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Environmental assessment of fungal spoilage of common fruits: Impact on rural economic development at tahsil - Naigarhi, disst. – Rewa (M.P.)

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Abstract
The systematic survey of fungal fruit Spoilage and Rural Economic Loss of Some common Fruits in the markets of town – Naigarhi and nearby villages of Tahsil – Naigarhi, Disst – Rewa (M.P.) was undertaken to assess impact on rural economic development. 120 Fruit sellers were randomly selected and interviewed to obtain socio-economic characteristics. The survey data were collected using oral questionnaires, personal interviews and chaupal discussions at panchayats and markets of study area. Descriptive statistics was used to analyze the data collected. Recurrent sampling from the some common fruits depicted variable intensity of fruit spoiling fungal flora. Fungal spoilage of 3 selected common fruits were studied and in all 11 spoilage fungi were observed. Among these Alternaria, Fusarium and Rhizopus were responsible for extensive fruit spoilage and economic losses to fruit sellers. Fruit spoilage fungi during extreme environmental conditions (rainy season) showing increased percent disease incidence in the markets of Naigarhi Tahsil, of district Rewa (M.P.). During rainy season temperature and related humidity were high. Therefore this study gives a brief account of fungal fruit spoilage and their impact on rural economic loss of fruit sellers.

Keywords: environmental assessment, fungal spoilage, fruit sellers, economic loss

1. Introduction
Fruits and vegetables typically constitute an essential part of the daily diet in India and they are in great demand round the year from most sections of the population. The commercial value of fruits and vegetables in terms of direct consumption, processing as well as trade has risen substantially in recent years. Their economic importance has also increased and high labor intensity in the production of most fruits and vegetables production also makes them important from the employment angle as well (Sharma 1991) [9]. Fruits have wide distribution in nature. The relatively short shelf-life period provoked by pathogens is one of the most important limiting factors that impact the economic value of fruits. Approximately 20-25% of the harvested fruits are deteriorated by pathogens during post-harvest handling even in advanced countries (Droby, 2006; Zhu, 2006) [4, 12].
Climatic conditions such as temperature and relative humidity have a strong effect on the nutritional quality of fruits. Delays between harvest and consumption or processing can result in losses of flavor and nutritional quality. The magnitude of these losses increases with exposure to temperatures, relative humidity outside the ranges that are optimum for each commodity during the entire postharvest handling system (Lee and Kader, 2000) [6].
The aim of this study to assess the environmental relation with fungal fruit spoilage and impact of fruit spoilage on rural economy of Naigarhi town and nearby village markets at Tahsil – Naigarhi. Retail selling and buying of agricultural and horticultural products are main market economic practices of study area. Naigarhi is a town and a nagar panchyat in Rewa district in the state of Madhya Pradesh, India. It is one of the eleven tahsils located in the N.E. part of Rewa district, Madhya Pradesh at 24°47′ 15”N 81°46′ 54”E. It has an average elevation of 135 metres. Villages Tatihara, Dihiya, Beohariya, Budha, Chhuhiya, Parasia, Mudhan, Panigawan, Puraini, Chilla, Pakara etc. are nearby villages.
The climate of Rewa District, M.P, characterized by a hot summer and general dryness except during the south west monsoon season. The year may divide into three seasons (summer, Rainy and Winter). The normal annual rainfall of Rewa District is 1141.5 mm. Rewa District received maximum rainfall during south west monsoon period i.e. June to September. About 89.2% annual rainfall received during monsoon season. Only 10.8% of the annual rainfall takes place between October to May period. Related humidity (%) during year 2013 was average 66% in Rainy season (July- Oct.) 66% in Winter season (Nov. – Feb.) and 44.25 in Summer season (Mar. - Jun).
(Source: District Statistical Hand Book 2012 and 2013)

2. Materials and Methods
Samples were collected in the months of July, 2014 – June, 2015 from different fruit retailers of Naigarhi town and nearby villages. The temperature during these months ranges from 08 - 46 ±2°C.

2.1 Collection, Isolation, identification and Pathogenicity test of fungal pathogens from fruits
a) Collection and Isolation of fungal pathogens from fruits
The sampling of spoiled common four fruits (viz. Apple, Banana and mango) was done during morning (08 a.m. to 10 a.m.). Disease incidence was calculated by counting visibly diseased fruits each market in relation to total fruits.

