contamination of aflatoxin in paddy (Table II) was in grains obtained from Mora (Afl. B_1-2830 ppb; Afl. G_1 -180 ppb) followed by Kothi; Chatka, Bukhari and Gunny bag. Lowest amount of aflatoxin was extracted from the seeds obtained from Iron bin i.e. 810 ppb of B_1.

In wheat (Table-III), highest amount of aflatoxin was elaborated in the grains collected from Kothi storage (Afl. B_1-1830 ppb) followed by Bukhari and Gunny bag. Seeds stored in Iron bin contained lowest amount of aflatoxin i.e. 650 ppb. Maize also presented a similar pattern of contamination. Highest amount of aflatoxin was extracted from the grains obtained from Kothi and lowest from Iron bin (Table-III). In barley, out of the two storage systems elaboration of aflatoxin B_1 in Gunny bag was 240 ppb whereas in samples collected from Iron bin it was present in traces only.

Seeds from all the storage systems had the association of toxigenic strain of *Aspergillus flavus* (Table-IV). Out of 62 isolates of *A. flavus* from paddy, 22 were toxigenic and from wheat out of 26 isolates, 10 were toxigenic. Toxigenic isolates were 10 and 2 respectively out of 26 and

TABLE I

% INCIDENCE OF SEED MYCOFLORA ON CEREALS FROM DIFFERENT STORAGE SYSTEMS

Fungi	PADDY						WHEAT				MAIZE				BARLEY	
	Mora	Kot-thi	Cha-tka	Buk-hari	G. bag	I. bin	Ko-thi	Buk-hari	G. bag	I. bin	Ko-thi	Mora	G. bag	I. bin	G. bag	I. bin
Alternaria alternata	21	42	26	14	15	13	18	7	4	—	10	12	—	—	4	—
Aspergillus candidus	2	—	—	4	—	—	5	—	—	2	1	—	—	1	—	—
A. flavus	34	42	28	24	20	19	32	30	19	15	35	27	16	14	17	1
A. niger	—	—	6	—	2	—	10	12	11	—	9	7	4	5	5	4
A. parasiticus	14	9	7	7	—	—	8	5	5	—	9	5	1	1	—	11
A. ochraceous	—	11	—	—	—	—	—	—	1	—	5	11	—	—	—	—
Chaetomium globosum	9	5	—	2	—	—	5	4	3	3	—	—	—	—	—	—
C. indicum	3	2	—	—	—	—	8	4	3	3	3	4	—	—	2	—
Circinella simplex	—	—	—	—	—	—	—	3	4	—	—	7	—	—	—	—
Curvularia lunata	14	12	10	10	—	—	7	—	—	—	5	3	—	1	2	3
Drechslera hawaiiensis	9	11	—	—	2	5	—	—	—	—	—	—	—	—	—	—
Fusarium moniliforme	11	15	9	—	8	10	8	5	3	3	7	3	2	—	2	—
F. oxysporum	7	6	3	5	—	—	2	—	—	—	—	7	—	2	—	—
F. semitectum	4	8	—	—	2	2	6	—	—	—	2	5	—	—	—	—
Penicillium citrinum	3	11	5	1	—	—	—	5	—	—	—	2	—	1	—	—
P. islandicum	—	8	—	—	—	—	2	1	1	1	1	1	—	—	—	1
Trichothecium roseum	11	5	—	—	—	13	—	—	—	—	—	—	—	—	—	—
Rhizopus nigricans	3	8	5	—	2	—	10	7	—	—	—	—	—	—	1	2
Nigrospora sphaerica	—	—	—	—	—	—	—	—	—	—	7	—	—	—	1	1

TABLE II

NATURAL OCCURRENCE OF AFLATOXIN IN PADDY UNDER STORAGE SYSTEM

Commodity	Storage system	No. of composite sample	No. of sample +ve to aflatoxin	Amount of aflatoxin produced	
				Aflatoxin B_1 (ppb)	Aflatoxin G_1 (ppb)
PADDY	Mora	9 (27)	3	1240-2830	180
	Kothi	6 (18)	2	T-2280	174
	Chatka	6 (18)	2	1184-2140	
	Bukhari	5 (15)	2	T -1240	90
	Earthen pot	5 (15)	1	1130	—
	Gunny bag	5 (15)	1	1080	—
	Iron bin	5 (10)	1	810	—

