

**“STUDIES ON MORPHOLOGICAL CHARACTERIZATION OF  
FLESHY FUNGI FROM DANGS DISTRICT”**

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THE AWARD OF THE DEGREE**

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**IN  
NAVSARI AGRICULTURAL UNIVERSITY  
PLANT PATHOLOGY**

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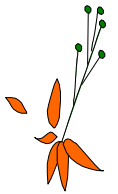
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GUJARAT STATE**

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**DEDICATED**  
**To**  
**MY BELOVED**  
**FAMILY**  
**AND**  
**MY GURU**  
**Dr. Priya John**





# ABSTRACT



**“STUDIES ON MORPHOLOGICAL CHARACTERIZATION OF  
FLESHY FUNGI FROM DANGS DISTRICT”**

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**A B S T R A C T**

Mushroom is a macro fungus with a distinctive fruiting body, which can be either epigeous or hypogeous and large enough to be seen with naked eye and to be picked by hand. Dangs district is one of the richest floristic areas located in between 20.39° to 21.05° north latitude and 73.29° to 73.51° east longitude with a wide range of ecosystem and species diversity. Studies on the taxonomy and diversity of macrofungi are gaining importance, as many macrofungi are becoming extinct and facing threat of extinction because of habitat destruction. The current study deals with the studies on morphological characterization of fleshy fungi from Dangs district; the average rain fall is about 3,048 mm. The average maximum and minimum temperature is 22 ° C.

A survey was conducted from July 2012 to December 2012 at 5 sampling stations using the opportunistic sampling method. The fleshy fungi were collected and photographed. They were further detected morphologically and taxonomically. From

the collected 111 samples, a total of 37 species were identified after grouping the similar samples in to the same genus. They were identified with the help of available literature. Among them *Auricularia polytricha*, *Schizophyllum commune*, *Xylaria carpophila*, *Ganoderma applanatum*, *Macrolapiota proera*, *Clavulina cristata*, *Psathyrella candolleana* were observed as most dominant species and found at all selected places and *Ascobolus furfuraceus*, *Calocera cornea*, *Crepidotus variabilis*, *Phellodon confluence* were very rarely collected during the survey. In Ascomycota, 3 families reported were Pyrenemataceae, Xylariaceae and Ascobolaceae. Among the phylum Basidiomycota, 21 families reported were Auriculariaceae, Agariaceae, Crapidotaceae, Coprinaceae, Lapiotaceae, Lycoperdaceae, Marasmiaceae, Pleurotaceae, Physalacriaceae, Psathyrellaceae, Tricholomataceae, Schizophyllaceae, Canharellaceae, Clavulinaceae, Dacrymycetaceae, Hymenochetaceae, Ganodermataceae, Steccherinaceae, Phallaceae, Russulaceae and Bankeraceae.

During the survey *Auricularia polytricha*, a dominant edible mushroom, observed in Dangs district was collected and isolated. It possessed resupinate or pileate, loosely attached, laterally and sometimes by a very short stalk, elastic, gelatinous. Surface of the cap is dark yellowish brown to dark brown with grayish brown bands, hairy and silky. Hymenium is smooth or wrinkled, pale brown to dark brown to blakish brown with a whitish boom. An attempt was made to grow it on different substrates under Navsari conditions. Among the six different

substrates, paddy straw was superior which recorded minimum days for spawn run (33.67 days), pin head formation (58.00 days) and first harvest (61.67 days) with highest number of fruit body (78.33), cap diameter (5.30 cm), maximum yield (556.71 gm) and highest biological efficiency (55.67 %).

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## C E R T I F I C A T E

This is to certify that the thesis entitled “**STUDIES ON MORPHOLOGICAL CHARACTERIZATION OF FLESHY FUNGI FROM DANGS DISTRICT**” submitted by **Mr. Ravat Hirendrasinh Rameshbhai** in partial fulfillment of the requirements for the award of the degree of **MASTER OF SCIENCE (AGRICULTURE)** in the subject of **PLANT PATHOLOGY** of the **NAVSARI AGRICULTURAL UNIVERSITY**, is a record of bonafied research work carried out by him under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma or other similar title.

**Place: Navsari**

**(Priya John)**

**Date: 29 July, 2013**

**Major Advisor**

# DECLARATION

This is to declare that the whole of the research work reported in the thesis in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **PLANT PATHOLOGY** by the undersigned is the result of investigations done by me under direct guidance and supervision of **Dr. Priya John**, Associate Professor, Dept. of Plant Pathology, N. M. College of Agriculture, Navsari Agricultural University, Navsari and no part of the work has been submitted for any other degree so far.

**Place:** Navsari

**Date:** 29 July , 2013

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# INTRODUCTION



## I. INTRODUCTION

The variety and galaxy of fungi and their natural beauty occupy prime place in the biological world and India has been a cradle for such fungi. Defining the number of fungi on earth had become a point of discussion and several studies have been focused on enumerating the world's fungal biodiversity (Crous *et al.*, 2006). Only a fraction of total fungal wealth has been subjected to scientific scrutiny and mycologists continue to unravel the unexplored and hidden wealth (Hawksworth, 2004).

Global fungal diversity has been estimated between 1.5 and 5.1 million species. There are approximately 20,000 described species of macroscopic fungi or "mushrooms". Mushrooms alone represent about 41,000 species, of which approximately 850 species are recorded from India. Out of the 2,000 edible species, 300 species belong to 70 genera are reported from India (Manoharcharya *et al.*, 2005).

Mushroom is a general term used mainly for the fruiting body of the macrofungi (Ascomycota & Basidiomycota) and represents only a short reproductive stage in their life cycle. Wild mushrooms have a profound biological and economical impact. They had a long association with humankind. From ancient times, wild mushrooms had been consumed by man with delicacy probably for their texture and pleasant flavour. They have rich nutritional value with high content of proteins, vitamins, minerals, fibers, trace elements and low/no calories and cholesterol. Many of

them have been used in folk medicine for thousands of years. Some of them are nutraceuticals (natural food having potential value in maintaining good health and boosting immune system of the human body). They are the sources of various bioactive substances like antibacterial, antifungal, antiviral, antiparasitic, antioxidant, antiinflammatory, antiproliferative, anticancer, antitumour, cytotoxic, DNA damaging, anti-HIV, hypocholesterolemic, antidiabetic, anticoagulant, hepatoprotective, etc. A number of mushrooms form mutual associations (mycorrhizal) with the roots of several forest trees. This beneficial association enhances absorption of water and nutrients amongst trees and is indispensable for the growth and development of these trees and mushrooms. Mushrooms are not of course always beneficial to mankind. Detrimentally, a large number of mushrooms are the wood-rotters causing serious damage to the forest trees. Hence causing considerable economic loss to timber industry every year. While a great many wild mushrooms are edible, it can be difficult to identify them correctly in the field. Besides, some are toxic, even deadly poisonous when eaten (Das, 2010).

The most basic data obtained from fungal surveys contribute to our knowledge of the number of species of fungi and fungus-like organisms that exist and their distribution across habitats landscapes and around the globe. Such information constitutes the baseline against which to measure changes in the presence and abundance of species at particular locations in response to natural or, especially, human-induced (e.g., global warming; air, water, and soil pollution; forest fragmentation)

environmental perturbations. Without baseline data, those changes could not have been detected. Because of the pivotal roles played by fungi in all ecosystems, species composition and/or abundance often are used as indicators of ecosystem health, pollution, and natural environmental perturbations on those ecosystems. Monitoring efforts may focus on entire fungal communities or on functionally or taxonomically related fungal groups.

Taxonomy an ancient Greek word, *taxis* means "arrangement" and *nomia* means "method", is the academic discipline of defining groups of biological organisms on the basis of shared characteristics and giving names to those groups. "The study of the identification, taxonomy and nomenclature of organisms, including the classification of living things with regard to their natural relationships and the study of variation and the evolution of taxa" is known as the taxonomy. Biological classification is a critical step in the taxonomic process, as it informs the user as to what the relatives of the taxon are hypothesized to be. Although the discipline of taxonomy itself does not deal with the investigations of how taxa are related to one another, it does serve to communicate these results to the user. To do this, it uses taxonomic ranks, including, among others (in order from most inclusive to least inclusive): Domain, Kingdom, Phylum, Class, Order, Family, Genus and Species.

The most common type of mushrooms are umbrella shaped with pileus and stipe, while other species additionally have a volva or annulus or with both of them. Furthermore, some

mushrooms are in the form of pliable cups, while others are round like golf ball. Some are in the shape of small clubs, some coral; others are yellow or orange jelly like globs and some even much resemble the human ear. Infact, there are countless varieties of mushrooms. The structure that we call a mushroom is in reality only the fruiting body of the mycelium and comprises of a system of branching threads and cord-like strands that branch out through soil, compost, wood, log or other lignocellulosic material on which fungus may grow after a period of growth and under favorable conditions. The established mycelium produces the fruit structure which is called the mushroom.

