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Morphotaxonomical studies of fungi, causing diseases to some Cucurbitaceae members from Akola region

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Abstract- Cucurbits, or the gourd family (Cucurbitaceae), represent a significant portion of global vegetable production, with important crops like watermelon, cucumber, and melons accounting for a substantial share of the world's vegetable acreage. These vegetables contain rich protein, carbohydrates and water to the extent of 90%. The Cucurbitaceae family comprises around 965 species across 101 genera. The reported members of this family are Cucumis sativus (Cucumber), Momordica charantia (Bitter gourd), Luffa actutangula (Ridge gourd), Cucurbita pepo (Pumpkin) and Lagenaria siceraria (Bottlegourd). A wide range of pathogens affect the productivity of cucurbits. Common fungal diseases affecting cucurbits include powdery mildew, downy mildew, anthracnose, and Phytophthora blight, which can cause 70% yield loss if not managed effectively. Some common fungal species are *Fusarium Phytophthora Acremonium. Pythium*. resulting up to 70% yield loss. *Colletotrichum orbiculare,Phomopsis sclerotioides, Phoma exigua, Cladosporium cucumerinum, Didymella bryoniae, Erysiphe cichoracearum* and *Pseudoperonospora cubensis, Alternaria Myrothecium roridum* are some of the important destructive fungal diseases of cucurbits.

Akola is situated in the middle east of Maharashtra state. It is situated between North 20.17 to 21.16 latitude and East 76.7 to 77.4 longitudes. Most of cucurbits are affected by fungal diseases which is almost untouched. Present study reveals some of the common fungi found on cucurbitaceous members.

Key words: Cucurbitaceous vegetables, Symptoms, fungal diseases

Introduction-

The Cucurbitaceae is a remarkable plant family, deserving of attention because of its economic, aesthetic, cultural, medicinal, and botanical significance. The Cucurbitaceae have largely worldwide distributions, but occur mostly in tropical regions. The family is well known and widely cultivated. It is a large family of plants with 130 genera and 800 species known all around the world and has been used in traditional medicine for ages. Vegetables from the Cucurbitaceae family have a positive influence on human health. Cucurbits show many biologic properties such as antioxidant, antimicrobial, anti-diabetic, anti-inflammatory and anticancer activity. Cucurbits are a source of polyphenols, tannins, and cucurbitacins. It can be used as a potential treatment for stomach and intestinal disorders. Specifically, cucurbits fruits which are eaten as vegetable are found to be beneficial in blood cleansing, purification of toxic substances and good for digestion, besides giving the required energy to improve human health.

The Most important cultivated genera are *Cucurbita, Cucumis., Citrullus., Lagenaria,* Momordica & Luffa. (Whitaker & Davis, 1962).The genus Cucumis consists of 52 species rather than 33species reported earlier (Ghebretinsae et al., 2007; Kocyan et al.2007; Schaefer, 2007; Renner et al., 2007).All parts of cucurbits (leaves, shoots, roots, flowers, seeds and fruits) can be used in the preparation of pickles, curries and salads

(Upaganlawar and Balaraman, 2009). Most Cucurbitaceae members are annual or perennial herbs, and 50% of the species are monoecious, 50% are dioecious (Kocyan et al., 2007; Schaefer& Renner, 2011b).

India is the second largest producer of vegetables with 2.8 % of total cropped area and 13.38% of total vegetable production. Being the largest cash crop, about 4,929,400 million tones of cucurbits were produced in India (Faostat, 2010). Production data for the predominant cucurbit crops are maintained by the Food and Agriculture Organization of the United Nations i.e.FAO (Accessed 10 March 2021). In 2019, worldwide cucurbit production included 100.4 Mt (mega tones) for watermelon, 87.8 Mt for cucumber, 27.5 Mt for other melons, and 22.9 Mt for pumpkins and squashes, while more than 100 countries (105–132) produce each of these crops in sufficient quantity to be recorded, in each case, the top 12 producing countries contribute greater than 70% of the global yield (ranging from 70.3% for pumpkins and squashes to 91.6% for cucumbers). China alone produces greater than one-third of worldwide production for each of these crops, contributing 36.7%of pumpkin and squash production; 49.1% of melons; 60.5% of watermelon; 80.1% of cucumber. The other cucurbit crop recorded by the FAO is the melon seed (Egusi), with a worldwide production of 1.0 Mt, of which 94% is produced in Africa, especially Nigeria with 60% of total production. Egusi seed can be produced from several different species, most commonly from *Citrullus monospermous*.

