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DIVERSITY OF FUNGI FROM DIFFERENT TYPES OF VEGETABLES IN THE MUMBAI METROPOLITAN REGION

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Research Article

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ABSTRACT

The present study was performed at exceptional markets in Mumbai for isolation, characterization and identity of fungi inflicting the degradation and deterioration of vegetable like Potato *(Solanum tuberosum*), Onion *(Allium cepa*), Eggplant (*Solanum melanogenic*), Cabbage (*Brassica oleracea*), Cucumber (*Cucumis sativus* L.), Tomato (*Solanum lycopersicum*), Pea (*Pisum sativum*), Lemon (*Citrus limon*), Capsicum (*Capsicum annum*), Spinach (*Spinacia oleracea* L.), Cauliflower (*Brassica oleracea*), Garlic (*Allium sativum*) and Carrot (*Daucus carota*) had been selected from 4 markets in Mumbai. Both healthful and diseased samples were gathered. Eleven fungal species: *Fusarium oxysporium*, *Aspergillus niger*, *Penicillium* sp, *Alternaria* sp, *Aspergillus flavus*, *Colletotrichum* sp, *Aspergillus fumigatus*, *Rhizopus stolonifer*, *Sclerotinia sclerotiorum*, *Cladosporium* sp. and *Geotrichum candidum* had been isolated at the duration of the research.

Keywords: Degradation, Vegetables, Deterioration, Fungi.

INTRODUCTION

Vegetable products have dramatically increased in India by more than 40% during the past few decades. About 30% of all vegetables are lost due to spoilage (Elufer, 2019). Vegetables are vital sources of nutrients for human beings. They are the fresh and edible portions of herbaceous plants. They are essential food, highly beneficial for maintaining health and are valued mainly for their high carbohydrate, vitamin and mineral contents (Nareen *et al*., 2017). Associated with disease prevention by improvement of good vision and gastrointestinal health and decrease the risk of chronic and degenerative diseases like diabetes, certain cancers, cardiovascular diseases, rheumatoid arthritis and obesity (João, 2012) are of the utmost importance.

Fungi play a substantial role in the spoilage of vegetables because of their pathogenicity to the harvested products. However, during the various stages of pathogenesis, most of these fungi may generate different mycotoxins, which can be harmful to humans and animals that consume them. In recent decades, various vegetables that form part of our daily diet have been added to the list of products exposed to mycotoxin contamination (Hero *et al.*, 2017). The contamination of vegetables by fungi could also be a result of poor handling of vegetable supply, Storage conditions, distribution, marketing practices and Transportation (Elufer, 2019). Fungi are increasingly implicated as the agent of spoilage of economically essential vegetables such as *Alternaria*, *Aspergillus*, *Fusarium*, *Mucor*, *Penicillium*, *Rhizopus* and *Trichoderma species*. (Nareen *et al.*, 2017). The dumped plant material and debris present in market places acts reservoirs of the plant pathogen and for the growth of different fungi, which carries biodegradation and deterioration due to the presence of nutrients like carbon and nitrogen etc. (Umesh *et al.*, 2012)

It has been an increase in the need to isolate the pathogenic fungi associated with the spoilage of vegetables. Due to which

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food becomes less palatable or even toxic, these changes may be accompanied by taste, smell, appearance or texture alternations (Benita B.R. *et. al.*, 2019). Therefore, this study was undertaken to isolate fungi associated with spoilt vegetables commonly sold in the Mumbai market. No systematic studies have been published on the incidence of plant pathogenic fungi from vegetables in the Mumbai market. However, such information is needed to evaluate diseases of vegetables due to pathogenic fungi, which can cause health effects. Hence, the present study was undertaken in four major vegetable markets in Mumbai city to investigate and isolate other pathogenic fungi from vegetables.

The selected vegetables in this paper are, Potato (*Solanum tuberosum*) belongs to the family Solanaceae, is the most commonly cultivated tuber and The fourth most important tuber crop, after wheat, rice and maize (Reddy *et al.*, 2018). India is the fourth biggest producer in Asia as well as Onion has been one of the necessary cash crops grown in India during the last 5000 years and throughout the tropical and sub-tropical countries of the world (Vaijayanthi *et al.*, 2019). Brinjal (*Solanum melongena L*), it is a non-tuberous vegetable crop from the *Solanaceae* family. It is a low-calorie vegetable, a great source of protein, vitamins, fibre, minerals, and antioxidants and contains anticancerous compounds (Damini *et al.*, 2021). Cauliflower (*Brassica oleracea variety botrytis*) is a vegetable that belongs to the family of *Cruciferous* and is characterized by its broad leaves and fleshy stem. They have compounds called isothiocyanates, which activate enzymes (substances that speed up chemical reactions) that reduce the activity of carcinogens (substances that promote the mutation of cells) (Supriya *et al.*, 2017). Also, Cabbage (*Brassica oleracea)* belongs to the same Genus and is an excellent source of vitamin C. In addition, it contains some B vitamins, and cabbage supplies potassium and calcium to the diet (Astrit, 2014). Carrot (*Daucus Carota L.*) is an important crop that refers to the Umbelliferae family. They are a great source of nutritional fibre and whit mineral molybdenum which are rarely found in many vegetables. It is a rich source of magnesium and manganese, which are needed for bone and protein, activating vitamin B, creating new cells, ergonomic muscles, nerves, and energy production (Moayad, 2018). The cucumber (*Cucumis sativus L.*) is one of the most essential vegetables which belong to the *cucurbit* family and has great economic importance.