Descriptions of macromorphological characters (e.g., colour, shape, size, odor) of sporocarps are among the most critical data for the identification of macrofungi. In many species of fleshy macrofungi, those characters are lost when the sporocarps are dried and so they must be documented carefully before drying. Conversely, sporocarps of many macrofungi that grow on woody substrata are no putrescent and they usually retain their macromorphological features when preserved. Most investigators begin with the pileus and move downward through the lamellae or tubes, stipe and finally to any veils that are present. Recording information about the context is also important (e.g., colour, colour changes, consistency, presence or absence of latex), as is the inclusion of data on all available developmental stages. Thus, data requirements vary among taxa and the detail required will depend on the scope of the project and the resources available. The

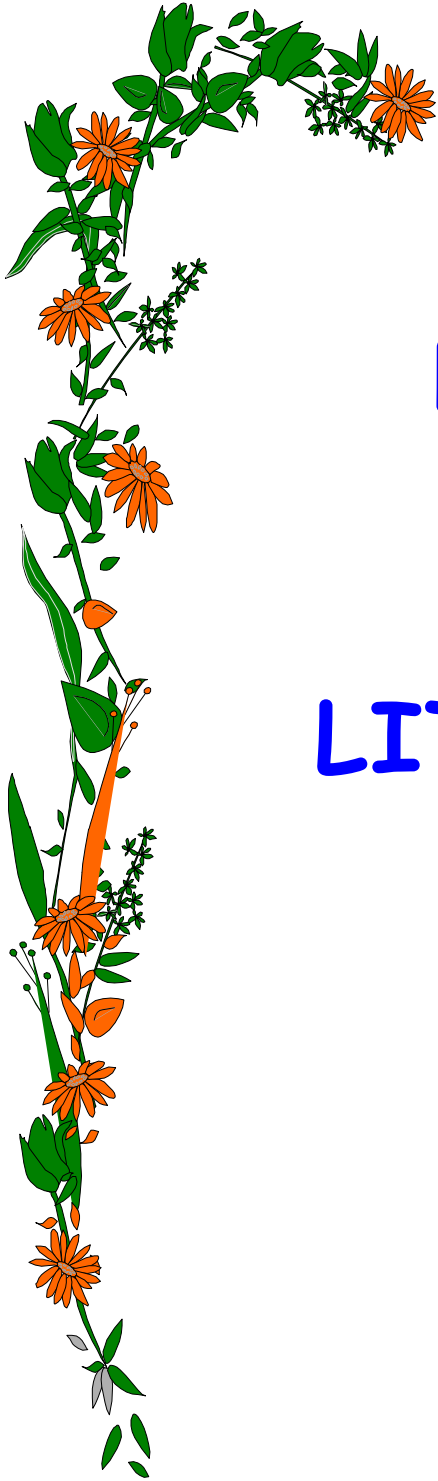
procedure for describing macrofungi depends on the type of fungus under consideration and also on the investigator.

India is a rich treasure of natural resources; among them macromycetes are one of them. Studies on mushrooms with special references to their edibility, utility and medicinal values with the early references on larger fungi may be beneficial for huminity (Hedawoo, 2010). Dangs district is a part with naturally rich biodiversity region of Gujarat. It is situated between 20.39° to 21.05° north latitude and 73.29° to 73.51° east longitude. The geographical area of district is about 1,764 sq. km. The average rainfall is about 3,048 mm and the average maximum and minimum temperature is of 22 °C. Due to high humidity, humus accumulation with low disturbance, it provides the luxuriant growth of fleshy fungi (Anon., 2012). So, *Auricularia polytricha* (fleshy fungi) is most dominant in Dangs district, which occurs in clusters on rotting branches and twigs and on decaying stumps and logs. It is also known as wood ear fungus, wood fungus, ear fungus, or tree ear fungus, an allusion to its rubbery ear-shaped growth, *Auricularia polytricha* is usually sold dried and needs to be soaked before use. While almost tasteless, it is prized for its slippery but slightly crunchy texture and its potential medicinal properties, including its newly discovered anticoagulant properties. It may be effective in reducing low density lipoprotein (LDL) cholesterol and aortic atherosclerotic plaque, as demonstrated in a study on rabbits.

The present investigation was carried considering the scope of availability of naturally occurring mushrooms from Dangs district with following objectives:

Objectives:

- 1) Survey of naturally occurring fleshy fungi in Dangs district
- 2) Detect collected fleshy fungi
- 3) Study the taxonomic position of collected fleshy fungi
- 4) Grow dominant species of fleshy fungi at Navsari condition



**REVIEW  
OF  
LITERATURE**



## II. Review of literature

### 2.1 Survey

Several workers reported the occurrence of fleshy fungi on different habitat (Alofe *et al.*, 1998 Chang and Miles 1989).

Kalitha *et al.* (1997) observed 20 edible fleshy fungal flora in tea gardens of Assam. Among them, *Termitomyces eurhizus*, *Termitomyces microcarpus*, *Termitomyces heimil*, *Schizophyllum commune*, *Armillaria mellea* were the most common mushrooms consumed by the local people.

Stojchev *et al.* (1998) reported 67 species of macrofungi from European part of Turkey. A few examples include *Agaricus arvensis*, *Amanita caesarea*, *Armillaria mellea*, *Ganoderma adspersum*, *Clavaria flava* etc.

Yongabi *et al.* (2004) conducted a survey at Cameroon in Central Africa. During the survey, several species belonging to the genera *Agaricus*, *Volvariella*, *Ganoderma*, *Flammulina*, *Auricularia*, *Pleurotus*, and *Termitomyces* were found to be useful as food or in traditional medicine by the indigenous people.

Abou-Zeid and Altalhi (2006) carried out survey in seven localities in Al-Taif Governorate of Saudi Arabia. During the survey, 14 species of mushrooms were collected and identified upto the genus level.

Niazi *et al.* (2006) studied biodiversity of mushrooms and ectomycorrhizas from Himalayan Moist Temperate Forests of Pakistan. *Russela brevipes* was found associated with *Pinus wallichina*. The fungus and its mycorrhiza were new records from Pakistan.

Swapna *et al.* (2008) carried out survey to study distribution of macrofungi of different families in semi-evergreen and moist deciduous forests of Shimoga district, Karnataka, India. In moist deciduous forest, taxonomically a total of 280 genera belonging to 41 families and 19 orders were recorded and in semi evergreen forest, macrofungi belonging to 14 orders, 33 families and 263 genera were identified.

Chidburee *et al.* (2009) studied biodiversity of wild mushrooms at Chae-Sorn National park of Thailand. During the survey, 112 species of wild mushrooms were found which composed of two subdivisions: Ascomycotina and Basidiomycotina. The subdivision Ascomycotina was classified into 6 families, 9 genera and 11 species; while Basidiomycotina was classified into 30 families, 62 genera and 101 species.

Dar *et al.* (2010) carried out survey in Jehlum Valley and Zabarvan hills of Kashmir forests and collected several macrofungi from lower forest range to alpine zone. *Russela atropurpurea* and *Suillus variegates* were first time reported from Jammu and Kashmir whereas, two genera *Russela aurea* and *Boletus rhodoxanthus* were first time reported from India.

Das (2010) observed 126 species of wild mushrooms, out of which, 19 species belonged to Ascomycota and 107 species belonged to Basidiomycota.

Hedawoo (2010) conducted a survey at Amaravati - Melghat region and revealed the occurrence and distribution of 43 species of wild mushrooms belonging to 37 different genera. Twenty one species of mushrooms were identified as edible (*Agaricus campestris*, *Auricularia mesenterica*, *Calocybe indica* etc), 15 as non edible (*Marasmius rotula*, *Tremella mesenterica*, *Peziza rutilanus* etc.) and 7 with medicinal potential (*Ganoderma applanatum*, *Schizophyllum commune* etc).

Saini *et al.* (2010) carried out survey at Manali and Churdhar in Himachal Pradesh. Two species *Russula lepidicolor* and *Russula azurea* were identified taxonomically and reported for the first time from India.

Sharma *et al.* (2010) reported 4 different macrofungi from Haveli tehsil in Poonch district of Jammu and Kashmir, viz., *Gymnopilus spectabilis*, *Lepiota oregonensis*, *Pleurotus populinus* and *Sparassis cystidiosa*.

Singh and Chhetry (2010) reported 6 different genera viz., *Ascocoryne*, *Macrolepiota*, *Polyporus*, *Merulis*, *Auricularia*, *Schizophyllum* of macro fungi from deep forest of North East region of Imphal.

Beig *et al.* (2011) studied macrofungal biodiversity in conifer-dominated forest of Jammu and Kashmir. During the

survey *Lycoperdon pedicellatum*, *Peziza boltonii*, *Clitocybe gibba*, *Collybia subsulphurea* and *Cortinarius bultiardii* were found to be most predominant.

Jonathan and Adeyoho (2011) conducted a survey at the tropical rain forest of Akoko area in Ondo state, Nigeria and revealed the occurrence and distribution of 26 species of wild mushrooms viz., *Agaricus blazei*, *Coprinus africanus*, *Coriolus vesicular*, *Marasmius zenkeri*, *Termitomyces globules*, *Pleurotus tuber-regium* etc.

Puspha and Purushotama (2012) studied the biodiversity of mushrooms at Bangalore, India. They reported a total number of 90 species with 48 genera belonging to 19 families and 5 orders. Among them 28 species were found to be recorded for the first time in India. Among the collected species, *Coprinus disseminates* followed by *Coprinus fibrillosis* and *Schizophyllum commune* were found to be abundant.

Korat *et al.* (2013) reported 17 species of fleshy fungi belonging to different families from NAU campus, which were *Ganoderma lucidum*, *Schizophyllum commune*, *Agaricus campestris* etc.

## **2.2 Detection of macrofungi**

Ozturk *et al.* (2003) carried out survey at Alanya District of Turkey and collected macrofungi from different localities. Based on field and laboratory studies, 188 taxa belonging

to two classes and 38 families were identified on the basis of morphological characters like cap surface, colour, stipe colour, length, gills colour, attachment etc. Eleven taxa belonged to Ascomycetes and 177 to Basidiomycetes.

Kaya (2005) carried survey of macrofungi in Golbasin (Adiyaman) district of Turkey. Based on field and laboratory studies, 77 taxa belonging to 22 families of Ascomycetes and Basidiomycetes were identified on the basis of morphological characters of different parts like pileus, stipe, gills etc.

Abou-Zeid and Altalhi (2006) carried out survey in seven localities in Al-Taif Governorate of Saudi Arabia. During the survey fourteen species of mushrooms belonging to 9 genera were collected and detected morphologically based on pileus colour, diameter, shape, stipe colour, length, diameter, gills colour, attachment etc.

