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MINI REVIEW

Post-harvest diseases of grapes and their control: Some aspects

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Abstract

Grapes are subjected during transit and storage to the attack by many of the fungi and some bacteria. Grapes form ideal substrate for the development of storage fungi and bacteria due to high sugar content. Around 40% of losses are noticed in Telangana, Andhra Pradesh and Maharashtra, which are known to grow Grapes (Thompson Seedless, Gulabi, Bangalore Blue varieties). In our studies, it has been noticed that the grape varieties suffer heavy losses due to storage fungi represented by *Aspergillus, Botrytis*, *Cladosporium, Fusarium*, *Penicillium*, *Mucor and Rhizopus, besides Erwinia and Xanthomonas*. Because of these infections the post harvest quality of grapes is lost. It has been found that prevention methods have to be carried out to protect the post- harvest losses which include physical, chemical and biological methods. A temperature range of 36-40°C are found favorable for causing decay. Different concentrations of neem and castor leaf extracts were sprayed on the grape berries and inoculated with *Aspergillus niger, Curvularia lunata, Rhizopus nigricens* and observed for the growth of the fungi, after inoculation for above 5 days. Both the extracts used were found to be antifungal agents and the decay of the fruits has been reduced to a greater extent. The grape fruits were also immersed in oils of castor and neem and those were found to be effective in controlling post-harvest pathogens in our preliminary studies.

Keywords: Bacteria, Control, Fungi, Grapes, Post-harvest.

Introduction

Grape is an important commercial crop grown in India. Normally it is a temperate crop got adapted to sub tropical climate. Grape cultivation has been introduced in India in 1300 AD by the travelers and invaders from Iran and Afghanistan respectively. Grape occupies 5th position among the fruit crops grown in India and stands at 10th position in the world. India with 1.21 million tones of Grape production in an area of 0.05 million hectares contributes to 2 % of world production. Around 80% of grapes come from Maharashtra, Karnataka, Tamilnadu, Andhra Pradesh, Telangana, UP and others. Nutritionally grapes contain 20% of sugar, and are rich in calcium and phosphorous. Grapes are used in wine making, raisin making besides being consumed as fresh fruit and also dry fruits.

Fresh fruits of grapes are exported by India to approximately 30 countries. Grapes can be grown in any of the climate and is mostly cultivated under subtropical climatic conditions in soils which are clay loam type with proper drainage and irrigation facilities having pH range of 6.5-7.5 and temperature range of 15-35°c. Grape suffers from major diseases like Anthracnose, downy mildew, bacterial leaf spot, powdery mildew, leaf blight, rust, bitter rot, black rot, grey mould, *Rhizopus* rot and others.

The common grape varieties that are grown in India being Bangalore bloom, Gulabi, Anab-e-shahi, Dilkush, Pusa, Thompson, Ganesh, Sonaka, Manik Chaman, Cheema Sahebi, Sharad, Perlette, Pandari Sahebi, Bhokri and others (Figure 1).

Post harvest losses due to fungal diseases are of great importance as they reduce quality (in terms of fresh weight and nutrients) and quantity of fruits leading to heavy losses to the farmers and marketers, respectively.

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Figure 1: Grape varieties growing in study area -1.Thomson seedless, 2. Dilkush, 3.Sharad seedless, 4.Bengalore Blue, 5.Anaha e shahe, 6.Bakri, 7. Gulabi, 8. Arka kanchan

Nutrients of Grapes:

Grapes are known to contain large amounts of sugar, water, calcium, potassium, magnesium followed by Vitamins (A C E & K) Manganese, Zinc, Niacin and others. The Table 1. Lists here the nutrients present for 100 g of Grapes. The shelf life of grape is only one week, hence the nutrient loss is very heavy. Therefore many of the nutrients gets released from the rotten fruits, due to post harvest damage.