Cucumbers are high in vitamins A, B, and C and contain almost (96%) water, (3%) carbohydrates, and (1%) protein, as well as minerals like manganese, copper, iron, calcium, and potassium (Ali et al., 2020). Tomato (Solanum lycopersicum) belongs to the family Solanaceae. Tomato is a widely grown and versatile vegetable worldwide for taste, colour, high nutritive value, and diversified use (Varinder et al., 2017) are rich in vitamins, minerals and lycopene, an excellent antioxidant (Khatoon et al., 2016). Pea (Pisum sativum L.) comes under Leguminoceae family. The second largest producer of green peas is India which ranks in the 10th position among vegetable crops (Junghare et al., 2014). It also has an important ecological advantage for its contributions to developing low-input farming systems by fixing atmospheric nitrogen (Mahmoud et al., 2018). Lemon (Citrus limon) belongs to the family Rutaceae. High juice contents, nutritional values and distinct taste have made the Citrus fruit unique among all other fruits with a great source of vitamin C (Anam et al., 2014). In high quantities, they contain essential natural compounds containing ascorbic acid, citric acid, minerals, essential oils, and flavonoids. Lemon shows antibacterial and anticancer activity due to alkaloid constituents in different parts of the lemon (Yahaya et al., 2016).

The *Capsicum* genus, which also includes more than 30 species of flowering pepper plants, belongs to one of the essential families known as Solanaceae. They are rich in fibre, capsicum is also rich in micronutrients and is hugely beneficial to body functions, and Bell peppers are rich in vitamin C, and they help in many functions like wound healing, immune function and collagen synthesis. With vitamin C, *capsicum* it is also high in vitamin A. Vitamin A is necessary for the immune system and reproduction. Cabbage (*Brassica oleracea*) is an excellent and rich source of vitamin C. In addition, it contains some B vitamins, and cabbage supplies potassium and calcium to the diet. (Astrit, 2014). Spinach (*Spinacia oleracea* L.), family Chenopodiaceae, is native to central and south western Asia. They are a source of vitamins A, B2, B6, B9, C, E and K. Spinach and other green leafy vegetables are huge sources of iron. Spinach also has high calcium content (Marraiki *et al*., 2012).

Garlic is a crop of great importance worldwide and is more valued for its culinary and medicinal properties. Secondary metabolites have been shown to positively affect health and prevent many common human diseases, particularly through their antioxidant, anti-inflammatory, and lipid-lowering effects (Laura *et al*., 2021). Diversity of flora and fauna indicate a good ecosystem. Biodiversity is important for ecological balance, sustainable development and human survival (Ashok, 2017, 2018; Verma, 2019), however climate change and anthropogenic activities badly influence the biodiversity (Verma, 2021; Prakash and Verma, 2022). In the present exploration, diversity of fungi from different types of vegetables in the Mumbai metropolitan region is taken into consideration.

MATERIAL AND METHODS

Survey and Sample Collection : Four markets in Mumbai region Maharashtra state: Byculla, Kurla, Thane and Mumbra markets were surveyed with diseased and healthy vegetables of Potato (*Solanum tuberosum*), Onion (*Allium cepa*), Eggplant (*Solanum melanogenic)*, Cabbage (*Brassica oleracea*), Cucumber (*Cucumis sativus* L.), Tomato (*Solanum lycopersicum*), Pea (*Pisum sativum*), Lemon (*Citrus limon*),

Fig: Map Mumbai showing different markets.