Swapna *et al.* (2008) detected the collected macrofungi from semi-evergreen and moist deciduous forests of Shimoga district, Karnataka, India. A total 280 genera were identified depending upon morphological characters of different part like pileus, stipe, gills etc.

Karawa and Rai (2010) tapped the edible fungal biodiversity of Melghat forest in Central India. They used morphological characters like cap surface, colour, stipe colour, length, gills colour, attachment etc. and identified 153 species of mushroom.

Chouhan *et al.* (2010) recorded new mushroom from Mount Abu, Rajasthan. The collected mushrooms were recorded morphologically for different parts like pileus, stipe, gills etc. and identified as *Boletus rubellus*, *Calocybe ionides*, *Crepidotus lundelli*, *Psathyrella magambica*, *Thelephora spiculata* belonging to different families i.e., *Boletaceae*, *Tricholomataceae*, *Crepidotaceae*, *Coprinaceae* and *Thelephoraceae*.

Dehariya *et al.* (2010) studied wild mushrooms of Patharia forest of Sagar. During the survey, a number of mushrooms were collected, morphological characters like pileus colour, diameter, shape, stipe colour, length, diameter, gills colour, attachment etc. were described and identified with 18 genera of 12 families.

Vishwakarma and Bhatt (2013) studied macrofungal biodiversity in Khirsu forest of Garval Himalaya, Uttarakhand, India. In this study 15 species of mushrooms belonging to 10 families were collected, identified and described with morphology.

### **2.3 Taxonomy**

Stojchev *et al.* (1998) reported 67 species of macrofungi from European part of Turkey. A few examples include *Agaricus arvensis* (Agaricaceae), *Armillaria mella* (Marasmiaceae), *Ganoderma adpersum* (Ganodermataceae), *Clavaria flava* (Clavulinaceae) etc.

Gezer (2000) studied macrofungi flora of Antalya province in Turkey. Taxonomically, they were placed within 29

families (Pyrenemataceae, Schizophyllaceae, Tricholomataceae, Pleurotaceae, Coprinaceae, Agariaceae etc.), 7 belonging to Ascomycetes and 74 to the Basidiomycetes.

Peksen and Karaca (2003) studied distribution of macrofungi in Samsun Province of Turkey and reported 169 species of macrofungi. Out of which 19 (*Daldinia concentrica* etc, *Xylaria hypoxylon*, *Mitrophora semilibera* etc.) belonged to the Ascomycota, 149 (*Agaricus bisporus*, *Coprinus atramentarius*, *Armillaria mellea*, *Ganoderma applanatum*, *Schizophyllum commune* etc.) to the Basidiomycota and one to the Myxomycota. Among these, 51 species were edible, 67 inedible, 28 edible but not worthwhile or avoided because of possible confusion with poisonous species and 12 species were poisonous. The edibility of 11 species was unknown.

Kaya (2005) carried survey in Golbasin (Adiyaman) district of Turkey. Taxonomically, they were placed within 77 taxa belonging to 22 families in the classes of Ascomycetes and Basidiomycetes. Five of them, *Cyathus stercoreus*, *Entoloma rusticoides*, *Pluteus dietrichii*, *Coprinus dilectus* and *Panaeolus guttulatus* were new records from Turkey.

Aktas *et al.* (2006) studied biodiversity of macrofungi from Bozkir and Kestel District of Turkey. *Lachnum virgineum* (Hyaloscyphaceae) and *Hymenoscyphus fructigenus* (Helotiaceae) were taxonomically investigated and described for the first time from Turkey.

Yagi *et al.* (2006) Studied distribution of macrofungi from Bolu and Duzce provinces of Turkey. Based on and laboratory results, the collected macrofungi were taxonomically described to 44 families (Pezizaceae, Pyrenomataceae, Agaricaceae, Clavulinaceae, Coprinaceae, Ganodermataceae, Geastraceae, Russulaceae etc.) with 7 families of *Ascomycetes* and 37 families of *Basidiomycetes*.

Swapna *et al.* (2008) carried out survey to study distribution of macrofungi of different families in semi-evergreen and moist deciduous forests of Shimoga district, Karnataka, India. In moist deciduous forest, taxonomically a total of 280 genera belonging to 41 families and 19 orders were recorded and in semi evergreen forest, macrofungi with 14 orders, 33 families and 263 genera were identified.

Chidburee *et al.* (2009) studied biodiversity of wild mushrooms at Chae-Sorn National park of Thailand. The collected mushrooms were taxonomically placed under subdivision of *Ascomycotina* with 6 families (Pyrenomataceae, Xylariaceae etc.), 9 genera (*Auleria*, *Xylaria* etc.) and 11 species, while *Basidiomycotina* was classified of 30 families (Coprinaceae, Marasmiaceae, Pleurotaceae, Schizophyllaceae etc.), 62 genera (*Coprinus*, *Marasmius*, *Pleurotus*, *Schizophyllum* etc.) and 101 species.

Kaya *et al.* (2009) conducted a survey at Goksun (Kahramanmaras) District of Turkey and revealed the taxonomic distribution of 110 species of macrofungi belonging to 33 families

(Pezizaceae, Pyronemataceae, Agaricaceae, Pleurotaceae, Polyporaceae, Psathyrellaceae, Schizophyllaceae etc.) and 70 genera in Ascomycetes and Basidiomycetes based on morphological identification.

Al-Thani (2010) conducted a survey at Qatar in Arabian Gulf. Taxonomically macrofungi were described as 14 genera belonging to 11 families (Morchellaceae, Xylariaceae, Agaricaceae, Coprinaceae, Ganodermataceae etc.) and 7 orders (Pezizales, Xylariales, Agaricales, Auriculariales, Cantharellales etc).

Kaur *et al.* (2011) conducted a survey at Sirmour and Churdhar in Himachal Pradesh. Two species of the genus *Amanita*, namely *Amanita liquii* and *Amanita orientifulva* were taxonomically investigated and described for the first time from India.

Tribhuvanmala *et al.* (2011) conducted a survey at Anaikatti, Attapadi, Palghat, Siruvani, Nilgiris and Lealer region of Western Ghats of India and revealed taxonomically the occurrence and distribution of 68 mushrooms flora belonging to 19 genera (*Auricularia*, *Lentinus*, *Agaricus*, *Pleurotus*, *Schizophyllum* etc).

Tribuhwa (2011) carried survey in Serengeti National park of Tanzania. New species were identified taxonomically as *Sarcoscypha ololosokwaniensis* belonging to phylum Acomycota,

Class *Pezizomycetes*, Order *Pezizales* and Family *Sarcoscyphaceae*.

Dwivedi *et al.* (2012) studied biodiversity of mushrooms of Amarkantak biosphere reserve forest of central India. They reported a total of 52 mushroom species belonging to 5 order (Boletales, Russulales, Polyporales etc), 8 genera (*Boletus*, *Russula*, *Ganoderma* etc), and 7 families (Russulaceae, Agaricaceae, Boletaceae etc.) with its taxonomic position.

Puspha and Purushotama (2012) studied biodiversity of mushroom of Bangalore, India. Taxonomically, they reported a total number of 90 species with 48 genera (*Agaricus*, *Coprinus*, *Schizophyllum*, *Russula*, *Ganoderma*, etc.) belonging to 19 families (Polyporaceae, Agaricaceae, Coprinaceae etc.) and 05 orders (Agaricales, Aphyllophorales etc).

#### **2.4 Growing of dominant species of fleshy fungi on different substrates**

Bermudes *et al.* (2001) studied cultivation of *Pleurotus* on the agricultural substrates in Cuba. *Pleurotus ostreatus f. sp. florida* was cultivated on several agricultural substrates including coffee pulp, coconut shalt etc. The highest biological efficiency was recorded on coffee pulp from *Coffea arabica*, (168.5 – 179.4 %), followed by coconut shell (90.0%).

Garasiya *et al.* (2007) reported the cultivation of jelly mushroom (*Auriculariya polytricha*) in Rajasthan. All the agro-

waste substrates tested as a medium of cultivation equally supported the good growth of *A. polytricha*, but the combination of sawdust and wheat straw (2.5%) triggered the maximum growth of fungus. The substrate composed of wheat straw and wheat bran (5%), seeded with spawn @ 40 g/kg wet wt. of substrate produced the highest yield. Yield of *A. polytricha* was maximized when spawning was done in three layers in between substrate and silting of bags.

Maheshwari *et al.* (2007) observed that paddy straw substrate required minimum spawn run of 12.6 days and pinhead formation at 18.5 days with a yield of 648 g/kg wet substrate of *Pleurotus flabellatus*.

Singh *et al.* (2007) reported successful cultivation of medicinal mushroom, *Ganoderma spp.* in Rajasthan. Two locally isolated *Ganoderma spp.* designated as Geno-1 and Geno-3 were cultivated on different combinations of substrates. The maximum yield was observed on wheat straw and saw dust (3:1) substrate.

Pani (2010) reported that the maximum yield (712.60 g) and biological efficiency (71.20 %) of the white summer mushroom were recorded on paddy straw as compared to maize stalk, sunflower stalk, sesamum stalk, sugarcane bagasse, cotton waste and coconut coir pith. They also reported that combination of maize stalk and paddy straw at ratio 1:3 gave highest yield of 671.30 g and biological efficiency of 67.10 %.

Rawal and Sharma (2010) studied agro-wastes as substrates of paddy and wheat straw supplemented with the wheat bran increased the biological efficiency in the production of black ear mushroom. The substrate combination of wheat straw and its bran at 10%, followed by paddy straw and wheat bran at 10% produced higher yield of 932 and 764 g/kg dry substrate.

Mishra and Kushwaha (2011) evaluated locally available agrowastes for the cultivation of medicinal mushroom *Lentinula edodes*. They collected species of *L. edodes* from Pantnagar, Uttarakhand and isolated on PDA medium and prepared spawn. All the agro-waste substrates as a medium of cultivation equally supported the good growth of *L. edodes*, but the wheat straw substrate resulted in maximum yield.