Pre-harvest Management and Transport

Many of the diseases can be managed before harvesting through agricultural practices such as pruning, balancing fertility, IPM, and careful harvesting. The harvesting time is mostly identified by colour, taste and size. Processing is one of the important part in pre and Post - harvest handling which involves trimming, sorting, grading and packaging as per market requirement. Physical damage may increase the losses in grapes. Higher temperature causes water loss and browning of grapes. Therefore the appropriate levels of temperature and relative humidity have to be maintained to preserve the grapes. The lack of the cold storage facility is a great challenge to the grape growers and exporters. Maintaining proper temperature during transportation is important. Proper and careful harvesting is important. The grape fruits have to be harvested early in the morning and have to be kept in the boxes under shade. Transport has to be done through covered trucks. Packaging is an important aspect. Therefore the packaging standards of international marketing such as 1. Clusters must be cushioned against impact by immobilizing within container, 2. Avoid over filling, 3. Labeling has to be done to the containers.

Table 1: Nutrients in Grapes (mg/Percentage per 100g fruit)

Nutrients	*Quantity*	*%*
Folates	2 µg	0.5
Niacin	0.188 mg	1
Pantothenic acid	0.050 mg	1
Pyridoxine	0.086 mg	7.5
Riboflavin	0.070 mg	5
Thaimin	0.069 mg	6
Vitamin A	.66 mg	3
Vitamin C	10.8 mg	18
Vitamin E	0.19 mg	1
Vitamin K	14.6 µg	12
Sodium	0.01	1
Potassium	191 µg	4
Calcium	10 mg	1
Copper	0,129 mg	14
Iron	0,36 mg	4.5
Magnesium	7 mg	2
Manganese	0.071 mg	3
Zinc	0,07 mg	0.5

Post-harvest Diseases

Grapes suffer post- harvest losses beginning at field level. It has been reported that during the storage or long distance transportation, loss of grapes quality is mainly because of weight loss, moisture loss, nutrient loss and infection due to moulds. Further storage conditions play an important role in the post- harvest loss. Nanda *et al.* (2010) have reported around 9% post-harvest loss in grapes. In Andhra Pradesh and Telangana the post harvest losses in seedless grapes had been around 8% in the market Anonymous (2003) and Ladania *et al.* (2005) have studied the post- harvest losses in Maharastra which produces around 50 % of grapes of India. The aggregate loss in Maharastra had been between 20-30% during transport, storage and post harvest stage. Roughly the economic value of the loss for Maharastra market has been considered to 434 crores. The major diseases that occur as post harvest disease in Telangana are given in Table 2 and shown in Figure 2.

Due to post harvest diseases heavy losses incur in the market followed by farmers and companies. After the collection of the diseased fruits, it is essential to isolate the pathogen and raise pure culture for identification. The respective post- harvest pathogens have been identified based on single spore culture using morpho-taxonomic and molecular tools. The pathogenicity tests were conducted by

Figure 2: Post Harvest diseases of Grapes 1. Anthracnose 2. Botrytis Bunch Rot or Gray Mold 3. Blue Mould Rot 4. Black Mould Rot 5. Green Mould Rot 6. Rhizopus Rot 7. Black Rot 8. Greenaria Bitter Rot

Table 2: Major Post-harvest diseases on grapes

S. No	*Disease*	*Pathogen*
1	Anthracnose	*Colletotrichum* spp.
2	Botrytis rot	*Botrytis senario*
3	Blue mold rot	*Pencillium* sp.
4	Rhizopus rot	*Rhizopus nigricans*
5	Brown rot	*Alternaria alternata*
6	Black mold rot	*Cladosporium* spp
7	Black mold rot	*Aspergillus niger*
8	Bitter rot	*Grenaria evicola*
9	Black rot	*Curvularia* spp.
10	Dry rot	*Phoma* sp.

inoculating the respective fungi following Koch postulates on grape varieties.