Sr. No.	Market	CO-ORDINATE
1	BYCULLA	18.9750° N, 72.8295° E
2	KURLA	19.0726° N, 72.8845° E
3	THANE	19.2183° N, 72.9781° E
4	MUMBRA	19.1761° N, 73.0229° E

Isolation and Identification of Fungi

The infected parts were put in 6% of sodium hypochlorite solution for 1-2 minutes, rinsed twice in sterilized water to remove the toxic material, and then the pieces were transferred by using forceps to a Petri dish containing solidified potato dextrose agar containing streptomycin to prevent the growth of bacteria, was conducted in laminar flow, then incubates for 5-7 days at 25ºC±2. After seven days of incubation, a small portion of mycelium from each fungal colony is transferred aseptically into fresh plates containing the medium. Purification of fungi is done by repeated sub-culturing. Identification of fungi was carried out by doing pure culture of the isolated fungi using a Microscope and studying different characteristics of fungi according to their shape, size, colours, and mycelia textures of the fungi and making reference to standard literature (Ainsworth, et al., 1972; Barnett, 1960; Ellis,1971; Ingold,1974; Gilman,1957; Smith, 1969), The percentage frequency was calculated by the following formula:

$$\text{Percentage frequency} = \frac{\text{Total number of observations}}{\text{Number of observations in which a species appeared}} \times 100$$

Table 1: Percentage Frequency of Fungal Isolate from Different locations.

Location	Vegetable sample	Isolated fungal species	Percentage Frequency (%)
Byculla	Potato (*Solanum tuberosum*)	*Fusarium oxysporium* *Aspergillus niger*	70% 90%
	Onion (*Allium cepa*)	*Aspergillus niger* *Penicillium* sp.	80% 35%
	Egg plant (Solanum melanogenic)	*Alternaria* sp. *Aspergillus flavus* *Colletotrichum* sp.	50% 60% 45%
	Cabbage (*Brassica oleracea*)	*Aspergillus niger* *Alternaria* sp.	70% 60%
Kurla	Cucumber (*Cucumis sativus* L.)	*Fusarium* sp. *Aspergillus fumigatus*	75% 55%

	Tomato (*Solanum lycopersicum*)	*Fusarium oxysporium* *Alternaria alternata* *Rhizopus stolonifer*	65% 50% 30%
	Potato (*Solanum tuberosum*)	*Aspergillus niger* *Fusarium* sp.	65% 70%
	Pea (*Pisum sativum*)	*Sclerotinia sclerotiorum*	45%
Thane	Lemon (*Citrus limon*)	*Alternaria* spp. *Aspergillus niger*	50% 80%
	Capsicum (*Capsicum annum*)	Aspergillus niger *Fusarium solani* Alternaria sp.	85% 70%
	Spinach (*Spinacia oleracea* L.)	*Fusarium* sp. *Cladosporium* sp.	55% 35%
	Cauliflower (*Brassica oleracea*)	*Aspergillus* spp. *Alternaria* sp.	60% 55%
Mumbra	Cauliflower (*Brassica oleracea* var. botrytis)	*Aspergillus flavus* *Alternaria alternata*	75% 60%
	Tomato (*Solanum lycopersicum*)	*Fusarium oxysporum* *Alternaria* sp. *Aspergillus flavus*	65% 50% 60%
	Garlic (*Allium sativum*)	*Aspergillus niger* *Fusarium* spp. *Alternaria* sp.	80% 65% 55%
	Carrot (*Daucus carota*)	Geotrichum candidum *Fusarium* sp. *Alternaria* sp.	40% 65% 30%

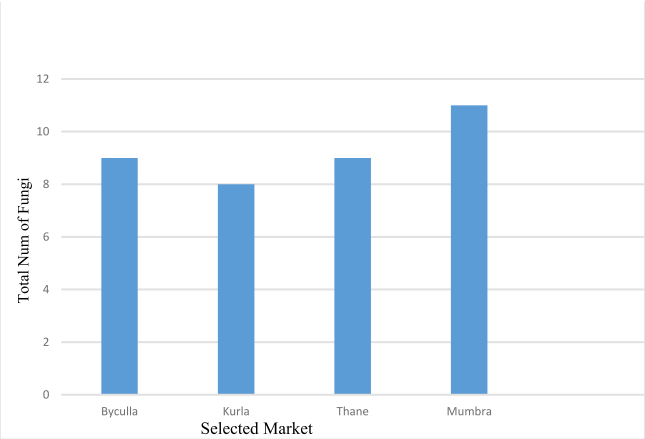

Fig: 1 Total number of Fungal species associated with Vegetable samples collected from four different markets

Potato (***Solanum tuberosum***) **Egg plant** (***Solanum melongena***)

Fig. 1: Collection of infected vegetables from markets of Mumbai.