Irawati *et al.* (2012) studied cultivation of edible mushroom *Auricularia polytricha* using saw dust based substrate madeup of three Indonesian commercial plantation species, *Falcataria moluccana*, *Shorea* sp., and *Tectona grandis*. They reported the fastest mycelial growth in the substrate madeup of *Shorea* sp. with the highest glucosamine content.



# MATERIALS AND METHODS



### **III. MATERIALS AND METHODS**

The experiment entitled, “Studies on morphological characterization of fleshy fungi from Dangs District” was carried out during July 1<sup>st</sup> 2012 to December 31<sup>st</sup> 2012. The details of materials used and methods adopted during the course of investigation are described in this chapter.

#### **3.1 Study area**

Dangs district is a part of naturally rich biodiversity region of Gujarat. It is situated between 20.39° to 21.05° north latitude and 73.29° to 73.51° east longitude. The geographical area of the district is about 1,764 sq. km. with average rainfall about 3,048 mm. Maximum and minimum temperature is 37°C and 6°C respectively. Luxuriant growth of fleshy fungi due to high humidity, humus accumulation and low disturbances occurs. The study area comprised of 5 locations of Dangs district, which were Waghai, Kukadnaki, Chichingavtha, Kudkachh and Bhenskatri. The soil in these areas is most fertile due to high rate of decomposition.

##### **3.1.1 Survey**

Surveys are particularly sensitive to timing and location. Macrofungi exhibit pattern of diversity that is related to substratum and host availability (Natrajan *et al.*, 2005). Surveying

is best just during the period of rain and after the period of rain. Therefore, present surveys was done during July 1<sup>st</sup> 2012 to December 31<sup>st</sup> 2012.

### **3.1.2 Sampling**

Vegetative zone and plant association were useful criteria to divide a landscape for sampling. Many macrofungi occur only in association with particular family or plants. The macrofungi generally fruit when temperature may be above 15<sup>0</sup>C and relative humidity more than 80-85%. Sampling was done using opportunistic sampling method (Mueller *et al.*, 2004).

### **3.1.3 Equipments**

Samples were collected using an axe, sharp knife, forceps, measuring tape, hand lens, pens, books, labels, camera, papers and containers. An axe was used to incise the depth sufficient to enable identification of the host and a sharp knife for collecting sporocarps from soil. Forceps were used for the collection of very small sporocarps and collected with the help of hand lens and containers were used for the collection of the specimens.

### **3.1.4 Collection and Observations**

Sporocarps were removed from ground with a great care to avoid damage to the base of the stipe to reveal any volva, rotting base, bulb or attachment to a sclerotium or buried substrata

that included cones, fruits and other fungi. Soil was removed using a soft brush (Stojchev *et al.*, 1998). The habitat and morphological characteristics of the macrofungi were noted (Kaya, 2005) and photographed for detection during the collection. If specimen was on the wood, it was collected along with substratum to facilitate identification. The specimens were collected in the plastic bags or boxes for further identification in the laboratory (Afyon *et al.*, 2005). The specimens were wrapped in the aluminum foil, which offered a good protection. Small plastic boxes were used for woody Basidiomycetes and Ascomycetes. Care was taken to avoid distortion of fleshy fungi and was labeled properly. The collected specimens are brought to the lab and preceded further for detection.

### **3.2 Detection of collected fleshy fungi**

The collected sporocarps were detected for the morphological characters like pileus color, diameter, shape, stipe color, length, diameter, gills color and attachment. A brief note of distinguishing microscopic features was studied under microscope. For this purpose, scale, Petri plate, black-white paper for spore print, microscope (40X) with camera under scope photo software and measuring scale ( $\mu\text{m}$ ) were used for identification.

The collected sporocarp/mushroom was studied for following morphological characters.

### **3.2.1 Pileus diameter**

Diameter of the pileus was measured from the base of stipe to the base of the fruiting body with the help of thread and expressed in cm.

### **3.2.2 Pileus colour**

The colours of pileus were critically observed by naked eyes.

### **3.2.3 Pileus shape**

The shape of pileus was critically observed by naked eyes.

### **3.2.4 Stipe length**

Length of the stalk was measured from the base of stipe to the base of the fruiting body with the help of thread and expressed in cm.

### **3.2.5 Stipe diameter**

With the help of thread diameter of stipe was measured and expressed in cm.

### **3.2.6 Stipe colour**

The colour of stipe was critically observed by naked eyes.

### **3.2.7 Gills colour**

The colour of gills was critically observed by naked eyes.

### **3.2.8 Gills attachment**

The structure of gill was critically observed by naked eyes.

### **3.2.9 Size of spore**

Section of the gills is cut and examined under the microscope, spores were observed microscopically.

### **3.2.10 Spore print**

The newly opened fleshy and healthy fruit body was selected to prepare a spore print. The cap of the mushroom was laid flat with the gills down on a half black and half white paper. The entire setup was placed in an undisturbed area about 6 hours. This resulted in spore print.

### **3.3 Taxonomic position of collated fleshy fungi**

Each collected specimen was examined and morphological characters were recorded. They were identified with the help of following literature (Dickinson and John, 1979; Geoffrey, 1982; Hard, 1961; Louis, 2007; Anon., 2007).

The collected fleshy fungi were classified and their taxonomic position upto species level was identified with the help of Kirk *et al.* (2008) Anisworth & Bisby's dictionary of the fungi (10<sup>th</sup> Edition).

1. Kingdom
2. Phylum
3. Class
4. Order
5. Family
6. Genus
7. Species

### **3.4 Grow dominant species of collected fleshy fungi at Navsari condition**

This experiment on possibility of growing *Auricularia polytricha*, a dominant edible mushroom observed in Dangs district was collected and attempt was made to grow them under Navsari conditions.

The experiments were conducted to improve productivity of highly potential *Auricularia polytricha* using various substrates. The study was conducted at the Department of Plant Pathology, N.M.College of Agriculture, N.A.U., Navsari. Materials used and the methods followed for the purpose were as described below.

#### **3.4.1 Selection of culture and growth media**

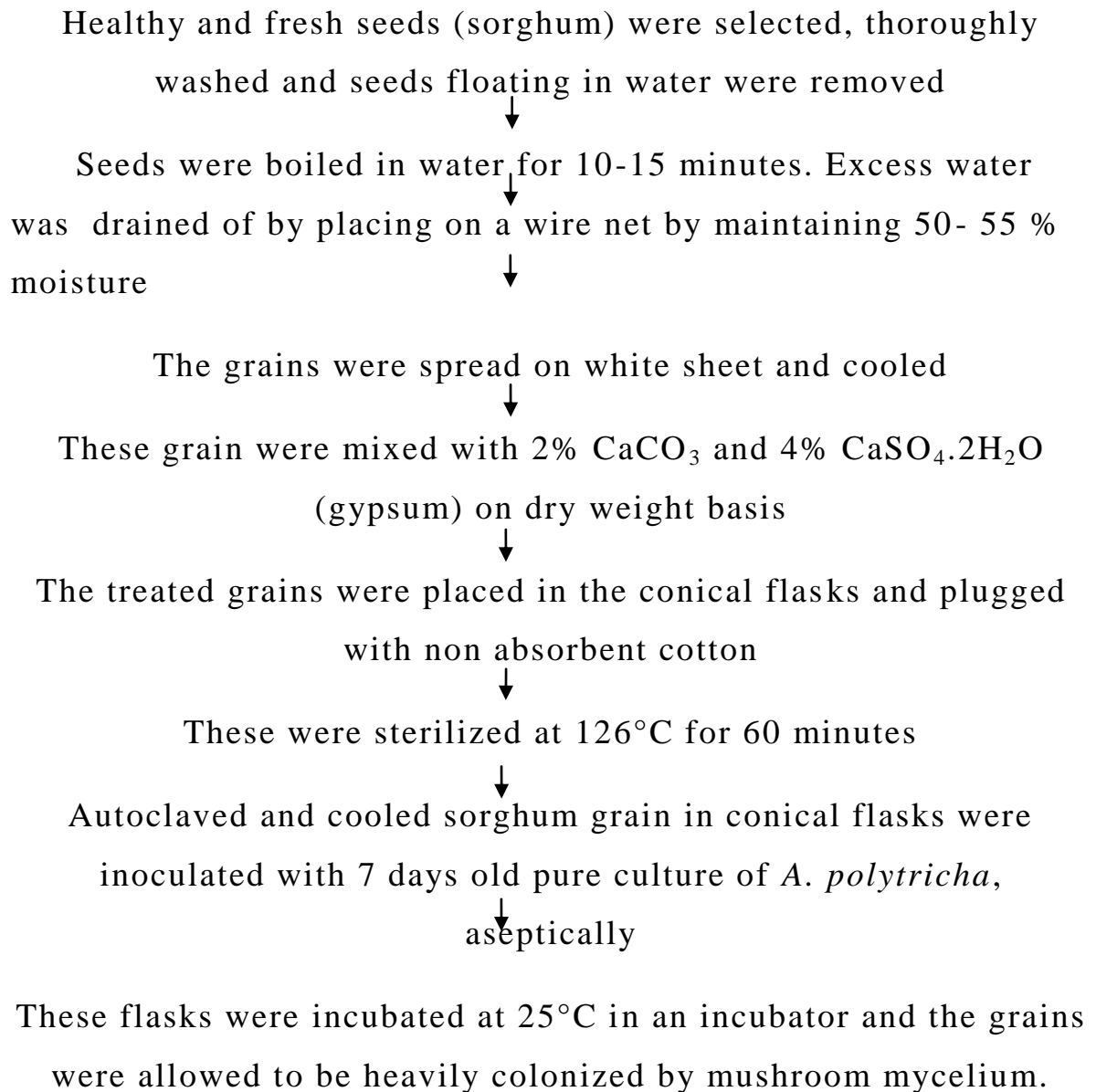
The pure culture of *Auricularia polytricha* was obtained tissue/spore isolating checked for its fruiting ability and maintained on potato dextrose agar (PDA) slant at 25°C. The same was sub-cultured at regular monthly interval to sustain their fruiting vigour and preserved at room temperature for studies.

