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Evaluation of Incidence and Alternative Management of Post Harvest Fungal Diseases of Papaya Fruits (*Carica papaya* L.) in Western U.P.

Vaibhav Sharma
Department of Botany,
Govt. P.G. College, Khair (Aligarh) (UP), INDIA

(Corresponding author: Vaibhav Sharma)
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ABSTRACT: In present study survey for post harvest fungal diseases of papaya fruits in western U.P. revealed that commonly associated diseases are *Anthracnose, Black rot, Rhizipus rot, Aspergillus rot, Botryodiplodia rot, Phytophthora rot* and *Penicillium rot*. Average data of survey shows that among the two seasons of papaya fruiting in western U.P. the cumulative incidence of diseases are more severe in post monsoon season (20.42%) in comparison to post winter season (12.93%). Experimentation reports on alternative management of post harvest fungal diseases showed that hot water dip of freshly harvested fruits at 49°C±1°C for 15 minutes in case of *Anthracnose* and 20 minutes for rest of diseases are most suitable to minimize the inoculants fungal growth. In present investigation it was also noted that storage of fruits at 10°C temperature is very effective to manage post harvest fungal diseases. In a study of use of biopreservative before storage or packaging, it was noted that coating of *Aloe vera* gel on harvested fruits have excellent potential to maintain quality and to extend their shelf life for a long time.

Key words: Alternative management, post harvest fungal diseases, hot water and temperature management, Aloe gel coating.

I. INTRODUCTION

Papaya *(Carica papaya L.)* also called Treemelon is an important tropical fruit belonging to the family *Caricaceae*. It is native to Tropical America but now cultivated in all parts of tropical world. According to electronic data information source cited during 2008-10, India had been the leading papaya producer with 38.6% share of the world production. Papaya fruits with excellent source of vitamins A, B_1, B_2, B_3, B_6, C and E have high nutritional value and are eaten fresh or preserved products like sauces, pickles, jams, puree for juices and mixed drinks etc. It is also recommended by dieticians as supplementary food because of its purgative nature, low calories, negligible fats and rich medicinal ingradients to cure hepatogastric disorders. Although the economic life of papaya is only 3-4 years but during this span in tropical climate of western Uttar Pradesh it has year round cultivation and consumers can enjoy papayas throughout the year. However the peak seasons of papaya in this region are post monsoon i.e. September to November and post winter i.e. February to April. Papaya being perishable fruit is highly susceptible to fungal pathogens that invade the fruits during post harvest operations and becomes significant limiting factor for its net production since it can cause 25-40% fruit losses during marketing channel (Sharma and Alam 1998).

Usually the conventional methods for controlling post harvest fungal diseases involves the use of synthetic fungicides. The residuals of these fungicides present on fruits may be harmful to consumers. To avoid the toxicity of fruits and to meet the stringent quality standard implementation of alternate sustainable methods to control the fungal diseases is the need of hour. The present investigation is an effort to mitigate the production of nontoxic fruits.

II. MATERIALS AND METHODS

A critical survey of post harvest diseases of papaya fruits was carried out during three consecutive years from 2011 to 2013 in prominent papaya growing districts of western Uttar Pradesh viz. Aligarh, Bulandshahr, Ghaziabad, Meerut, Hapur and Muzaffarnagar. To determine disease incidence fresh mature fruits were randomly selected in bulk fortnightly from orchards and local markets of each district during peak seasons i.e. post monsoon (September to November) and post winter (February to April). The sampled fruits were kept in sterilized polythene bags. Out of sampled bulk of fruits healthy and diseased fruits showing visual symptoms of particular diseases were sorted out and counted in each location to calculate percentage incidence at each location. Total disease wise incidence was determined calculating mean values of each location.

