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A survey of post-harvest spoilage of mahula (*Madhuca latifolia* L.) flowers

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Abstract Mahula (*Madhuca latifolia* L.) belonging to the family Sapotaceae, is a deciduous tree found in abundance in the tropical rain forests of Asian and Australian Continents. Due to unhygienic collection, storage and processing practices mahula flowers suffer post-harvest losses such as weight loss, insect infestation and pathological decay during transportation from forest to local market and in storage. Therefore a survey was conducted in the year 2009 among the people of Santhal tribe in Odisha, India to get additional information on the spoilage of flowers. The study area concentrated in and around the deep forest pockets of Chandbill village of Bangiriposi Block on the northern border of the Similipal Biosphere Reserve, Odisha. Fungi and insects were found to be more spoiling than bacteria.

Key words: Mahula, Spoilage, Tribal people.

Introduction

Mahula (*Madhuca latifolia* L.) belonging to the family Sapotaceae, is a deciduous tree found in abundance in the tropical rain forests of Asian and Australian Continents (Awasthi *et al.,* 1975; Banerji and Mitra, 1996; Bhagmol and Joshi, 2002). It is one of those multipurpose forest tree species that provide an answer for the three major Fs *i.e* food, fodder and fuel (Patel *et al.,* 2011). The whole tree, its flowers and seeds have been very useful in Indian sub-continental economy for a long time. The corolla (the whorl of petals of the flower), an important useful bioresource (US$35–40 ton^{-1}) is rich in fermentable sugars (glucose and maltose) (40–47%, on fresh weight basis [fwb]), which can be utilized as carbohydrate source for bio-ethanol production (The Wealth of India, 1962; Behera *et al.,* 2010 a,b,c). They are edible and used as a sweetener in preparation of many local dishes like halwa, kheer, puri and burfi (Patel and Naik, 2008) in the mahula production belt of India.

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Due to the lack of proper scientific investigation and post harvest processing technologies, the flowers are collected and subjected to open yard sun drying before storage (Patel and Naik, 2008). Under extreme temperature (<40^0C) and relative humidity (<85%) during summer months (April to June) in the tropics, mahula flowers suffer post-harvest losses such as weight loss, insect infestation and pathological decay during transportation from forest to local market and in storage (Sidhu *et al.,* 2009; www.novodboard.com/Mahua.pdf). Spoilage or rottage is the most significant form of wastage that accounts for 20–25% of post-harvest losses in mahula flowers, which become unsuitable only for the liquor distillation units and as cattle feed (Behera *et al.,* 2011; Patel *et al.,* 2011).

However, there is little systematic/scientific study on spoilage pattern and post-harvest losses due pathological and insect decay in mahula flowers. Therefore the present study aimed to gather information on mahula flowers, especially on post harvest spoilage.

Materials and methods

The Study Area

The study area concentrated in and around the deep forest pockets of Chandbill tribal villages of Bangiriposi Block which is situated in the bank of Budhabalanga river passing through Similipal Biosphere Reserve (210 28/ to 220 08/ N latitude and 860 04/ to 860 37/ E longitude) located in part, in Mayurbhanj districts of Odisha, India (Fig. 1). Similipal range shows diversified vegetation pattern i.e. from tropical deciduous to a virgin semi-ever green forest, which express the climatic climax type of vegetation (Braham *et al.,* 1990). The region is very mountainous and complex mosaic of vegetation types as well as a high proportion of plant species. The soil of all the forest sites is reddish in color and loam to sandy loam in texture. The soil is slightly acidic in nature with pH ranging from 5.23 to 6.52 and average monthly soil moisture content varies from 18.13 to 40.25 % (Mishra *et al.,* 2006). Chandbill has been selected in this study due to the following points.

The village is situated in the vicinity of the Similipal forest which harbors rich bio-diversity. The village is chiefly inhabited by the Santhal tribes. The dependency of the inhabitants upon the plants resources is high. The residents showed a deep knowledge and interest in mahula plants.

Chandbill has a substantial number of elders, who are generally repositories of extensive mahula tree knowledge. Most importantly, Chandbill residents welcomed the opportunity to record the distribution of mahula tree and local use of the plant parts. The village had a population nearly 500 people

belong to "Santhal" community. The number of residents actually present in the village is variable at any time.