Percent Disease Incidence =
no. of diseased fruits ÷ total no. of fruits

The spoiled fruits were collected from Naigarhi market and nearby villages. Samples were brought in to the laboratory in separate sterilized polythene bags. Rotten samples were kept under refrigeration at 0^0C to prevent further deterioration. Nichrome inoculating needles duly sterilized were used to isolate & the pathogens was transferred directly to PDA aseptically. The infected tissue was cut after surface application of alcohol & sterilization with 0.1% Hgcl2 in sterilized distilled water.

b) Identification of pathogens

The materials were examined critically with respect to symptomatology and etiology. In some cases the infected tissues were stained by cotton blue and Lactophenol (Mc Lean and Ivimey 1965) [7] and observed under compound microscope. Identification of the pathogens was made with the help of available literature (Biligrami *et al.* 1981 and 1991, Subramanian 1971 and Barnett 1999) [10]. Some species were identified in the Agharkar Research Institute (ARI), Pune. Pure cultures of the pathogens were maintained in the laboratory on PDA slants for further study.

c) Pathogenicity test

The pathogens were isolated, identified and cultures were used to confirm their pathogenicity test in their respective hosts. Fresh disease free samples were brought in to the laboratory and surface sterilized with 0.1% Hgcl2. For inoculations, cork borers of (2mm) diameter were used. They were sterilized by placing in spirit lamp flame, dipping in alcohol & shaking off the excess alcohol by flaming (Granger and Horne 1924). The inoculated samples and their respective controls were kept under sterile humid conditions at room temperature under bell jars. The artificially inoculated samples were examined daily & the extent of damage was recorded. The pathogens were reisolated and disease symptoms were clearly evident, the culture and symptoms signs were compared with original.

2.2 Sampling procedure for assessment of rural economics

A sample was randomly drawn from a population of 120 fruit sellers. In picking the sample, attempts were made to ensure representation of common fruits sold in the market.

Primary and secondary data collection

The study was conducted along with Collection, Isolation, identification and Pathogenicity test of fungal pathogens from fruits, using the self- administered questionnaires approach designed to address specific objectives of the study. The approach enabled the collection of both qualitative and quantitative information on various aspects from respondents (Prinsloo, 2000) [8]. The questionnaire was divided into two parts: section A (Personal information) and section B (information on postharvest loss of fruits). The administered questionnaires generated information on age of respondents, level of education, type of fruit sold with price, distance of farms or source from the market, type of transport used to the market,, working time in a year, frequency of fruit harvest, purchase or supply, quantity sold or lost, most frequent type of losses, type of storage facilities, problems encountered during storage, security of produce at the location, measures taken to control post-harvest loss and any suggestions to minimize losses. Secondary data were from various relevant books, electronic media and other sources (Aliber *et al.*, 2006) [1].

Data processing and analysis

The data generated from the questionnaire were captured using a template before applying descriptive statistics of frequency and percentage (Trochim, 2006). Statistical Package for the Social Sciences (SPSS) program was used to generate data.

3. Results and Discussion

Among 120 fruit sellers interviewed, their gender, age and average monthly loss of fruits were quantified. In gender category, 68(56.67%) of them were males and rests of them were females. It shows the males were involved much in fruit vending. Among the age groups of the fruit venders, the maximum of 42 members were 21-30 years of age followed by 37 members (31 to 40 years) and 23 members(≥41 years) of age and the minimum of 18 venders belongs to ≤ 20 years of age. The average monthly economic loss of fruits due to fungal spoilage in the markets among the fruit sellers, the maximum 78 fruit sellers loss 31 – 40 % fruits followed by 21(21 – 30%), 03(0-10%) fruit sellers and minimum of 11(31-40%) fruit sellers. All Fruit sellers were involve in fruit business works not throughout the year among them maximum 41(34.17%) fruit sellers works for six months, followed by 32(26.67%) fruit sellers works three months, 29(24.17%) fruit sellers works one year or more and minimum of 18(15%) fruit sellers works nine months. Fruit sellers facing average monthly loss of fruits due to fungal spoilage. Among them maximum of 78(65%) fruit sellers were facing 31-40% average monthly economic loss and minimum of 03(2.5) fruit sellers were facing 0-10% average monthly loss due to fungal fruit spoilage during study as given in table 1.