#### **3.4.2 Spawn preparation**

Spawn, the seed of mushroom was prepared by following standard procedure (Krishnamoorthy, 2003). For this purpose uninfected clean sorghum grains were boiled with equal

amount of water till grains become soft but did not split open. The moisture content of boiled grains was allowed to leave as such for hours for air drying so that water on surface is evaporated to obtain 50 to 55 per cent moisture. Then the grains were mixed with 0.5 per cent calcium carbonate and 2.0 per cent calcium sulphate so as to maintain pH of the grains around 7.0 to 7.8 and do not form clumps. First gypsum and chalk powder were mixed separately and then they are thoroughly mixed with grains. These grain were filled into 15 × 20 cm size polypropylene bags. The mouth part of bag was plugged with clean, non-absorbent cotton. These bags were sterilized for one hour at 22 pound pressure (126°C). Upon cooling for 24 hours, the content was inoculated with bits of fresh fruiting culture of under aseptic conditions and at incubated at 25-27°C for 23-28 days complete ramification over the substrate. These sorghum grains fully covered with *A. polytricha* mycelium were used as spawn to cultivated *A. polytricha* on various substrates.

### 3.4.2.1 Flow chart of making Spawn



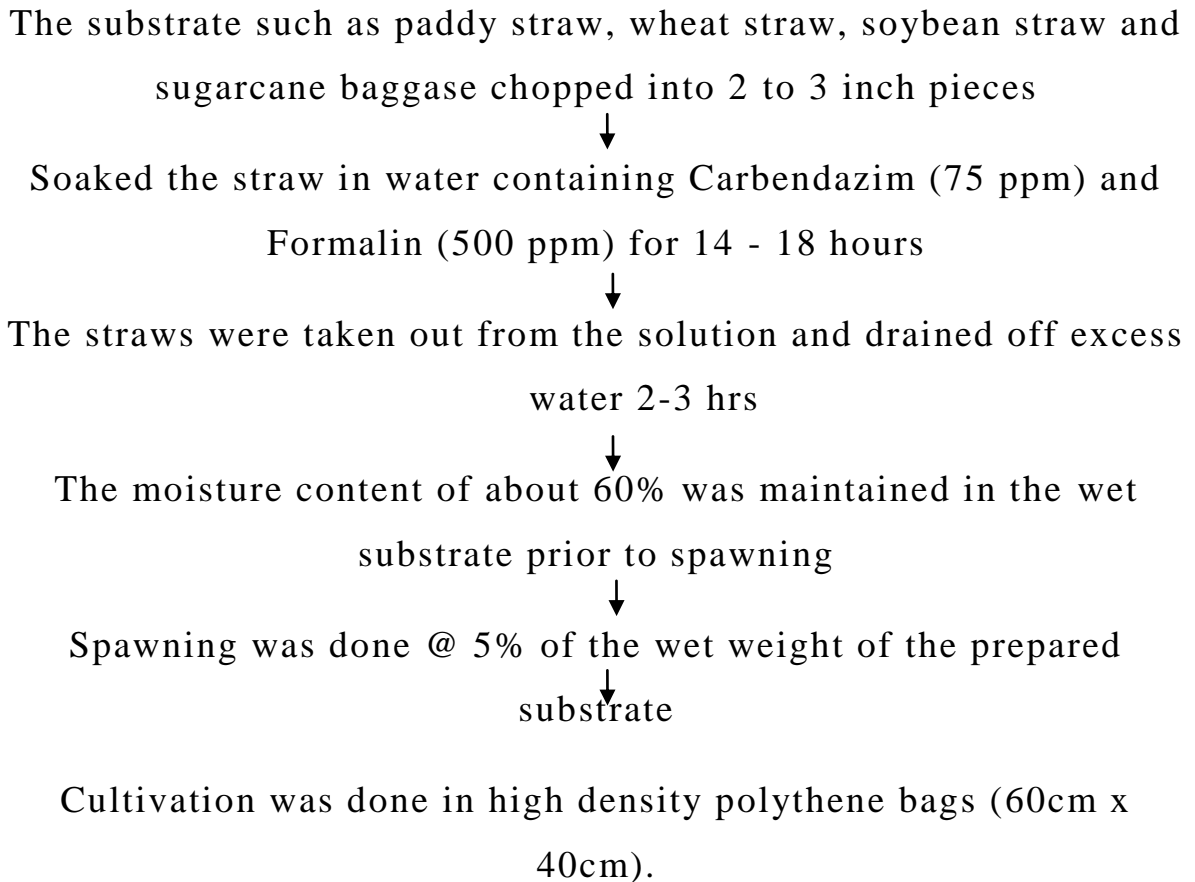
### **3.4.3 Selection and collection of substrate**

The potential locally available substrates such as paddy straw, wheat straw, soybean straw, sugarcane baggase, cotton waste and coconut coir pith selected were collected obtained from the farm of Navsari Agricultural University, Navsari and use as the substrates for cultivation of *A. polytricha*.

#### **3.4.3.1 Substrate preparation**

The substrate such as paddy straw, wheat straw, soybean straw and sugarcane baggase were chopped into 2 to 3 inch pieces and soaked in water containing Carbendazim (75 ppm) and Formalin (500 ppm) for 14 - 18 hours. After that, the straws were taken out from the solution and excess water was drained off for 2-3 hrs. While cotton stalk and coconut coir pith were used as such after overnight soaking. The moisture content of about 60 percent was maintained in the wet substrate prior to spawning. Spawning was done @ 5 percent of the wet weight of the prepared substrate using high density polythene bags of 60cm x 40cm, size and about 100 gauges (Pani and Das, 1998).

### 3.4.3.2 Flow chart of substrate making



### 3.4.3.3 Experimental detail:

- a. Location : Dept. of Plant Pathology, P.G. Laboratory, N.A.U., Navsari
- b. Year of experiment : 2012-13
- c. Design : Completely Randomized Design (CRD)
- d. Repetition : 3 (Three)
- e. Treatments : 6 (Six)
  - 1. Paddy Straw
  - 2. Wheat straw
  - 3. Coconut Coir Pith

4. Soybean Straw
5. Cotton Stalk
6. Sugarcane Baggase

- f. Temperature :  $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$
- g. Humidity : 85%

### **3.4.4 Observations recorded**

#### **3.4.4.1 Day's for spawn run**

After the spawning, the bags were kept to see the numbers of days required for development of mycelium in complete bags were recorded.

#### **3.4.4.2 Day's for pinhead formation**

After the spawn run, the bags were kept to see the how many days required for formation of pinhead in complete bags which is filled by substrate.

#### **3.4.4.3 Day's for first harvest**

The no. of days required from pin head formation to full fruit bodies development were recorded.

#### **3.4.4.4 Total No. of fruit bodies**

After harvesting to count the total numbers of matured fruit bodies were counted.

#### **3.4.4.5 Average diameter of sporocarp**

With the help of thread, diameter of the fruiting bodies was measured and expressed in cm.

#### **3.4.4.6 Yield (g)**

Average yield of fruiting bodies of each substrate was measured.

#### **3.4.4.7 Biological efficiency**

Biological efficiency of the mushroom was calculated by using following formula given by Chang and Miles (1989).

$$\text{Per cent biological efficiency} = \frac{\text{Fresh weight of mushroom (g)}}{\text{Dry weight of substrate (g)}} \times 100$$

#### **3.4.5 Statistical method**

All experimental data were statistically analyzed by using Completely Randomized Block Design. The significance of each data was analyzed by calculating critical difference at 5 per cent level.



# RESULTS & DISCUSSION



## IV. RESULTS AND DISCUSSION

Mushrooms have been extensively studied in the western countries, while in tropical countries like India including western India *i.e.*, Dangs forest, these were less explored. The variety and diversity of Ascomycetes and Basidiomycetes fungi are more in Dangs district region. However, no efforts have been made for a detailed study of them. No attempt on detection and taxonomic position was carried out on naturally occurring fleshy fungi.

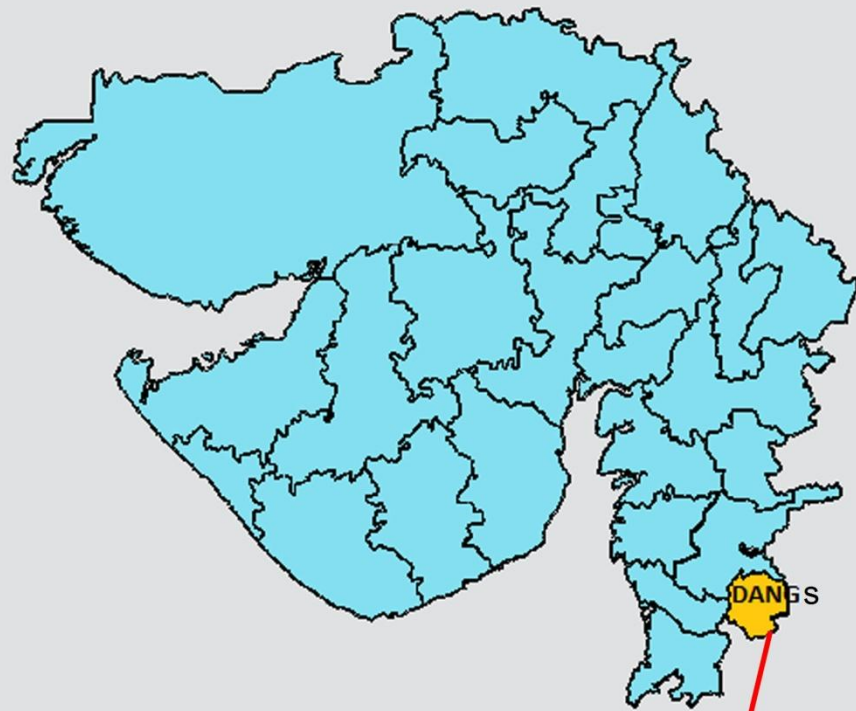
During the survey, collected fleshy fungi were described morphologically and taxonomically and the results are being presented and discussed in this chapter.