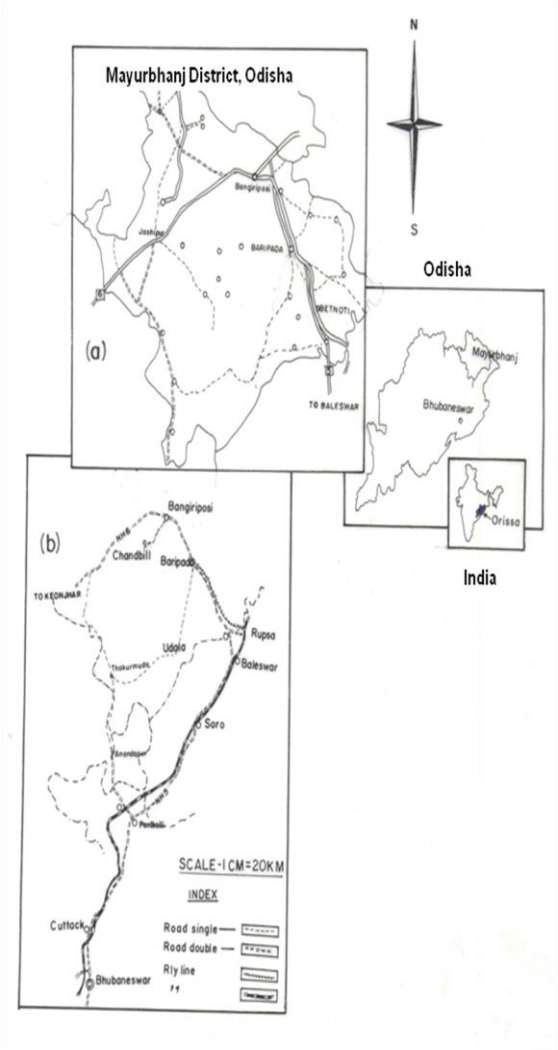

Fig. 1. Location map of study area (a) Mayurbhanj District (b) Road and railway map from Bhubaneswar to Chandbil village, (Bangirposi, Dist. Mayurbhanj, Odisha, India).

Methodology of Survey

Field research in Chandbill village was carried out in flowering seasons for a total period of two months (March-April, 2009). We visited to the tribal area where they were utilizing the natural resources. During this field work, it was found that all tribal people were living under thatched roofs. During this

time we become acquainted with the distribution of mahula species among the other plants. The fresh and spoiled mahula flower samples were collected from the tree and storage sites with the help of the tribal people.

In total, 100 (56 men and 44 women, respectively) tribal people of different age groups (the youngest was 15 and oldest one 75 years old) in Chandbill village were formally interviewed for this study, on repeated basis. Participants were interviewed individually and in community gatherings. Questionnaire regarding spoilage of mahula flowers were categories in: "spoilage", "insect infestation", "post harvest losses" and "others". The questionnaire was administered in their languages by a person who helped us in our study. Different places were visited in the above mentioned village to gather the information on mahula flowers, especially on post harvest spoilage.

.*Methodology of Isolation and Identification of Spoilage Micro flora*

The isolation and identification of spoilage microorganisms found in mahula samples was carried out by the method described in the following section.

Fungi

Fungi were isolated using potato dextrose agar (potato, 200g; dextrose, 20g; agar, 15g; water, 1000ml) at room temperature (28 ± 2^0 C). Cultures from single spore or single hyphal tip were prepared before identification and identification was made using the Mannual Fungi of India, Part I (Bilgrami *et al.,* 1979).

Bacteria

The isolation of bacteria was made aseptically from the collected spoiled mahula flowers. Pieces of spoiled flower was transferred to nutrient agar (beef extract, 1g; yeast extract, 2g; peptone, 5g; sodium chloride, 5g; agar, 15g; water, 1000ml) at room temperature (28 ± 2^0C). Bacteria isolates were repetitively sub-cultured until pure cultures were obtained and then grown on agar slants. The isolated bacteria were identified according to Bergey's Mannual of Determinative Bacteriology (Buchanan and Gibbons, 1974).

Insects

The insects isolated from the stored flowers were identified by the Entomology Research Division, Orissa University of Agriculture and Technology, India.

Results and discussions

Storage

The flowers after transportation are usually dried in sunlight (≈ 40 to 43 °C) for 5 to 7 days. The dried flowers were packed in gunny bags and stored in dark ventilated rooms. Mahula has a hygroscopic tendency and gathers moisture, especially during the monsoon, when moisture percolates from earthen floors and roofs. Almost 30 % of all the mahula flowers collection are spoiled due to lack of proper storage facilities.

Spoilage Microorganisms

The preliminary results revealed that the isolated spoilage bacteria are belongs to the genus *Bacillus*, *Micrococcus*, *Siderococcus*, *Nocardia* and *Pseudomonas*. The higher microbial load in fresh samples might be due to higher content of nutrients and moisture. Fungi were found more spoiling than bacteria. The important fungi isolated from spoiled mahula flowers samples were: *Aspergillus niger*, *Aspergillus flavus*, *Penicillium* and *Rhizopus* (Fig. 2. a, b, c and d).