The diseases of plants are harmful deviation or alteration from the normal functioning of physiological as well as metabolic processes. In diseased conditions plant cells or even the whole plant lose the ability to carry out these important functions. It happens due to the influence of pathogenic organisms, these pathogenic organisms disturbs the normal functioning of plants, alters the fundamental processes of the host plants due to which the host plant become diseased. All kind of crop plants can be affected by hundreds or even more plant diseases. The diseases which develop on harvested parts of the plants like seeds, fruits are known as post harvest diseases. Pathogen attack may take place during harvesting and subsequent handling, storage, marketing, and after consumer purchase. The plant parts may get infected in the field, but expression of symptoms may take place later, at any stage before final consumption. The postharvest diseases that cause spoilage of both durable and perishable commodities are widespread. Losses inflicted throughout the supply chain due to pathogen-induced diseases are the major component of food wastage and may occur at any time from pre harvest to consumption. The capability of a microorganism to initiate postharvest diseases, as well as its final outcome, depend on a number of factors that can conveniently be associated with, microorganism, the host or the environment. The deterioration of vegetables and fruits are caused due to fungal pathogens. The fungal disease can be caused to plants before harvesting or after harvesting. The diseased plant produce is not suitable for consumption and marketing purpose. The fungal infections may occur through surface wounds which may be formed due to mechanical injury. The vegetables have a significant role in enhancing income, sustainable food and nutritional security. The vegetables may get suffered from pathogens of fungal or bacterial categories.

The Postharvest loss of vegetable may be from 30 to 40% due to poor post harvesting and storage practices. These diseases cause qualitative and quantitative loss of vegetables and fruits. The disease make them unfit for consumption due to health risks. A fungus causes carcinogenic mycotoxin and mutagenic secondary metabolites (Klich et. al., 2007; Ahsan et. al., 2006). Food scarcity is one of the important major problems faced by several countries. It is reported that nearly 1 billion people are challenged by severe hunger in these nations of which 10% actually die from hunger-related complications. A substantial part of this hunger problem stems from inadequate agricultural storage and produce preservation from microbes induced spoilages. (Salami and Popoola, 2007; Kana et al., 2012)

The factors affecting post-harvest losses of fruits and vegetables vary from place to place and varied environmental conditions. The yield loss may occur during harvesting, handling, packing, storage and transportation and delivery. The fungal infection decreases the market value of produce and thus hampers economy the growers. The decay of vegetables and fruits may start from germination of seeds to flowering and fruit set. The blemished vegetables and fruits are not eaten or sold commercial market. The yield loss depends upon the susceptibility of host plant and resistance to fungal pathogen. (Singh et.al. 2012)Cucumber and melon, which originate in India, both have had their genomes completely sequenced (Huang et al. 2009; García-Mas et al. 2012), and many have been included in family-wide phylogenetic analyses (Kocyan et al. 2007; Schaefer et al. 2009; Schaefer and Renner 2011b).

In recent time no such survey has been conducted in Akola region aiming the identification of fungal pathogens causing infection on fruits & vegetables of cucurbitaceae members. Our aim is to identify potential risks associated with consuming infected locally available fruits & vegetables as it is crucial for ensuring food safety, promoting sustainable agriculture, and enhancing consumer confidence in fruit & vegetables products. Surveying fungal infections on locally available fruits & vegetable is vital as it helps to safeguard public health by identifying potential risks associated with consuming infected fruits & vegetables. Such surveys aid in protecting agricultural crops by providing insights into the prevalence and types of fungal pathogens affecting fruit & vegetable production. Understanding the economic impact of these infections can inform decision-making processes for farmers and fruit producers, leading to the implementation of effective control measures. Survey data contributes to research efforts aimed at developing innovative strategies for managing fungal infections and improving fruit & vegetable quality.

Akola district is situated in the middle east of Maharashtra state. The climate is tropical hence the most of the vegetation here is dry deciduous type. The maximum temperature is 48°C and the minimum temperature is 10°C. Fruit& vegetable plants like other plants have specific fungal diseases. Our aim is to focus on the problems of farmers while cultivating cucurbitaceous vegetables and fruits which are having pre and post harvest diseases in Akola region.