TABLE III

NATURAL OCCURRENCE OF AFLATOXIN IN WHEAT, MAIZE AND BARLEY UNDER DIFFERENT STORAGE SYSTEMS

Commodity	Storage system	No. of sample composite	No. of sample +ve to aflatoxin	Amount of toxins produced	
				Aflatoxin B_1 (ppb)	Aflatoxin G_1 (ppb)
WHEAT	Kothi	3 (6)	2	245-1830	—
	Bukhari	3 (6)	2	1050-1640	70
	G. bag	3 (6)	2	Trace-1260	—
	I. Bin	3 (6)	1	650	—
MAIZE	Kothi	2 (4)	2	Trace-1740	110
	Mora	2 (4)	1	1225	—
	G. Bag	2 (4)	1	1020	—
	I. Bin	2 (4)	1	826	—
BARLEY	G. Bag	4 (8)	1	240	—
	I. Bin	2 (4)	1	Trace	—

TABLE IV

AFLATOXIN PRODUCING POTENTIALS OF *A. flavus* ISOLATES

Cereals	Storge system.	Total no. of isola-tes	No. of toxigenic isolates	Aflatoxin production					Amount of afla-toxin B_1 (ppm)
				B_1	B_1B_2	B_1G_1	$B_1B_2G_1$	$B_1B_2G_1G_2$	
PADDY	Mora	10	5	2		2	1	—	30
	Kothi	10	5	3	2	2	—	—	28
	Chatka	10	4	2		2	—	—	24
	Bukhari	8	2	2		—	—	—	22.5
	Earthen Pot	8	2	2		—	—	—	25
	G. Bag	8	2	1		1	—	—	21.2
	I. Bin	8	2	1		1	—	—	19
WHEAT	Kothi	8	3	2		1	—	—	23.6
	Bukhari	8	3	1		2	—	—	18.4
	G. Bag	5	2	1		1	—	—	15.8
	I. Bin	5	2	2		—	—	—	11.9
MAIZE	Kothi	8	3	2	1	—	—	—	24.7
	Mora	8	3	2	—	1	—	—	20.5
	G. Bag	5	2	2		—	—	—	16.8
	I. Bin	5	2	2	—	—	—	—	12.5
BARLEY	G. Bag	5	1	—	—	1	—	—	5.54
	I. Bin	5	1	1	—	—	—	—	4.9

10 isolates obtained from maize and barley.

In paddy, highest amount of aflatoxin B_1 was elaborated by the isolates obtained from Mora (30 ppm) followed by Kothi, Earthen pot, Chatka and the lowest amount was from that of Iron bin (19 ppm).

Potentiality of *A. flavus* isolates obtained from wheat to produce aflatoxin ranged from 11.9 ppm to 23.6 ppm, highest being from isolate obtained from Kothi (23.6 ppm) and lowest from iron bin (11.9 ppm). Isolates from maize exhibited more or less similar pattern. Highest concentration of aflatoxin was produced by the isolates obtained from Kothi grains and lowest from that of Iron bin.

Almost similar amount of aflatoxin was produced by the isolates from barley obtained from Gunny bag and Iron bin.

From the above results it is evident that Mora, Kothi and Chatka support higher production of aflatoxins. Quantitatively higher amount of aflatoxin in Mora may be assigned to its constructional design and nature of material. Paddy might be getting soft in humid atmosphere and the grain consequently be acquiring more moisture in it, thereby making the condition more appropriate for mould growth and toxin elaboration. Elaboration of toxin is dependent on growth pattern of the mould (Ciegler *et al.* 1983).

Kothi, widely used as storage structure by the farmers of Bihar, also support high synthesis of aflatoxin in the stored grains. This structure is also not fully moisture-proof. Side by side metabolic water released due to seed respiration on account of increased temperature inside Kothi probably provides congenial conditions to the fungus to grow luxuriantly and produce aflatoxin (Ghos and Nandi, 1981).

In Bukhari, however the elaboration of toxin in the grains is nearly half to that elaborated in Kothi and Mora. The thick covering of husk (2-3 feet) from both the sides of grain together with the wall of Bukhari might be providing better protection from atmospheric moisture.

The lowest amount of toxin in the grains obtained from Iron bins could be attributed to their air tight nature. In a closed storage structure the rate of respiration by fungus tends to decrease as compared to ventilated storage where ample supply of O_2 supports respiration. Iron bin, being of closed storage type structure might not be providing conditions ambient to fungal growth and respiration and this in turn could be said to be responsible for low elaboration of toxin in Iron bin.

On the basis of the present investigation it can be said that none of the storage systems commonly used by the farmers is totally perfect to prevent aflatoxin contamination. All these storage systems, therefore, need some structural modifications for attaining better storage conditions. In the present situation storage of grain in Iron bin is comparatively safer.

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