III. EXPERIMENTAL

A. In vitro studies

To identify the fungal strain associated with particular disease symptomatic patches were scrapped from the infected parts of fruits and kept in sterile filter paper bags. Pathogens were surface sterilized and aseptically transferred to freshly prepared sterilized PDA media marked separately for each disease. Petri plates of inoculated media were put into incubator at 30°C for 4 to 6 days for proper growth of fungus. From the culture a single colony of each pathogen was lifted and restreaked on fresh PDA petri plate for the purification of the fungus associated with particular disease. The purified pathogens were identified under microscope as per description in standard monographs. For confirmation of identified fungal strain pathogenecity tests were conducted in vitro by artificially inoculating on a set of three fresh healthy fruits per isolated pathogenic strain using Granger and Horne (1924) method. Fruits were observed daily till appearance of full flashed symptoms of diseases under study. The symptoms were matched carefully with the sampled diseased fruits.

B. Management of post harvest diseases

Management of diseases involves the prevention of infection, eradication of pathogen or delaying of symptoms until the fruit would normally have been consumed. It should be concerned with the cumulative efforts of growers, pickers, packers and people engaged in transporting, storing and marketing of fruits. To avoid use of toxic fungicides sustainable alternative control measures like hot water treatment, temperature management and use of biopreservatives before packaging have been programmed.

C. Hot water treatment

Hot water treatment was done as per method reported by Nishigima and Gomes (1993). Three sets of five fruits each were washed with tap water, cleaned and dried using cotton cloth and then immersed in sterilized hot water maintained at 49±1°C for 5, 10, 15, 20, 25 minutes and dried at room temperature. All sets of fruits were stored in separate sterilized polythene bags according to dipping time for one week. Simultaneously control was also kept at room temperature for comparison. After one week, effectiveness of hot water treatment on fruit disease was recorded on the basis of disease development in fruits. Data was recorded and analyzed statistically.

D. Temperature Treatment

An experiment was conducted to investigate most appropriate temperature for long time storage of papaya fruits as reported by Aziz *et.al.* (1975). Mature fresh fruits were collected from orchards and markets of study areas. Five to ten fruits were kept in BOD incubator at different temperatures viz 7°C, 10°C, 13°C, 16°C for 10 days duration for each temperature. Simultaneously parallel control experiment was set aside. After ten days data was recorded and analyzed statistically for each temperature set to determine appropriate temperature for storage of fruits.

E. Use of biopreservatives

An attempt was made to evaluate the efficacy of *Aloe vera* gel to control post harvest fungal diseases of papaya fruits. Fresh leaves of *Aloe vera* were washed and their epidermal peelings were scrapped with sterilized sharp knife. The colourless hydroparenchyma (gel matrix) was separated from outer cortex of leaves. Gel matrix was ground in a blender and filtered to separate Aloe gel from fibres. The gel was pasteurized at 70°C for 45 minutes. It was then cooled at ambient temperature (Maughan 1984). The gel was thickened by adding 1% gelling agent (High Methoxyl Pectin) to falicilate the proper coating.

Papaya fruits were harvested at preclimacteric stage (nearly ripe) showing yellowish green tinge on the skin. Fruits were washed and dried at room temperature. For experimentation three sets of 5-6 fruits each of medium size were selected and brushed with *Aloe vera* gel and allowed to dry in air to form a thin film on the fruit surface. Each set was kept in perforated wooden box for 12 days at room temperature side by side uncooled fruit set was also kept in the same environment as control. During 12 days storage life of papaya the effect of *Aloe vera* gel was observed on post harvest diseases, ripening condition and quality of fruits. The observation data was recorded after every four days intervals examining each fruit carefully.

IV. RESULTS AND DISCUSSION

Results of surveys during three consecutive years 2011 to 2013 revealed that commonly associated post harvest fungal disease of papaya are *Anthracnose, Black rot, Rhizopus rot, Aspergillus rot, Botryodiplodia rot, Phytophthora rot and Penicillium rot caused by Colletotrichum gloeosporioides, Phoma-carica-papayae, Rhizopus stolonifer, Aspergillus nigre, Botryodiplodia theobromae, Phytophthora palmivora and Penicillium expansum* respectively.

Table 1: Average incidence of post harvest fungal diseases of papaya in western U.P. during peak seasons.