The experiment on possibility of growing *Auricularia polytricha*, a dominant edible mushroom, observed in Dangs district was collected and attempted to grow under Navsari conditions. These studies were conducted in the department of Plant Pathology, N. M. college of Agriculture, N. A. U. Navsari.

### **4.1 Survey of naturally occurring fleshy fungi from Dangs District**

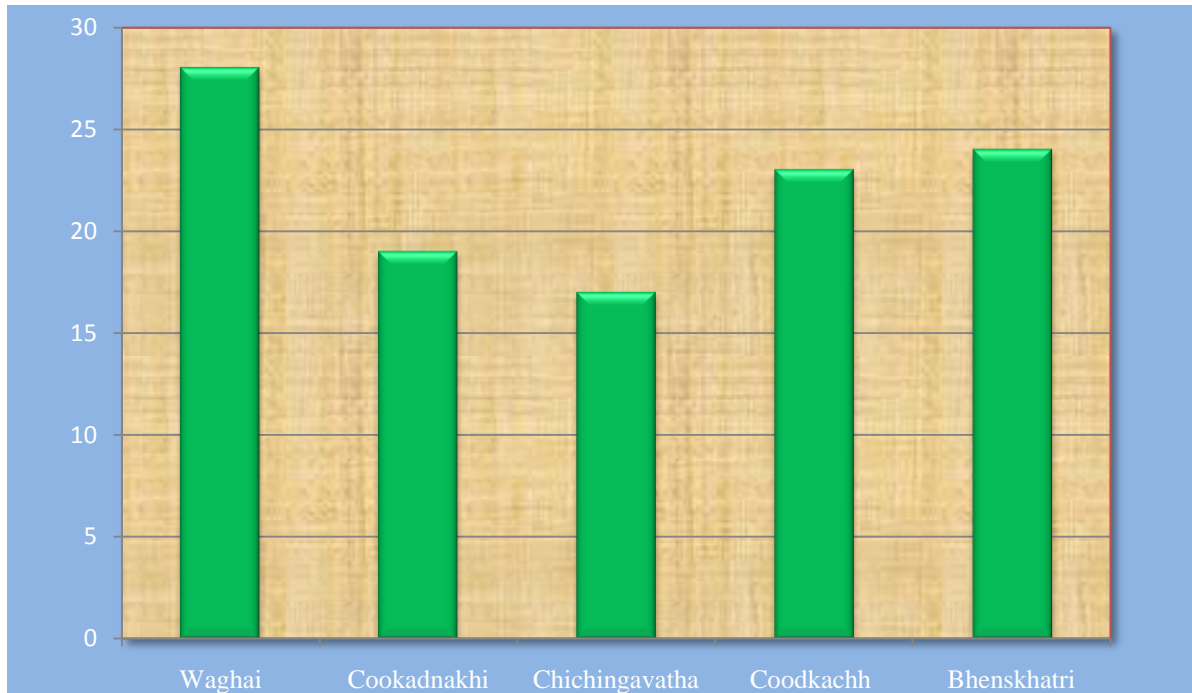
To find the distribution and occurrence of fleshy fungi in a particular area, survey was conducted for 6 different months from July 2012 to December 2012, at the places of Waghai,

Plate- 1: Selected places of Dangs district for collection of fleshy fungi



**Table: 1 Number of samples of fleshy fungi collected from different location of Dangs district**

<b>Sr. no.</b>	<b>Locations</b>	<b>No. of Samples observed</b>	<b>Host preference</b>
1	Waghai	28	Leaf litter, woody debris, senescent roots around stumps, small logs of hardwoods, organic debris, wood chips, Soil inhabiting, pastures, lawns.
2	Kukadnakhi	19	
3	Chichingavatha	17	
4	Kudkuchh	23	
5	Bhenskantri	24	



**Fig.1. Number of samples of fleshy fungi collected from different locations of Dangs district**

Kukadnaki, Chichingavtha, Kudkachh and Bhenskatri (Plate 1). Samples of fleshy fungi were collected from selected five places of Dangs district. The result clearly revealed that fleshy fungi were encountered on every visit, but their distribution was fluctuated during the survey period.

Twenty eight (28) samples of mushrooms were collected from Waghai, 19 samples from Kukadnaki, 17 samples from Chichingavtha, 23 samples from Kudkachh and 24 samples from Bhenkatri region in the Dangs district. The collected fleshy fungi found to be distributed on decaying wood, leaf litter, woody debris, senescent roots around stumps, small log of hard woods, organic debris, wood chips, soil inhebitant, pastures and lawns at almost all the places surveyed (Table 1). A total 111 samples of macrofungi were collected during the survey. These samples were labeled properly and carried to the place of study for further detection. They were also recorded for their presence and absence from different selected localities. The samples with similar morphology collected from different places were kept as a single group (Table 2).

Higher occurrence of these macrofungi may be as a result of availability of variety of dead woods, litters of dead plants materials, favourable climatic conditions that could easily aid spore dissemination and germination. Their availability in Dangs district may also be linked to the ability of these mushrooms to metabolize cellulose and lignin possessed by

**Table: 2 List of identified fleshy fungi of Dangs district**

<b>Sr. no</b>	<b>Species</b>	<b>Waghai</b>	<b>Kukadnakhi</b>	<b>Chiching avatha</b>	<b>Kudkachh</b>	<b>Bhenskantri</b>
1	<i>Auleria aurantia</i>	-	+	+	-	+
2	<i>Ascobolus furfuraceus</i>	-	-	-	-	+
3	<i>Daldinia concentrica</i>	+	+	+	+	-
4	<i>Xylaria carpophila</i>	+	+	+	+	+
5	<i>Auricularia polytricha</i>	+	+	+	+	+
6	<i>Agaricus hondensis</i>	+	-	-	-	+
7	<i>A. praeclares quamosus</i>	+	-	-	-	+
8	<i>Lucocoprinus cepaestipes</i>	+	-	-	+	-
9	<i>Lucocoprinus brebissonii</i>	-	+	-	-	+
10	<i>Crepidotus variabilis</i>	+	-	-	-	-
11	<i>Coprinopsis atramentaria</i>	+	+	+	+	-
12	<i>Coprinus lagopides</i>	+	+	-	+	+
13	<i>Macrolapiota procera</i>	+	+	+	+	+
14	<i>Lapiota ignivolvata</i>	+	+	-	-	-
15	<i>Calvatia cynthiformis</i>	+	-	-	-	+
16	<i>Marasmius siccus</i>	+	+	+	-	-

17	<i>Marasmius sulivantti</i>	+	+	+	-	+
18	<i>Marasmius felix</i>	+	+	-	+	+
19	<i>Armillaria mellea</i>	+	-	+	-	-
20	<i>Pleurotus populinus</i>	+	-	-	+	-
21	<i>Pluerotus tuber-regium</i>	-	-	+	+	-
22	<i>Corticium evolvens</i>	-	-	-	+	+
23	<i>Psathyrella candolleana</i>	+	+	+	+	+
24	<i>Parasola auricoma</i>	+	+	-	+	+
25	<i>Clitocybe nuda</i>	+	+	-	+	+
26	<i>Clitocybe nebulars</i>	+	+	-	+	-
27	<i>Collybia confluence</i>	-	-	+	-	+
28	<i>Schizophyllum commune</i>	+	+	+	+	+
29	<i>Canthrellus subalbidus</i>	+	-	+	+	+
30	<i>Clavulina cristata</i>	+	+	+	+	+
31	<i>Calocera cornea</i>	-	-	+	-	-
32	<i>Coltricia cinnamonea</i>	-	-	-	+	+
33	<i>Ganoderma applanatum</i>	+	+	+	+	+
34	<i>Irpex lacteus</i>	+	-	-	+	-
35	<i>Dictyohora indusiata</i>	+	-	-	+	+

36	<i>Russula aeruginea</i>	+	-	-	-	+
37	<i>Phellodon confluence</i>	-	-	-	+	-

different species in the tropical rain forest. Alofe *et al.* (1998) reported that mushrooms as the common saprophytes found on decaying deadwood trunk. Some of these organisms could also parasitize the living trees leading to their death (Chang and Miles, 1991).

The present results are on the same line with the findings of Swapna *et al.* (2008) who carried out survey to study distribution of macrofungi in semi-evergreen and moist deciduous forests of Shimoga district Karnataka, India. They reported a total of 280 genera from semi evergreen forest and 263 genera from deciduous forest of the macrofungi. Similarly, Jonathan and Adeoyoho (2011) who collected and attempted morphological characterization of some wild mushrooms from Akoko, Ondo State, Nigeria, and recorded 26 species of mushroom during the survey.

#### **4.2 Detection of collected fleshy fungi**

A total 111 samples collected from Waghai, Kukadnaki, Chichingavtha, Kudkachh and Bhenshkantri were further processed for their detection based on morphological characters like pileus colour, diameter, shape, stipe colour, length, diameter, gills colour and attachment. A brief note of distinguishing macroscopic and microscopic features studied is given under microscope.

## **4.2.1 Description of identified fungal species**

### **4.2.1.1 *Aleuria aurantia***

Habitat: Saprobiic, usually growing in clusters on the ground, often in clayey soil or on disturbed ground.

Fruiting body: Cup-shaped, often becoming flattened or irregularly shaped as a result of the clustered growth habit, reaching widths of 10 cm, but often smaller, bright orange and smooth above, undersurface usually whitish-fuzzy, at least when young, but often orange and more or less smooth, without a stem.