Material & Method-

A regular survey of infected vegetable from family Cucurbitacean members was made from Janata &Jatharpeth local market from the month of January to February 2024. *(See Photoplate 1A&B)*More than 10 different hosts were collected in sterilized polythene bags. Symptoms of collected diseased of fruits as vegetable were recorded. Isolation was made by cutting small fragment of diseased spot along with healthy region of fruit which is used as vegetable. These pieces were surface sterilized with 90% alcohol & transferred aseptically to sterilized slants prepared from Asthana and Hawker's media 'A'. (Glucose- 5 gram , KH_2PO_4–1.75g, $MgSO_4.7H_2O$-0.75gram, KNO_3 –3.5 gram, Agar- agar –15 gram, Distilled water – 1 liter) under aseptic condition at temperature 27^0 C($\pm$2).

After three days of incubation the mycelium & conidia were coming out from the diseased tissue. Morphological studies of the organism were carefully recorded. Slides were prepared & identified by the reference book "Illustrated genera of imperfect fungi" by H. L. Barnett and Barry B. Hunter. (See *Photoplate-II,A,B,C,D,E,F,G.)*

Result-

S. No.	**Name of the fruit used as vegetable**	**Symptoms**	**Fungi obtained**
1	*Cucumis sativus L.*	The spots were olive brown with pycnidia on upper surface. The infection usually started from the dorsal side &gradually advanced to ventral side. Occasionally irregular spots were produced complete rottening of fruit was the ultimate phase. *(See Photoplate-1,F)*	*1)Phoma sp.* *2)Aspergillus sp.* *3)Mucor sp.*
2	*Cucumis melo L*	Small water soaked spots appear on fruit. Fruit becomes soft. *(See Photoplate-1,C).*	*1)Aspergillus sp.* *2)Fusarium sp.* *3) Mucor sp.*

3	*Citullus lanatus (Thunb.)Matsum.& Nakal*	The most striking diagnostic symptoms are produced on the fruit, where circular, black, sunken cankers appear. *(See Photoplate-1,D)*	*1)Penicillium sp.* *2)Mucor sp.* *3)Aspergillus* *4)Fusarium*
4	*Lagenaria siceraria* (Molina)Standl	Spots irregular, brown with dark boundary simple. Pustules dorsal as well as ventral, small, black, spherical & scattered. At severity complete rottening of fruit formation takes place. *(See Photoplate-1,E)*	*1)Aspergillus* *2)Curvularia* *3)Fusarium sp.* *4)Phoma sp.*
5	*Cucurbita maxima Duchesne*	Infection appears in the fruit as a small spots; with wood brown or dark brown margin. Light brown or olive brown spots ultimately changed to dark brown, dark grey or dark olive at maturity. Pustules dorsal as well as ventral, small, black, spherical & scattered. Shot hole formation occurs at severity of infection. Drying of fruit was also observed. *(See Photoplate-1,I)*	*1)Curvularia* *2)Phoma sp.* *3)Mucor sp.* *4)Aspergillus*
6	*Luffa actangula (L.)Roxb.*	Spots scattered irregularly on dorsal surface, diamorphic, larger brown, few smaller pale brown irregular, scattered. Infection starts from dorsal surface and advanced towards ventral surface. Pustules black, small scattered, found only in the larger spots. Drying of fruits occurred at severity of infection. *(See Photoplate-1,H)*	*1)Mucor sp.* *2)Aspergillus* *3)Fusarium*

7	*Mimordica charantia L.*	Initially small, circular, isolated, brown spots appeared on fruit surface gradually enlarged to form irregular patches. The infected portion became sunken &turned dark brown in colour in advanced stages. *(See Photoplate- 1,G).*	1)*Rhizopus* *2)Fusarium* *3)Mucor sp* *4)Aspergillus*

Mycological studies of the fungi-

1.Phoma Sp. Saccardo.

Family-Didymellaceae

***Morphological characters*:-**Light to dark brown hyphae; pycnidia are ostiolate, globose to subglobose, with a border of dark brown and immersed in the host tissue (See Photoplate–III, D).

2.Aspergillus sp.Micheli ex Haller

Family-Aspergillaceae

Morphological characters:-Growth initially white but change to black after a few days producing conidial spores. The conidiophores are protrusions from septate and hyaline hyphae. The conidial heads radial and split into columns (biseriate). Conidiophores are smooth and hyaline. The phialids produce conidia that have a rough texture, dark brown coloured. (See Photoplate– III,A).

3. Mucor sp.Fresen.

Family-*Mucoraceae*

Morphological characters: - Colonies floccose, pale grayish-brown grow poorly. Sporangiophores hyaline and mostly sympodially branched with long branches erect; shorter branches becoming circinate (See Photoplate– III,B).