Table 1: Socio-economic characteristics of the fruit venders in Tahsil – Naigarhi and nearby villages

Socio-economic characteristics of fruit sellers		Frequency	Percentage (%)
Gender	Male	68	56.67
	Female	52	43.33
Age	≤ 20	18	6.67
	21-30	42	35
	31-40	37	30.83
	≥41	23	19.16
Sole business	Owner	34	28.33
	Employee	86	71.67
Average monthly economic loss of fruits due to fungal spoilage	0-10%	03	2.5
	11-20%	18	15
	21-30%	21	17.5
	31-40%	78	65

Average working time in fruit business.	3 months	32	26.67
	6 months	41	34.17
	9 months	18	15
	1 year / more	29	24.17

In other hand fungal spoilage of fruits were studied and in all 11 fruit spoiling fungal species belonging to 09 genera were observed. Among these highest Percent Disease Incidence 42.46 % was in Mango during rainy season and lowest percent disease of incidence was in Banana during winter season. The present investigation revealed Fruit spoilage fungi during extreme environmental conditions (rainy season) showing increased percent disease incidence in the Naigarhi region. During rainy season temperature and related humidity were high. Therefore this study gives a brief account of fungal fruit spoilage and their impact on rural economic loss of fruit sellers as given in table 2 and 3.

Table 2: Seasonal Percent disease incidence on common fruits during this investigation.

Season of survey	Type of fruit Total Percent disease incidence		
	Apple	Banana	Mango
RAINY (July- Oct.)	23.69	34.21	42.46
WINTER (Nov. – Feb.)	12.84	9.32	00
SUMMER (Mar. - Jun)	16.74	14.25	19.66

Table 3: Summary of different types of fungal species isolated from spoiled common fruit samples during this investigation.

S. No	Genus	Species	Type of fruit		
			Apple	Banana	Mango
1.	*Alternaria*	*Alternaria alternata (Fr.) Keissler*	+	+	+
2.	*Aspergillus*	*Aspergillus niger Van Tiegh*	+	-	-
		Aspergillus versicolor (Vuill.) Tiraboschii	+	-	-
3.	*Botrytis*	*Botrytis cinerea Pers*	-	+	-
4.	*Cladosporium*	*Cladosporium herbarum (Pers) Link ex. Gray*	+	+	-
5.	*Colletotrichum*	*Colletotrichum musae (Berk. & M.A. Curtis) Arx*	-	+	-
6.	*Fusarium*	*Fusarium moniliforme J. Sheld*	+	+	+
		Fusarium oxysporum Schlecht	+	+	+
7.	*Mucor*	*Mucor piriformis Fischer*	+	-	-
8.	*Penicillium*	*Penicillium crustosum Thom.*	+	-	-
9.	*Rhizopu*	*Rhizopus stolonifer (Ehren. Ex Fr.) Lind*	+	-	+
	No. of genera		07	05	03
	No. of species		09	06	04

+ : Present, - : Absent

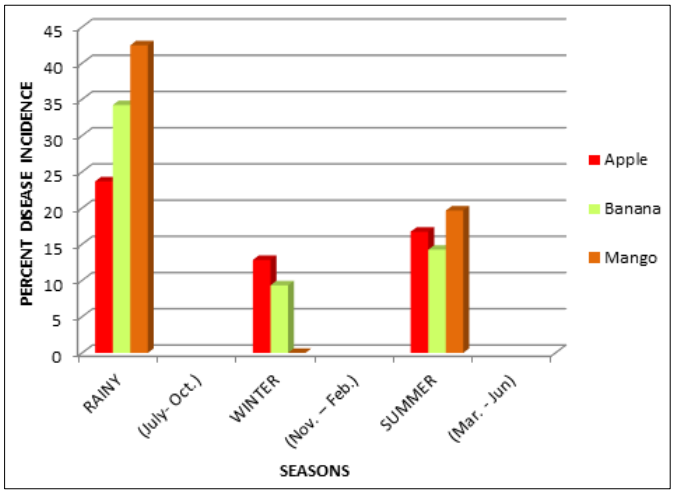

Fig 1: Seasonal Percent disease incidence on common fruits during, July, 2014 – June, 2015

4. Conclusion

On the basis of survey results of the fungal biota associated with common fruit spoilage its impact on rural economic development from a population of 120 fruit sellers from different localities in town – Naigarhi and nearby villages. Several fungal species (11) belonging to 08 Genera could be regarded as most common cause of fungal fruit spoilage in the market. The study revealed that poor infrastructure for storage, transportation and marketing of common fruits contributed to losses to the fruit sellers. Cold storage and better marketing practices could be minimizing the economic losses of rural fruit sellers and give a better employment also in fruit sole business to rural population. This study gives a brief account of fungal fruit spoilage and their impact on economic loss of rural fruit sellers.

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