Factors Affecting Post-harvest Diseases

The factors like fruit maturity stage, method of harvesting, time of harvesting, sorting, grading, packaging, materials used in packaging, type of storage, temperature and relative humidity levels to be maintained during storage, conditions prevailing in transporting vehicles and others will affect. However climatic factors and genetic factors have their own influence in pre harvesting and post- harvesting conditions. In developing countries like India cold storage conditions are very few available to the farmers and marketers. The combined effect of all factors namely pre and post-harvest condition, decides the percentage and deterioration and spoilage. If scientific methodologies are not followed during pre and post- harvest conditions leads to large scale post-harvest loss. The fruit quality deterioration present at storage gets continued till it is consumed. In many of the countries fresh fruits are preferred, hence management of factors affecting the quality gained importance. There is a necessity of improving the skills and knowledge for the stakeholders in respect of post-harvest handling of the fruits. The education to farmers, vendors and others about suitable handling of fruit at pre-harvest and post-harvest stages will benefit them to reduce the post-harvest losses. The education on this aspect could be delivered by governments, NGOs, educated farmers groups and media.

Methodology

The storage godowns located in Hyderabad and surrounding district for grapes were selected. The seedless varieties of grapes were found stored in baskets, wooden carts, aerated bags, polythene covers and some were found in open yard. However the maintenance was in poor condition. Different grape varieties have been collected at random from storage godowns and markets of Andhra Pradesh and Telangana in the year 2020-21. On the whole 8-50 % of losses are noticed due to fungal infection (Table 2). It is noticed that market value got reduced by 40%. The losses have been calculated as per the weight loss of grape berries due to infection by fungi. The fungi have been isolated in pure culture from the diseased grape berries and single spore cultures have been raised. The fungi have been identified as per monograph of Ellis (1971, 1976). The single spore cultures of different fungi have been used to establish pathogenicity following Koch Postulates. Around 500 fruits were used for testing. The seedless grape variety of Telangana has been used for testing effectiveness of essential oils and plant extracts. The methods followed are given below:

Oils of neem (*Azadirachta indica*), castor (*Ricinus communis*) have been purchased from the market and got sterilized by heating at 45°C under 125 psi pressure. The testing solutions were prepared as 2000ppm (200mg/100ml), 1000ppm (100mg/100ml) and 500ppm (50mg/100ml) in acetone (Tripathi *et al*., 2008), respectively.

Leaves of Neem (*Azadirachta indica*) and Castor (*Ricinus communis*) were collected from University Botanical garden Hyderabad and have been sterilized with 0.01 Sodium hyphochlorite. About 40 grams of above sterilized leaves were washed in sterile water and blended in 100 ml of sterilized distilled water. After blending the aqueous solution were passed through muslin cloth and Seitz filters and kept in refrigerator until use Riaz *et al.* (2008). The extracts were used in three different concentrations 12.5, 25 and 50%. Infection data was collected using the methodology of Artés-Hernández *et al.* (2004).

Control of Post Harvest Diseases

Protection

Fungal disease of grapes during the post-harvest condition has been reported worldwide. Rotting caused by fungi manly by *Aspergillus, Botrytis, Cladosporium, Rhizopus, Alternaria, Curvularia, Penicillium* and others can be controlled by using of several methods such as employing fungicides at minimum level, biological methods of using antagonistic bacteria belonging to *Bacillus* and fungi like *Trichoderma* and also botanicals proved higher beneficial (Zhimo *et al.* 2016).