Microscopic features: Spores 18-24 x 9-11  $\mu\text{m}$ , becoming warted and reticulate by maturity (Plate 2: 1).

### **4.2.1.2 *Ascobolus furfuraceus***

Habitat: Common on dung.

Fruiting body: Saucer to disc shaped or shallowly cup shaped, 2-8 mm. Inner surface green-yellow and outer surface secure scurfy, with somewhat decent, pale green yellow (Plate 2:2).

### **4.2.1.3 *Daldinia concentric***

Habitat: Saprobiic on decaying hardwood stumps.

Fruiting body: The fungus is ball-shaped, with a hard, friable, shiny black fruiting body, 2 to 7 cm wide. The flesh of the fungus is purple, brown, or silvery-black inside, and is arranged in concentric layers. Each layer represents a season of reproduction (Plate 2:3).

Microscopic features: spores 2.4-3 x 1-1.5  $\mu\text{m}$ .

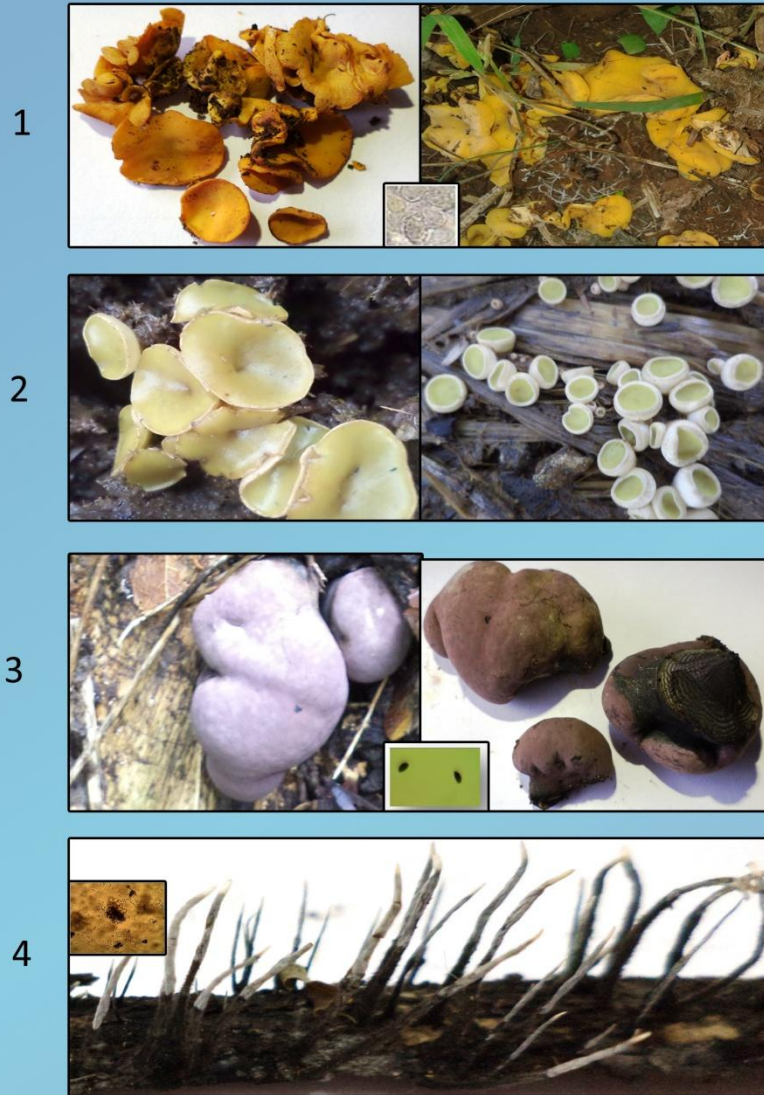


Plate-2 Detected species of fleshy fungi

1. *Aleuria aurantia*
2. *Ascobolus furfuraceus*
3. *Daldinia concentrica*
4. *Xylaria carpophila*

#### **4.2.1.4**    *Xylaria carpophila*

Habitat: Saprobiic on decaying hardwood stumps and logs, usually at or near the base, sometimes appearing terrestrial but actually attached to buried wood, growing alone or, more commonly in clusters.

Fruiting body: 1–3cm high, subcylindric at first becoming flattened the upper branches powdered white, finally tipped black when mature, stalk black and hairy (Plate 2: 4).

Microscopic features: spores 3-3.5 x 2-2.5  $\mu\text{m}$ .

#### **4.2.1.5**    *Aurciularia polytricha*

Habitat: Saprobiic on dead wood or on living wood, growing more frequently, gregariously to clustered.

Fruiting body: Resupinate or pileate, loosely attached, laterally and sometimes by a very short stalk, elastic, gelatinous, sterile surface dark yellowish brown to dark brown with grayish brown bands, hairy, silky. Hymenium smooth or wrinkled, pale brown to dark brown to blakish brown with a whitish boom. Hairs thick-walled; spores, hyaline, reniform to allantoids, 13-16  $\times$  4-5.5 $\mu\text{m}$ , guttulate (Plate 3:5).

#### **4.2.1.6**    *Agaricus praeclaresquamosus*.

Habitat: Saprobiic, growing alone, scattered, gregariously in conifer and hardwood forests, frequently where woody debris are present.



Plate-3 Detected species of fleshy fungi

5. *Auriularia polytricha*
6. *Agaricus praelarequamosus*
7. *Agaricus hondensis*
8. *Leucocoprinus cepaestipes*

Pileus: 5-20cm across, convex with flattened disc, with gray to gray-brown or blackish flattened scales on a white background, dry.

Gills: Free, crowded, white to grayish then deep brown.

Stipe: 8-15 x 1-3cm, equal to clavate, white, often discoloring reddish brown, smooth, ring white, flesh firm, white, bruising bright yellow in the extreme base of the stipe, finally reddish brown, ring white, thick, felt-like, membranous, persistent.

Spore Print: Dark brown

Microscopic features: Spores 4-5 x 2-3  $\mu\text{m}$ , elliptical, smooth (Plate 3:6).

#### **4.2.1.7 *Agaricus hondensis***

Habitat: Saprobiic, growing alone, scattered, gregariously in conifer and hardwood forests, frequently where woody debris are present.

Pileus: 6-15 cm, convex, becoming broadly convex or flat, dry, fairly smooth or, more commonly, with appressed fibres that are initially pale but darken to brown or reddish brown as the mushroom matures.

Gills: Free from the stipe, close, whitish at first, becoming pinkish and, eventually, brown.

Stipe: 7-9 cm long, 1-2 cm thick, equal or slightly tapered toward apex, smooth, whitish, becoming pale brownish with age, with a persistent, thick ring.

Spore Print: Dark brown

Microscopic features: Spores 4.5-6 x 3-4  $\mu\text{m}$ , elliptical, smooth (Plate 3:7).

#### **4.2.1.8**    *Leucocoprinus cepaestipes*

Habitat: Saprobic, growing in groups or clusters in wood chips.

Pileus: 5-8 cm, oval when young, becoming broadly conical or bell-shaped or nearly flat, dry, powdery with soft, white granules, sometimes becoming scaly in age, white brownish center with a swollen base, smooth or with white powder, often discoloring yellowish to brownish and/or bruising these shades, with a white ring on the upper stipe that is fairly persistent but easily removed.

Gills: Free from the stipe, white, crowded.

Stipe: 8-14 cm long, 1-1.5 cm thick, more or less equal, but frequently swollen in places.

Microscopic features: Spores 6-11 x 5-8  $\mu\text{m}$ , smooth, elliptical (Plate 3:8).

#### **4.2.1.9**    *Leucocoprinus brebissonii*

Habitat: Common in humus rich soil or grows in woods or on the ground.

Pileus: 2–3cm across, conical then flattened, white with uniform dark grey-brown disc, elsewhere ornamented with dark grey-brown scales becoming more dispersed toward the coarsely grooved margin.

Gills: Crowded, white.



Plate-4 Detected species of fleshy fungi

9. *Leucocoprinus brebissonii*

10. *Crepidotus variabilis*

11. *Coprinus lagopides*

12. *Coprinopsis atramentaria*

Stipe: 4.5–6×3–6mm, pure white with a small white ring, slightly thickened towards the base. Flesh thin; white (Plate 4:9).

#### **4.2.1.10 *Crepidotus variabilis***

Habitat: Saprobic, growing gregariously or in overlapping clusters on sticks and small logs of hardwoods.

Pileus: 0.5-2 cm across (rarely up to 4 cm), shell-shaped or fan-shaped, densely but finely hairy, white to whitish.

Gills: Radiating from the point of attachment, close or nearly distant, whitish, becoming brownish in maturity.

Stipe: Absent, but a tiny pseudo-stipe is occasionally present.

Spore print: Brown

Microscopic features: Spores 5.5-8.5 x 4-5  $\mu\text{m}$ . smooth, more or less elliptical (Plate 4:10).

#### **4.2.1.11 *Coprinus lagopides***

Habitat: Saprobic, growing alone or in clusters, lines, or fairy rings on lawns, wood chips, or hard-packed ground.

Pileus: Cap 2–6cm, cylindrical to conical, expanding with margin gradually enrolling, white to grey, at first covered in a conspicuous whitish to greyish fibrillose veil remnants, later less so and striate from margin inwards.

Gills: Free from stipe, soon dark vinaceous then black.

Stipe: 3-11 cm long, 0.1-1.2 cm thick, white, initially with white down then smooth in places, base white and woolly. Smell none. Gills soon dark vinaceous then black.

Spore print: Black

Microscopic features: Spores ellipsoid to subglobose, 3–4 x 2–3  $\mu\text{m}$  (Plate 4:11).

#### **4.2.1.12 *Coprinopsis atramentaria***

Habitat: Saprobic, growing in clusters on decaying wood, often growing from senescent roots around stumps.