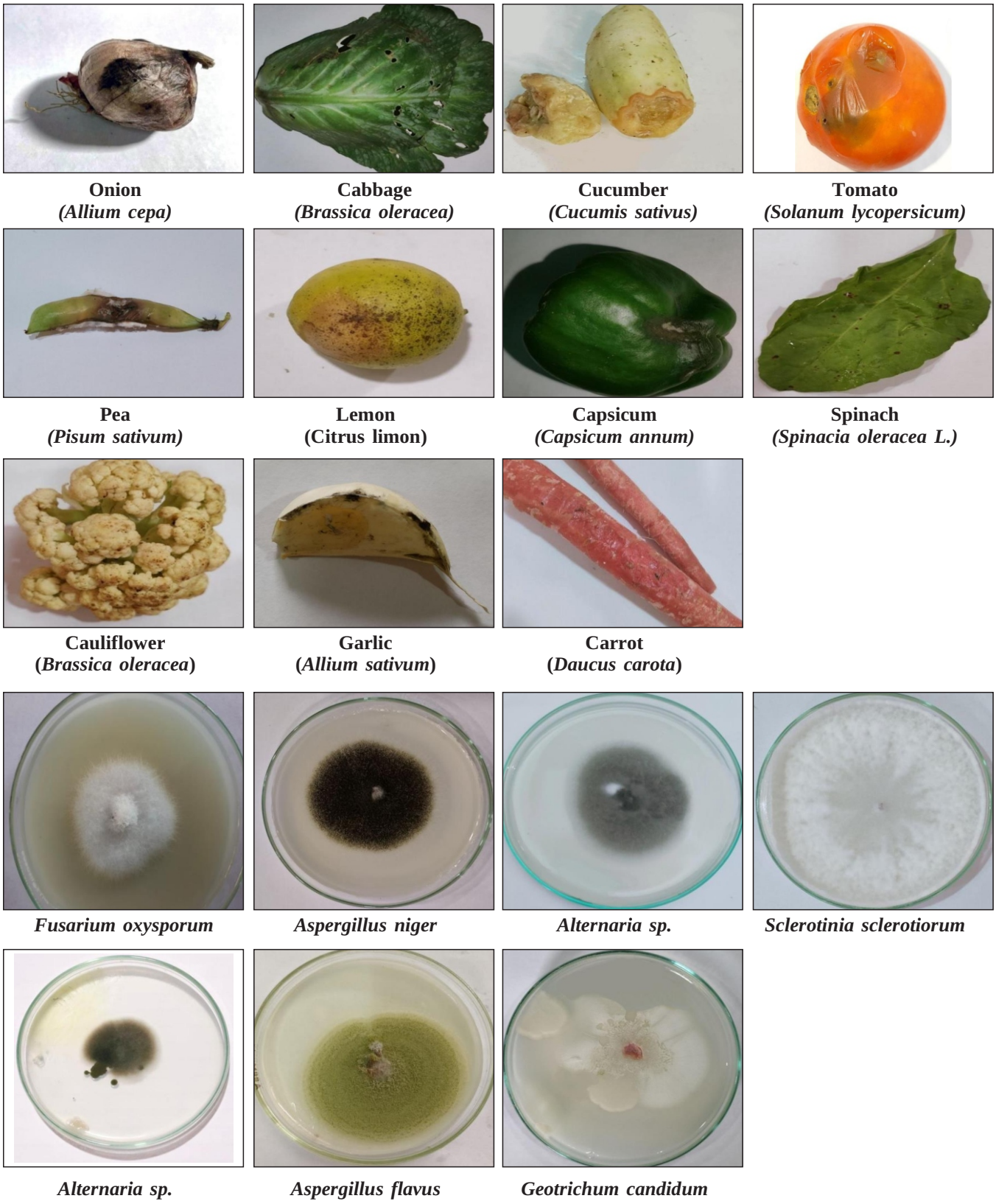

Figure 2: Growth of different species fungal culture on PDA.

RESULT AND DISCUSSION

Fungi were isolated from vegetables, namely Potato *(Solanum tuberosum)*, Onion *(Allium cepa)*, Eggplant *(Solanum melanogenic*), Cabbage *(Brassica oleracea*), Cucumber (*Cucumis sativus L.)*, Tomato *(Solanum lycopersicum*), Pea (*Pisum sativum*), Lemon (*Citrus limon*), Capsicum (*Capsicum annum*), Spinach (*Spinacia oleracea L.*), Cauliflower (*Brassica oleracea*), Garlic (*Allium sativum)* and Carrot (*Daucus carota*) which were collected from Four different markets of Mumbai, i.e. Byculla, Kurla, Thane & Mumbra markets. The occurrence and distribution of fungi are present in Table 1 and Fig-1. All total fungi were isolated. *Aspergillus niger, Aspergillus flavus, Fusarium oxysporum* and *Alternaria* sp. were predominant in all four markets of the Mumbai region. The common fungi found are opportunistic and grow on rotten vegetables, thrown away material and produce spores enormously. The present study revealed that the vegetables marketed in the diff erent markets of Mumbai are contaminated by several fungal pathogens and opportunistic Fungi. The market values of vegetables are reduced as a result of pathogen infection. Their presence in these food products also constitutes health risks.

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