

## STUDIES ON THE ORGANOLEPTIC QUALITIES OF CEREALS FUMIGATED WITH ALUMINIUM PHOSPHIDE

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### Introduction

Aluminium phosphide (phosphine) being easy in handling, safe and effective, has been recommended for all types of fumigation in India<sup>1</sup>. Earlier studies showed that this fumigant has left toxic residues in the grain<sup>2,3</sup>, and as such the absorbed residues may affect the acceptability and other qualities of cereals and their products, hence these studies were undertaken.

### Materials and Methods

Wheat, maize and sorghum the staple food grains of Rajasthan, were filled in air-tight galvanised circular metal drum (diameter 0.86 m and height 0.50 m) and fumigated with aluminium phosphide at a recommended dose of two tablets/ton and an exgearated dose of four tablets/ton. The structures were sealed immediately and properly to ensure no leakage. Continuous exposure of three days (72 hours) was given before the fumigated structures were opened. The samples of grain drawn at this stage were designated as zero day sample.

The phosphine residue in fumigated wheat, maize and sorghum grains and their products at zero, two and four days intervals was determined by the colorimetric method developed by Bruce *et al.*<sup>4</sup> and recommended by the Joint Committee of FAO/WHO on Pesticide Residues<sup>5</sup> (Table I). The sensory evaluation of wheat, maize and sorghum grains and their products was carried-out at the same intervals as per the Scoring Method of Griswold<sup>6</sup>.

The chapaties of all the three fumigated grains and *dalia* (cracked grain) of wheat and maize were prepared as per the standard method and served to a panel of five judges who evaluated them for taste, flavour, appearance, doneness and softness. Simultaneously, the chapaties and *dalia* prepared from the untreated grains were served to panel members which served as control. The panel of judges granted scores (Very good - 5; Good - 4; Fair- 3; Satisfactory -2; Poor-1 and Very poor - 0) for each criterion. The average scores were compared with that of untreated wheat, maize and sorghum. The data (Tables II to VI) thus obtained were subjected to analysis of variance.

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TABLE I Residues of Phosphine in Different Food Grains and their Products

Dose Tablet/ ton	Days after aeration	Residues (ppm)				
		Whole grain	Flour	Chapati	Dalia	
					uncooked	cooked
<i>Wheat</i>						
2	0	0.012	0.003	0.001	0.008	BDL
	2	0.004	BDL	BDL	0.001	BDL
	4	BDL	BDL	BDL	BDL	BDL
4	0	0.021	0.013	0.002	0.015	0.001
	2	0.011	0.003	BDL	0.005	BDL
	4	BDL	BDL	BDL	BDL	BDL
<i>Maize</i>						
2	0	0.015	0.007	0.001	0.012	BDL
	2	0.003	BDL	BDL	0.001	BDL
	4	BDL	BDL	BDL	BDL	BDL
4	0	0.031	0.012	0.002	0.022	0.001
	2	0.006	0.002	BDL	0.003	BDL
	4	BDL	BDL	BDL	BDL	BDL
<i>Sorghum</i>						
2	0	0.018	0.004	0.001	0.008	BDL
	2	0.003	BDL	BDL	0.001	BDL
	4	BDL	BDL	BDL	BDL	BDL
4	0	0.043	0.012	0.002	0.018	0.001
	2	0.025	0.003	BDL	0.005	BDL
	4	0.004	BDL	BDL	BDL	BDL

BDL = Below detectable level

TABLE II Sensory Evaluation of Chapaties Made out of Fumigated Wheat

	Sensory characteristics					
	Taste	Flavour	Appearance	Softness	Doneness	Colour
<i>2 Tablets/ton</i>						
Control	4.00	3.83	3.91	3.91	4.00	3.91
0 day	3.75	3.50	3.50	3.75	3.25	3.75
2 days	3.25	3.00	3.25	3.75	3.50	3.75
4 days	4.00	3.75	4.00	4.00	4.00	4.00
CD <sub>1</sub>	NS	NS	NS	NS	NS	NS
CD <sub>2</sub>	NS	NS	NS	NS	NS	NS
<i>4 Tablets/ton</i>						
Control	3.83	3.58	3.66	3.83	4.00	3.66
0 day	3.00	3.00	3.50	3.50	3.75	3.50
2 days	3.50	3.25	3.25	3.25	3.75	3.75
4 days	4.00	3.25	3.75	3.75	3.75	3.50
CD <sub>3</sub>	NS	NS	NS	1.33	NS	NS
CD <sub>4</sub>	NS	NS	NS	1.06	NS	NS

NS = Non significant

CD<sub>1</sub> = Between average of control and low phosphine dose observed at any period after fumigation.CD<sub>2</sub> = For comparing averages of low phosphine dose at any two different periods of fumigation.CD<sub>3</sub> = Between averages of control and high phosphine dose observed at any period after fumigation.CD<sub>4</sub> = For comparing averages of high phosphine dose at any period of fumigation.