4. Fusarium sp. Link

Family-Nectriaceae

Morphology of isolate- Mycelium septate, cottony and somewhat pink in culture; conidiophores vary in length and branching pattern, conidia hyaline, microconidia formed simple, unbranched chains; macroconidia frigle, oval shaped and taper towards both ends. (See Photoplate-III,C).

5. ***Penicillium sp.Link***

Family-Trichocomaceae

Morphology of isolates-The colonies velvety, widely spreading, densely sporulating; produce submerged, septate, phialids-bearing terminal clusters of globular, elliptical, smooth conidia in a chain mycelium. (See Photoplate-III,E)

6. Curvularia sp. Boedijn

Family-Pleosporaceae

Morphological characters:-The mycelium branch, septate, subhyaline to light brown; colonies dark black; third cell is noticeably larger, broader, darker than the other cells. The other cells curve slightly sub-hyaline with rounded apical cells somewhat obconical, basal cells that bear a scar indicating point of attachment to the

conidiophores. Conidiophores erect, slightly bent, dark brown, and branch; septate geniculate towards the apex, produced acrogenously at the tip of conidiophores. (See photoplate-III,F)

7. ***Rhizopus sp.Ehrenb.***

Family-Mucoraceae

Morphological characters: - Filamentous, hyphae branched, body of branching mycelia composed of three types of hyphae; stolons, rhizoids & unbranching sporangiophores. The production of sporangiophores took place within a spherical structure called a sporangium, which is held up by a large apophyte columella at the top; (See Photoplate-III,G)

DISCUSSION

Fungi constitute the largest number of plant pathogens and are responsible for a range of serious plant diseases. Most vegetable diseases are caused by fungi. They damage plants by killing cells or causing plant stress. Sources of fungal infections infected seed, soil, crop debris, nearby crops and weeds. Fungi are spread by wind and water splash, and through the movement of contaminated soil, animals, workers, machinery, tools, seedlings and other plant material. They enter plants through natural openings such as stomata and through wounds caused by pruning, harvesting, hail, insects, other diseases, and mechanical damage.

Fruit and vegetable infection by fungal pathogens significantly impacts on fresh produce availability, quality, market ability, and safety in pre harvest and post harvest scenarios. Once if harvested, fresh produce undergoes an intricate journey from the field to consumers, resulting in high accumulative losses mainly due to fungal decay. Most fungal inoculation of fruits and vegetables occur pre harvest, yet those insidious fungi infections remain latent until the onset of ripening or senescence events during post harvest. The latent fungal pathogens sense these changes and switch to an aggressive necrotrophic stage, where disease symptoms appear. Studies of fungal pathogenicity and the responses of fruits and vegetables to fungal infection will provide a better understanding of the biology of their interaction and lead to applied solutions for reducing food losses.

Fast-rising fungal attacks on the world's most important crops threaten the planet's future food supply, scientists have said, warning that failing to tackle fungal pathogens could lead to a "global health catastrophe". Fungi are already by far the biggest destroyer of crops. They are highly resilient, travel long distances on the wind and can feast on large fields of a single crop. They are also extremely adaptable and many have developed resistance to common fungicides.

According to a postharvest report of 2021, more significant postharvest losses occur with fruits and vegetables, with estimates of approx 45%. One of the main causes of these losses is postharvest fruit rotting, which is predominantly brought on by fungal infections after the ripening phase.

A regular survey was done for collection of infected fruits which is use as vegetable in various localities of Akola region. During collection common vegetables and fruits such as *Cucumis melo.*,*Citullus lanatus Lagenaria siceraria, Luffa actangula, Mimordica charantia, Cucurbita maxima, Cucumis sativas,* were selected for study because these fruits & vegetables are easily available in market. They are more consumed by people in their diet.

In this study, a survey was carried out to assess the fungal diseases from the Cucurbitaceae vegetables and fruits. The survey allowed us to isolate and identify several fungi including species of Aspergillus, *Fusarium, Rhizopus, Penicillium Mucor, Phoma and Curvularia.*

From the infected vegetable and fruits of Cucurbitaceae the *Mucor* has been found in almost all members except *Lagnaria siceraria. Aspergillus* infect to all members except *Luffa actangula. Phoma* is isolated from *Cucumis sativas, Cucurbita maxima* and *Lagenaria siceraria.* Curvularia infect only Cucurbita *maxima while Fusarium* found on almost all members except *Cucurbita maxima*, *Cucumis sativas*. *Rhizopus* infects only *Mimordica charantia.*

Presence of same fungi on different vegetables and fruits shows the capacity of Ascomycetean fungi to obtain food from different hosts. As a result of which these fungi have ability to cause infections on new hosts

rapidly and also have higher chances of survival. These fungi are flexible regarding their nutritional requirements.