Several reports showed that sugar and ascorbic acid content decreased following pathogen infection. The recent studies have demonstrated that biochemical parameters like total sugar and ascorbic acid of mahula flowers decreases with increase in fungal (*Aspergillus niger* and *Rhizopus oryzae*) infection period (Behera *et al.,* 2011). Likewise, Tripathy and Mishra (2009) reported 85.5% loss of total sugar in powdered red pepper upon in vitro infection of *Aspergillus flavus*. Amadi and Adebola (2008) observed six mould species including *A. niger* and *Rhizopus* sp. with yellow and white gari (food prepared from the roots of cassava) samples and found reduction in starch, sugar, proteins and lipids with time and increasing moisture. Raj and Singaravadivel (1990) studied two varieties of paddy infected by the fungal flora and found increase of total sugar and decrease of reducing sugar with the increasing moisture levels. Further, Palejwala *et al.* (1987) reported the decrease of total carbohydrates, sucrose, glucose and fructose with concomitant increase in the levels of hydrolytic enzymes, i.e. amylase, invertase and

cellulase upon infection of mangoes with *A. niger*. Embaby *et al.* (2007) found the average decrease of ascorbic acid content from 17.1 mg to 6.2 mg/100 g with 63.7% reduction with the infection of *Aspergillus parasiticus* in rotted apricot fruit. Further, Ray and Ravi (2005) found several species of micro-organisms including *A. niger* and *R. oryzae* responsible for the spoilage of sweet potato that showed significant decrease in starch, total sugar and organic acid (ascorbic acid and oxalic acid) following infection.

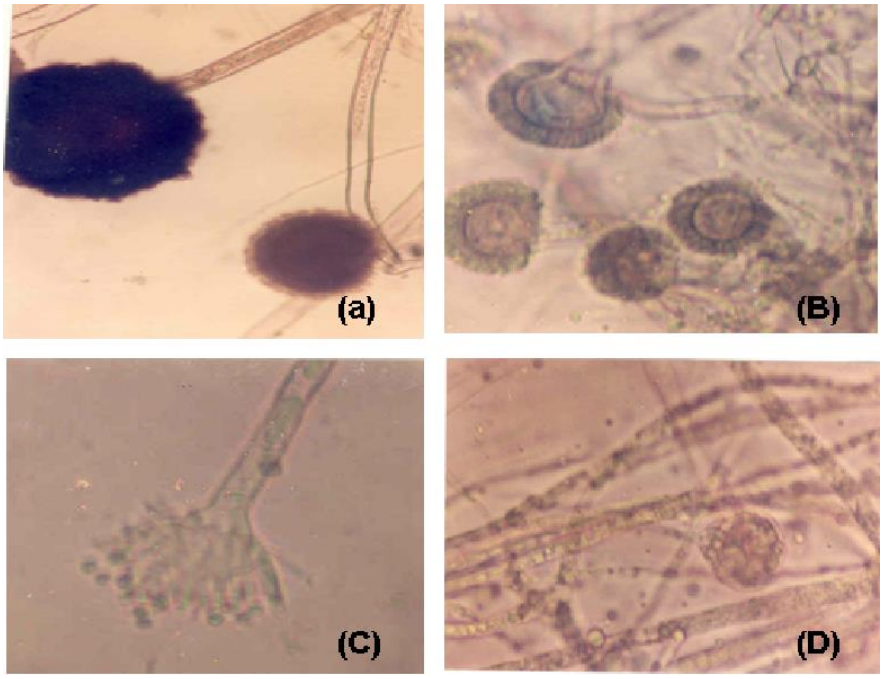

Fig. 2. Morphology of the spoilage fungus isolated from *Madhuca latifolia* flowers. (a) *Aspergillus niger* (b) *Aspergillus* (d) *Rhizopus*.

Diseases and Pests

The collected insects and larvae from the storage mahula flowers belongs to the family Noctuidae, Anthocoreidae, Cucujidae, Bostrychidae, Tephritidae and Formicidae (Fig. 3. a, b, c, d, e and f). Defoliation and flower drop are common insect pests problem associated with mahula flowers. *Dendrophthoe falcate* (L.f.) Etting that is seriously parasitized for attacking the growth and productivity of *Madhuca*. There is considerable reduction in the formation of inflorescence and the flower size of the plant. The parasite simultaneously weakens the plants and on ageing the plant dies.

Fig. 3. Morphology of the spoilage fungus isolated from *Madhuca latifolia* flowers. (a) Family Noctuidae (b) Fam. Anthocoreidae (c) Fam. Cucujidae (d) Fam. Bostrychidae (e) Fam. Tephritidae (f) Fam. Formicidae.

Conclusion

This study showed that mahula flower which is an important part in the tribal life undergoes microbial and insect infestation due to unhygienic collection, storage and processing practices.

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