TABLE III Sensory Evaluation of Chapaties Made out of Fumigated Maize

	Sensory characteristics					
	Taste	Flavour	Appearance	Softness	Doneness	Colour
<i>2 Tablets / ton</i>						
Control	4.16	3.83	3.91	4.08	4.16	4.16
0 day	3.75	3.00	3.25	3.75	3.75	3.75
2 days	4.00	3.50	3.75	3.75	3.75	4.25
4 days	4.00	3.75	4.00	4.00	4.00	4.00
CD <sub>1</sub>	NS	NS	NS	NS	NS	NS
CD <sub>2</sub>	NS	NS	NS	NS	NS	NS
<i>4 Tablets / ton</i>						
Control	4.00	3.56	3.91	3.91	4.00	4.08
0 day	3.00	2.50	2.25	2.75	3.00	2.00
2 days	3.75	3.25	3.50	3.75	3.75	3.00
4 days	3.75	3.50	3.50	3.75	4.00	3.75
CD <sub>3</sub>	NS	NS	1.16	NS	NS	1.48
CD <sub>4</sub>	NS	NS	0.93	NS	NS	1.20

NS = Non significant

CD<sub>1</sub> = Between averages of control and low phosphine dose observed at any period after fumigation.

CD<sub>2</sub> = For comparing averages of low phosphine dose at any two different period of fumigation.

CD<sub>3</sub> = Between averages of control and high phosphine dose observed at any period after fumigation

CD<sub>4</sub> = For comparing averages of high phosphine dose at any period of fumigation.

### Results and Discussion

It is evident from Table I that the residues of phosphine in whole grains of wheat, maize and sorghum were below the tolerance limit of 0.05 ppm<sup>7</sup> at zero day interval when the grains were fumigated at two and four tablets/ton. The flour of wheat and maize contained residues more than the tolerance level of 0.01 ppm<sup>7</sup> at zero day interval in case of higher dosage (four tablets/ton) which subsequently dissipated and could not be detected at four days interval. But the chapatias prepared out of the flour of wheat and maize containing 0.013 ppm and 0.012 ppm had only traces of phosphine residues. Perhaps baking of chapatias at higher temperature caused such loss of pesticides.

The *dalia* prepared from wheat and maize fumigated with two and four tablets/ton dosage contained 0.008, 0.015 ppm and 0.012, 0.022 ppm at zero day interval. Residues contained in all except *dalia* of wheat were above the tolerance level. Higher residues in maize as compared to wheat may be attributed to size of grain. Larger grains perhaps absorbed more of phosphine. The cooking also removed the residues and in cooked *dalia* the residues were well below the tolerance limit (Table I).

Perusal of results in Tables II to IV shows that the chapatias made out of the flour of fumigated wheat, maize and sorghum had no significant difference in any sensory characteristic except in case of the chapatias made out the wheat and maize fumigated with higher dosage (four tablets/ton). The treated wheat chapatias lost softness, while the maize chapatias lost appearance and colour as

compared to untreated ones. The amount of phosphine residue present in the flour of wheat and maize treated with higher dosage (four tablets/ton) might have affected the kneading ability and colour of the flour.

There was no significant difference in the scores of sensory characteristics of *dalia* prepared from treated wheat in comparison to untreated sample at all the time intervals, but *dalia* of treated maize was significantly dull in appearance and doneness particularly in case of higher treatment dosages at zero day of aeration of the grain (Tables V to VI). The wheat *dalia* though had higher residues did not show such tendency because it was roasted before cooking as per prevailing practice. The roasting perhaps removed the residues.

With the increase in aeration period, there was an increase in the scores in all the parameters suggesting no ill effect on the organoleptic quality of wheat, maize and sorghum. The results are in agreement with those of Sarid *et al*.<sup>8</sup> and Sharma<sup>9</sup> who also found no ill effect on the organoleptic quality of phosphine fumigated rice, wheat and maize respectively.