The yield loss may occur during harvesting, handling, packing, storage and transportation and delivery. The fungal infection decreases the market value of production and thus hampers economy of the growers. The decay of vegetables and fruits may start from germination of seeds to flowering and fruit set. The blemished vegetables and fruits are not eaten or sold in commercial market. The yield loss depends upon the susceptibility of host plant and resistance to fungal pathogen. The study illustrated that the fungi obtain are responsible for the severe crop diseases and losses.

Conclusion

The Cucurbitaceae is a remarkable plant family containing wide range of wild and cultivated fruits & vegetables. It shows enormous variation in size, shape, and color patterns in plants. A few Cucurbit genera e.g., *Cucumis, Cucurbita, and Citrullus* are widely cultivated and have extraordinary human importance for many reasons such as economic, aesthetic, cultural, medicinal, and Botanical values. Cucurbits are among the oldest domesticated plants, emerging as some of the first vegetable crops 8,000-12,000 years ago, both in the Old and New Worlds. However, the current state of knowledge about the origins, domestication processes, post-domestication diversification, and geographic expansion of important cucurbits is still relatively limited.

Now a day, the people are engulfing into the diet for nutritional purpose or for healthy lifestyle. In today's era, whatever nutrition we are getting from the plants are the pesticides and insecticides. But in this situation, the Cucurbitaceae is rich in nutritional value. Because of their high nutritional content, flavor, unique taste, and nutraceutical qualities, as well as their proven health-promoting effects, cucurbits are being consumed and accepted by more people.

Vegetables and fruits diseases brought on by fungus infestation leads to postharvest losses of fresh fruits and vegetables. Approximately 30% of harvested fruits or vegetables do not reach consumers plates due to postharvest losses. Fungal pathogens play a substantial part in those losses, as they cause the majority of rots and consumer complaints.

Understanding fungal pathogenic processes and control measures is crucial for developing disease prevention and treatment strategies. Cucurbit fruit diseases can cause a complete loss of cucurbit yields in commercial fields, as well as in home gardens. The fungal pathogens were identified and isolated from the infected portion of the fruits and vegetables will help in furthermore research.

This work provided a comprehensive overview on diseases associated with cucurbitaceous fruits which is used as vegetable emphasized on the need for further research towards better production of fruits and vegetables so that farmers can bear minimum pre and post- harvest losses.

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Photo plate I

Collection of infected fruits &vegetables

A. Janata market

B. Jatharpeth local market

Infected fruits used as vegetables

C.Cucumis *melo*

D.*Citrullus lanatus*

E. *Lagenar*ia siceraria

F. *Cucumis sativas*

G. Mimordica charantia

H. *Luffa actangula*

I. Cucurbita maxima

Photo plate II
Cultures of fungal colonies isolated from vegetables

A.Cucurbita maxima

B.Citrullus lanatus

C.Lagenaria siceraria

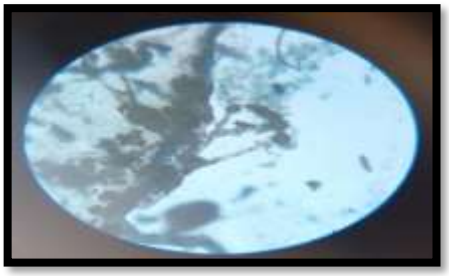
D.Cucumis melo

E. Mimordica charantia

F. Cucumis sativas

G.Luffa actangula

Photo plate III
Microphotograph of fungi



A. Aspergillus sp**.**

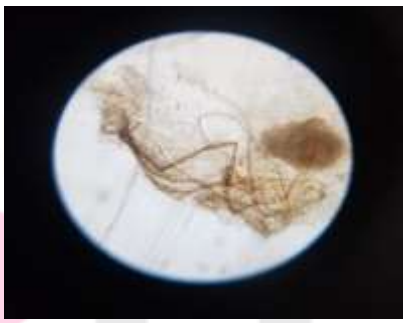
B. *Mucor sp.*

C. *Fusarium sp*

D. *Phoma sp.*

E. *Penicilliium sp.*

F. *Curvularia sp.*



G. Rhizopus sp.