S.No.	Disease	Pathogen	Post monsoon (Sept. - Nov.) Percentage disease incidence			Average %	Post winter (Feb. - April) Percentage disease incidence			Average %
			2011	2012	2013		2011	2012	2013	
1	Anthracnose	*Colletotrichum gloeosporioides*	5.30	6.20	5.96	5.82	3.83	3.40	2.97	3.40
2	Black rot	*Phoma-caricae-papayae*	5.06	5.85	4.73	5.21	3.10	3.20	2.54	2.94
3	*Rhizopus* rot	*Rhizopus stolonifer*	3.47	3.30	3.43	3.40	2.06	1.70	2.10	1.95
4	*Aspergillus* rot	*Aspergillus nigre*	1.97	2.13	1.96	2.02	1.43	1.83	1.33	1.53
5	*Botryodiplodia* rot	*Botryodiplodia theobromae*	2.00	2.30	1.70	2.00	1.16	0.93	1.30	1.13
6	*Phytophthora* rot	*Phytophthora palmivora*	1.23	1.40	1.13	1.25	0.97	1.32	0.83	1.04
7	*Pencillium* rot	*Penicillium expansum*	0.96	0.90	0.83	0.89	0.67	0.93	0.91	0.83
8	Cumulative incidence					20.42				12.93

Average data of survey presented in Table 1 shows that among the two peak seasons of papaya fruiting in western Uttar Pradesh the cumulative prevalence of post harvest fungal diseases are more severe in post monsoon season (20.42%) in comparison to post winter season (12.93%). This result suggests that increased temperature and humidity during post monsoon season support sporulation and respiration of pathogens and low temperature and humidity in post winter season reduces sporulation, respiration and enzyme degradation capacity of fungus. Present findings confirm the earlier reports of Singh *et.al.* (2012). The highest seasonal incidence of *Anthracnose* (5.82%) and *Black rot* (5.21%) have been reported in post monsoon season. Although their prominence also exists in post winter season but with less intensity i.e. 3.4% and 2.94% respectively (Table 1). The incidence of other diseases has been recorded in descending order of intensity in both post monsoon and post winter seasons respectively viz. *Rhizopus rot* (3.40% and 1.95%), *Aspergillus rot* (2.02% and 1.53%) *Botryodiplodia rot* (2.00% and 1.13%), *Phytophthora rot* (1.25% and 1.04%). The *penicillium rot* has been recorded with its least incidence in both the seasons (0.89% and 0.83%).

A. Hot Water Treatment

The hot water treatment was conducted at 49°C±1°C for 5, 10, 15, 20 and 25 minutes on freshly harvested papaya fruits. Results obtained from the experiment revealed that hot water dip for 15 minutes is the optimum heat treatment to minimize *Anthracnose* disease upto 21.96% in comparison to control (66.18) However treatment for 20 minutes duration had a pronounced effect on *Black rot*, *Rhizopus rot Aspergillus rot*, *Botryodiplodea rot*, *Phytophthora rot* and *Penicillium rot* reducing to 24.15%, 25.15%, 24.77%, 25.51%, 24.39% and 35.33% respectively in comparison to control (Table 2). Similar findings were also reported by Aragaki *et al.* (1981) Couhey *et al.* (1984) and Xueping *et al.* (2013).

B. Temperature Treatment

Data recorded in Table 3 revealed that out of different temperature Variations *viz* 7°C, 10°C, 13°C and 16°C tried for 10 days storage to manage post harvest fungal diseases of Papaya the storage of Papaya fruits at 10°C resulted in best management of diseases in all the three years, followed closely by 13°C.

Table 2: Effectiveness of hot water treatment on Post harvest fungal diseases of Papaya.

S.NO.	Dipping Period during treatment of hot water at 49°C ± 1°C	Average data of percentage (%) incidence of Various fungal diseases						
	In Minutes	Anthracnose	Black rot	Rhizoepus rot	Aspergillus rot	Botrydiplodia rot	Phytophthora rot	Penicillium rot
1	5	46.71	44.42	39.69	44.32	44.23	42.38	44.85
2	10	32.41	34.89	31.51	36.73	36.94	35.64	43.83
3	15	21.96	26.52	26.78	33.21	29.45	29.41	40.09
4	20	22.73	24.15	25.15	24.77	25.51	24.39	35.33
5	25	38.53	26.32	28.54	28.94	27.39	28	39.96
6	Control	66.18	64.62	64.27	63.09	62.05	56.11	53.39
7	SEM ±	1.804	1.44	0.84	1.43	1.354	1.142	0.32
8	CD 1%	8.28	6.48	3.773	6.417	6.069	5.121	1.435

Fruit storage at 7°C showed chilling injury and the severity of diseases was recorded maximum in fruits stored at 16°C. It was also noted that storage at 10°C shows best characteristics of fruits for long period. These results agree with earlier reports of Aziz *et al* (1975) and Gupta *et al* (1979).