Parthasarathi *et al.* (2017) have reported many microbial antagonists to control post harvest diseases.Synthetic fungicides used to control post-harvest diseases have developed resistance among the post-harvest pathogens, besides having hazardous impact of environmental footprint. Several microbial antagonists have been evaluated against post-harvest pathogens. Biocontrol agents act as cheap biocides and include *Bacillus subtilis*, *Pseudomonas flourescence, Streptomyces* sp, *Penicillium oxalicum, Trichoderma harzianum, Chaetomium globosum* and others which act as potential biocontrol agents against post-harvest pathogens. Mechanisms involved in the biocontrol include antibiosis, competition, production of lytic enzymes and induced systemic resistance. Several

Table 3: Effect of plant extracts on Post-harvest disease causing fungi

Fungal Strain	*Treatment*	*3 Days*				*Days*				*10 days*			
		Control	*10%*	*25%*	*50%*	*Control*	*10%*	*25%*	*50%*	*Control*	*10%*	*25%*	*50%*
A.flavus	Neem Extract	7.69	5.34	4.69	2.3	30.24	14.3	12.7	9.52	63.8	44.23	39.13	28.78
	Castor Extract	6.85	4.23	3.23	2.21	30.78	12.9	13.06	8.13	76.5	35.37	31.63	20.33
Rhizopus nigricans	Neem Extract	9.97	5.07	3.34	3.16	33.68	11.06	9.36	7.23	71.5	44.67	39.45	32.89
	Castor Extract	5.87	3.23	3.33	2.74	33.49	19.30	14.50	10.7	72.5	58.6	39.34	32.90
		CV 14.53 T Value 1.79				7.72 3.48				3.36 3.97			

Table 4: Effect of Neem Oil and Castor Oil on *A. flavus* and *R. nigricans* the fruit rot fungi

Fungal Strain	*Treatment*	*3 Days*				*Days*				*10 days*			
		Control	*500 ppm*	*1000 ppm*	*2000 ppm*	*Control*	*500 ppm*	*1000 ppm*	*2000 ppm*	*Control*	*500 ppm*	*1000 ppm*	*2000 ppm*
A.flavus	Neem Oil	7.69	4.23	3.92	3.23	26.35	10.73	9.63	7.62	64.36	29.32	21.64	20.56
	Castor Oil	6.38	5.31	4.33	3.33	31.61	14.12	9.39	8.51	66.79	37.9	28.6	25.5
Rhizopus nigricans	Neem Oil	5.97	5.31	4.42	3.86	27.79	13.56	12.26	8.29	76.35	42.12	34.9	18.96
	Castor Oil	6.43	4.46	3.43	2.96	28.89	11.21	9.68	8.62	66.48	36.7	23.6	14.45
CV T value		14.25 1.68				6.68 2.87				3.73 3.42			

of the biocontrol agents are now made available as bio-formulations in the market to control post harvest diseases. Plant extracts are also known to contribute for the control of post-harvest disease causing fungi as shown in the Table 3. Further, essential oils also serve as controlling agents of post-harvest losses in grape Table 4.

Chemicals are used to control post harvest diseases and these include mostly the fungicides. The fungicides are known to create a toxic barrier between the host surface or tissues and the pathogen. It is also known to eradicate the pathogen from a particular region of the host. Fungicides are known to reduce pathogen inoculums density besides inactivating the pathogen and offer resistance to the invading pathogen. Fungicides are applied as protectants, eradicants and also as systemic chemicals. In the present investigation carbendazim is used as it controls number of post harvest diseases further mancozeb, zinab, captan, topsin are known to be surface dressing chemicals for the control of post harvest diseases.

Fungicides have been in use since time immemorial to control fungal diseases in grapes. Use of fungicides like carbendazim, at 0.1% has helped to control Anthracnose. *Alternaria* rot of grape can be controlled with mancozeb, zinab, captan, topsin at 0.1 to 0.2%. Bitter rot of grapes caused by *Greenaria* can be controlled by spraying ravirol at 0.2%. The post harvest rot of grapes caused by *Phomopsis, Botrytis, Aspergillus*, and *Rhizopus* can be controlled by spraying Dithane Z -78, Captan and Benomyl 0.2%. Maintaining cold storage between 0-1°c prevents the fungal rot of grapes.

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Conflict of Interest

The authors declare that there are no conflicts of interest in the course of conducting the research. Both the authors had the final decision regarding the manuscript and decision to submit the finding for publication.

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