### Summary and Conclusions

Organoleptic evaluation of cooked products prepared from wheat, maize and sorghum fumigated with aluminium phosphide at two and four tablets/ton, was carried-out for the acceptability of consumers/human beings. There was no effect of phosphine residue observed on any of the sensory characteristics except in wheat chapati, maize chapati and maize *dalia* prepared out of the

TABLE IV Sensory Evaluation of Chapaties Made out of Fumigated Sorghum

	Sensory characteristics					
	Taste	Flavour	Appearance	Softness	Doneness	Colour
<i>2 Tablets/ton</i>						
Control	3.80	3.75	3.80	3.80	3.84	3.92
0 day	3.72	3.50	3.45	3.65	3.70	3.80
2 days	3.60	3.45	3.50	3.70	3.70	3.80
4 days	3.75	3.70	3.75	3.70	3.80	3.80
CD <sub>1</sub>	NS	NS	NS	NS	NS	NS
CD <sub>2</sub>	NS	NS	NS	NS	NS	NS
<i>4 Tablets/ton</i>						
Control	3.85	3.65	3.75	3.77	3.90	3.85
0 day	3.70	3.50	3.54	3.65	3.75	3.75
2 days	3.72	3.55	3.60	3.65	3.85	3.75
4 days	3.80	3.60	3.70	3.70	3.85	3.80
CD <sub>3</sub>	NS	NS	NS	NS	NS	NS
CD <sub>4</sub>	NS	NS	NS	NS	NS	NS

NS = Non significant

CD<sub>1</sub> = Between averages of control and low phosphine dose observed at any period after fumigation.

CD<sub>2</sub> = For comparing averages of low phosphine dose at any two different period of fumigation.

CD<sub>3</sub> = Between averages of control and high phosphine dose observed at any period after fumigation.

CD<sub>4</sub> = For comparing averages of high phosphine dose at any period of fumigation.

TABLE V Sensory Evaluation of Dalia Made out of Fumigated Wheat

	Sensory characteristics					
	Taste	Flavour	Appearance	Consistency	Doneness	Colour
<i>2 Tablets/ton</i>						
Control	4.00	3.75	3.75	3.85	3.91	3.91
0 day	3.75	3.50	3.25	3.75	4.00	4.00
2 days	3.75	3.75	3.75	3.75	3.75	4.00
4 days	3.75	3.75	3.50	3.75	3.50	3.50
CD <sub>1</sub>	NS	NS	NS	NS	NS	NS
CD <sub>2</sub>	NS	NS	NS	NS	NS	NS
<i>4 Tablets/ton</i>						
Control	3.83	3.75	3.75	3.50	3.83	3.41
0 day	3.00	3.50	3.00	3.50	3.25	3.00
2 days	3.50	3.50	3.75	3.75	3.50	4.00
4 days	3.75	3.75	3.50	3.60	3.50	3.50
CD <sub>3</sub>	NS	NS	NS	NS	NS	NS
CD <sub>4</sub>	NS	NS	NS	NS	NS	NS

NS = Non Significant

CD<sub>1</sub> = Between averages of control and low phosphine dose observed at any period after fumigation.

CD<sub>2</sub> = For comparing averages of low phosphine dose at any two different period of fumigation.

CD<sub>3</sub> = Between averages of control and high phosphine dose observed at any period after fumigation.

CD<sub>4</sub> = For comparing averages of high phosphine dose at any period of fumigation.

TABLE VI Sensory Evaluation of *Dalla* Made out of Fumigated Maize

	Sensory characteristics					
	Taste	Flavour	Appearance	Consistency	Doneness	Colour
<i>2 Tablets/ton</i>						
Control	4.08	3.91	4.08	4.00	4.16	4.08
0 day	3.75	3.50	4.00	4.00	4.00	4.25
2 days	4.25	4.00	3.75	3.75	3.75	4.00
4 days	4.00	4.00	4.00	3.75	4.25	4.00
CD <sub>1</sub>	NS	NS	NS	NS	NS	NS
CD <sub>2</sub>	NS	NS	NS	NS	NS	NS
<i>4 Tablets/ton</i>						
Control	3.83	3.66	4.00	3.50	4.00	3.66
0 day	2.50	3.00	2.25	3.75	2.50	2.25
2 days	4.00	4.00	3.25	3.50	3.75	3.50
4 days	4.00	4.00	4.00	3.50	3.75	3.50
CD <sub>3</sub>	NS	NS	0.81	NS	1.33	1.48
CD <sub>4</sub>	NS	NS	0.50	NS	1.06	NS

NS = Non significant

CD<sub>1</sub> = Between averages of control and low phosphine dose observed at any period after fumigation.

CD<sub>2</sub> = For comparing averages of low phosphine dose at any two different periods of fumigation.

CD<sub>3</sub> = Between averages of control and high phosphine dose observed at any period after fumigation.

CD<sub>4</sub> = For comparing averages of high phosphine dose at any period of fumigation.

grains fumigated with higher dosage (four tablets/ton). The effect was only found on softness of wheat chapati, appearance and colour of maize chapati and doneness of maize *dalia*. However, the fumigation by aluminium phosphide can be done by consumers for safe storage of wheat, maize and sorghum without any fear of hazard.

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