C. Use of Biopreservative

Efficacy of Aloe gel coating was studied to enhance the storage life of papaya fruits. The data presented is Table 4 reveals that no disease signs were observed in Aloe gel coated fruits until 8 days after the beginning of storage period but in uncoated fruits (control) during this period incidence of disease was found to be 13.72% in post monsoon (PM) and 10.6% in Post winter (PW) seasons. On 12th day the gel coated fruits have shown only 1.5% (PM) and 0.8% (PW) incidence, while in control the fruits were more or less damaged showing 80.30% (PM) and 62.74% (PW) incidence during the same period. This indicates that Aloe gel contains some bioactive agents which mainly serve to protect the fruits from post harvest fungal diseases. Similar findings were reported by Habeeb *et al.* (2007) and Nidiry *et al.* (2011).

Table 3: Effectiveness of temperature variation on Percentage disease incidence.

S.No.	Storage Temperature 0^C	Average Disease incidence in different experimental years			Average %
		2011	2012	2013	
1	7	Chilling injury	Chilling injury	Chilling injury	Chilling injury
2	10	10.26	12.2	10.67	11.04
3	13	15.95	15.85	14.47	15.42
4	16	22.8	23.98	24.19	23.65
5	Control (Room Temp.)	83.24	85.04	78.73	82.35
	SEM±	—	—	—	0.837
	CD 1%	—	—	—	3.975

Table 4: Effect of Aloe gel Coating on disease incidence (Cumulative) during 12 days Storage life.

S.No.	Storage Period in days	Average Disease incidence of three experimental years (in %)			
		Aloe gel Coated fruits		Control	
		Post Monsoon (PM)	Post winter (PW)	Post Monsoon (PM)	Post winter (PW)
1	0	—	—	—	—
2	2	—	—	—	—
3	4	—	—	—	—
4	8	—	—	13.72	10.6
5	12	1.5	0.8	80.3	62.74

Table 5: Effect of Aloe gel on Ripening Condition and Quality of Papaya fruits.

Treatment	Storage Period in days	Peel Colour	Firmness	Fruit Condition
Aloe gel Coating	0	GSYT	Hard	Good
	4	GSHY	Moderately Hard	Good
	8	YSGA	Slightly Soft	Good
	12	CHYS	Slightly Soft	Good
Control	0	GSYT	Hard	Good
	4	YSGA	Slightly Soft	Good
	8	CHYS	Pulpy	Inferior
	12	YBBP	Damaged	Unusable

GSYT- Green skin with yellow tinge
GSHY- Green skin with half yellow
YSGA- Yeelow skin with some green areas
CHYS- Charactristic Yellow Skin
YBBP- Yellowish brown with black patches

Visual assessment of fruit colour is the key feature in determining the ripening of papaya fruits. Average data of three years shows that on 8th day peel colour of gel coated fruits became yellow with some green areas (YSGA) and with slightly soft firmness, while in control this condition was observed only after 4 days storage and in 8 days fruits attained characteristic yellow coloured skin (CHYS) with pulpy firmness presenting inferior quality (Table 5).

On the other hand after 12 days gel coated fruits could attained characteristic yellow coloured skin (CHYS) with slightly soft firmness showing good edible condition but the uncoated fruits become yellowish brown with black patches (YBBP) unable to use. This work revealed that Aloe gel coated fruits acquired an extended shelf life and gel coatings preserved the valuable attributes of the fruit.

The present work revealed that alternative management of post harvest fungal diseases are highly successful means having no adverse effect on fruits, environment and consumers health.

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