Pileus: 3-6 cm high and oval when young expanding to conical-convex when mature, lead gray, grayish, or gray-brown, fairly smooth, but usually finely scaly to slightly scruffy over the center.

Gills: Attached to the stipe or free from it, whitish, becoming black.

Stipe: 4-6 cm long, 6-12 mm thick, equal, smooth, white (Plate 4: 12).

#### **4.2.1.13 *Macrolepiota procera***

Habitat: Saprobic, growing alone or scattered in pastures, on trails, and other disturbed ground areas.

Pileus: 7-15 cm, oval when young, becoming convex to broadly convex in age with a dark central bump, dry, at first smooth and brownish, soon becoming scaly, the surface below whitish and later grayish or brownish.

Gills: Free from the stipe, white when young, close.

13



14



15



Plate-5 Detected species of fleshy fungi  
13. *Macrolapiota procera*  
14. *Lapiota ignivolvata*  
15. *Clavatia cynthiformis*

Stipe: 12-15 cm long, 0.5-1.5 cm thick, long and slender, with an enlarged base pale above the ring, below the ring with small brown scales.

Spore print: White.

Microscopic features: Spores 12-18 x 8-12  $\mu$ , smooth, broadly elliptical, dextrinoid, with a small pore (Plate 5:13).

#### **4.2.1.14 *Lepiota ignivolvata***

Habitat: Saprobic, growing alone or scattered in pastures, on trails, and other disturbed ground areas.

Pileus: 4–10cm across, convex then expanded and umbonate, centre reddish-brown, slightly bulbous to club-shaped stipe, which often has an orange flush at its base.

Gills: The gills are white to cream, giving a white spore print. They are free of the stipe, and are fairly crowded together. The flesh is white throughout.

Stipe: 6–10 x 0.6–1.5m, whitish, slightly bulbous.

Spore print: White

Microscopic features: The spores are almond in shape, with dimensions of 8–12 to 4–5.5  $\mu$ m (Plate 5:14).

#### **4.2.1.15 *Calvatia cyathiformis***

Habitat: Saprobic, fruiting on lawns, pastures.

Fruiting Body: 5-10 cm high and/or broad, round or flattened when young, becoming pear-shaped or round with a flattened top and narrowed base, white, tan or pinkish gray to light brown, smooth.

Microscopic features: Spores 3.5-7.5  $\mu\text{m}$ , round, spiny or warty to nearly smooth (Plate 5:15).

#### **4.2.1.16** *Marasmius felix*

Habitat: Saprobic on fallen leaves of trees growing alone or gregariously from petioles or major veins.

Pileus: 1.5-8 mm across, convex, becoming planoconvex, usually pleated by maturity, often somewhat wrinkled, dry, at first nearly white, becoming pale brown with age.

Gills: Attached to the stem, often by means of a collar that may or may not completely encircle the stem, distant, whitish or faintly pinkish.

Stipe: 1.5-7.5 cm long; less than 1 mm thick, equal, dry, wiry.

Spore: 8-8.5 x 3-3.5  $\mu\text{m}$ , smooth (Plate 6:16).

#### **4.2.1.17** *Marasmius siccus*

Habitat: Saprobic on leaf litter and woody debris in hardwood forests.

Pileus: 5-30 mm, cushion-shaped or bell-shaped, with a knob or a central depression.

Gills: Attached to the stem or free from it, very distant, white to pale yellowish.

Stipe: 2.5-6.5 cm long, about 1 mm thick, equal, dry, wiry, whitish or yellowish above, brown toward the base (Plate 6:17).

16



17



18



19



Plate-6 Detected species of fleshy fungi

16. *Marasmius felix*

17. *Marasmius siccus*

18. *Armillaria mellea*

19. *Marasmius sullianti*

#### **4.2.1.18 *Armillaria mellea***

Habitat: mushrooms typically appearing in large clusters on wood after rain.

Pileus: 3-15 cm, convex to broadly convex colour extremely variable, but typically honey yellow, smooth, or with a few tiny, dark scales concentrated near the center and vaguely radially arranged.

Gills: Attached or beginning to run down the stem, nearly distant, whitish.

Stipe: 5-20 cm long, 0.5-1.5 cm thick, smooth and pale near apex, darker and nearly hairy below, with a persistent ring at maturity and a white partial veil covering the gills when young.

Spore print: White

Microscopic features: Spores 7-8 x 6-7  $\mu\text{m}$  (Plate 6:18).

#### **4.2.1.19 *Marasmius sullivantii***

Habitat: Saprobic on leaf litter and woody debris in hardwood forests, growing alone or gregariously.

Pileus: 2.5 cm across, convex, becoming flat, not pleated, becoming faintly lined at the margin, dry, reddish orange or rust-coloured.

Gills: Free from stem, close, white.

Stipe: 1-4 cm long, 1-1.5 mm thick, equal, dry, very finely silky or hairy, often with copious white basal mycelium, white or nearly clear at the apex, reddish to orangish in the midsection, reddish brown to black below

Spore: 7-8 x 3-4  $\mu\text{m}$ , smooth, elliptical (Plate 6:19).

#### **4.2.1.20 *Pleurotus populinus***

Habitat: Saprobic, growing in shelf-like clusters on dead and living wood.

Pileus: 2-15 cm, convex, becoming flat or somewhat depressed, kidney-shaped to fan-shaped, or nearly circular if growing on the tops of logs, somewhat greasy when young and fresh, smooth, whitish to pinkish gray or pale tan, without dark brown colorations, the margin inrolled when young, later wavy.

Gills: Running down the stem, close or nearly distant, whitish.

Stipe: Usually absent or rudimentary, when the mushroom is growing from the side of a log or tree. When it grows on the tops of logs or branches, or at an angle, however, it may develop a substantial and thick stem that is dry and slightly hairy near the base.

Spore print: Whitish.

Microscopic features: Spores 9-12 x 3-5  $\mu\text{m}$ , smooth, cylindric to long-elliptical (Plate 7:20).

#### **4.2.1.21 *Corticium evolvens***

Habitat: Saprobic, growing on dead and living wood.

Fruit body: resupinate, 2–20cm across, white, cream or tan with white fimbriate margin, on vertical surfaces the fungus may form small delicate brackets up to 1.5cm (Plate 7:21).

20



21



22



Plate-7 Detected species of fleshy fungi

20. *Plurotus populinus*

21. *Corticium evolvens*

22. *Pleurotus tuberregium*

#### **4.2.1.22 *Pleurotus tuber-regium***

Habitat: Saprobic, growing in shelf-like clusters on dead and living wood.

Pileus: 2-15 cm, convex, somewhat greasy when young and fresh, smooth, whitish to pinkish gray or pale tan, the margin inrolled when young, later wavy.

Gills: Running down the stem, close or nearly distant, whitish.

Microscopic features: Spores 4-6 x 1.5-3  $\mu\text{m}$ , smooth, cylindric to long-elliptical (Plate 7:22).

#### **4.2.1.23 *Psathyrella candolleana***

Habitat: Saprobic, growing alone or gregariously in lawns, pastures, and cultivated areas-also in woods.

Pileus: 3-11 cm, rounded-conical or convex when young, expanding to broadly convex, broadly bell-shaped, or nearly flat, bald, often developing shallow radial wrinkles, honey yellow when young, changing colour markedly to pale brownish or nearly white as it dries.

Gills: Attached to the stem or nearly free from it, whitish at first, becoming grayish and finally dark brown, close or crowded.

Stipe: 4-13 cm long, 3-8 mm thick, equal, fragile, white.

Spore print: Dark purplish brown.

Microscopic features: Spores 6.5-9.5 x 4-5  $\mu\text{m}$  (Plate 8:23).

#### **4.2.1.24 *Clitocybe nuda***

Habitat: Saprobiic, growing alone, scattered, gregariously, or in clusters in organic debris.

Pileus: 4-20 cm, convex with an inrolled margin when young, becoming broadly convex to nearly flat or with an uplifted, wavy margin in age, surface smooth, slightly tacky when moist, sometimes finely cracked over the center, usually dull purple, or purplish with brown shades when fresh.

Gills: Attached to the stem, sometimes by a notch or beginning to run down it, close or crowded, pale lavender to lilac, fading to buff, pinkish-buff, or brownish.

Stipe: 3-10 cm long, 1-3 cm thick at apex, equal, or enlarged at the base, dry, finely hairy near the apex, pale purple or colored like the gills, becoming brownish in age.

Spore print: Pinkish.

Microscopic features: Spores 5.5-8 x 3.5-5  $\mu\text{m}$ , ellipsoid, roughened (Plate 8:24).

#### **4.2.1.25 *Parasola auricoma***

Habitat: Saprobiic, growing scattered or gregariously on soil, in grass, or (more frequently) in wood chips.

Pileus: 10-60 mm across at maturity, egg-shaped at first, becoming convex or slightly conic, then nearly flat, bald to the naked eye (but finely hairy with a hand lens), becoming deeply grooved from the margin nearly to the center, oranges brown when young, becoming grayish in the grooves, without veil remnants.

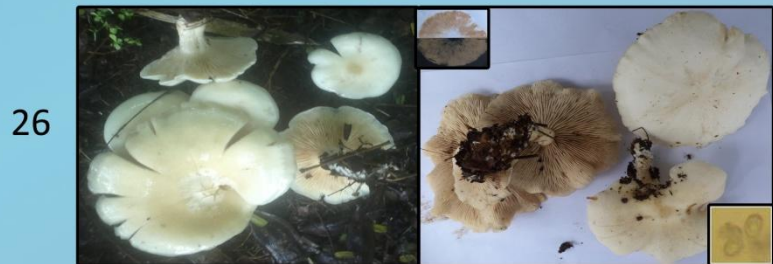


Plate-8 Detected species of fleshy fungi

23. *Psathyrella candolleana*

24. *Clitocybe nuda*

25. *Parasola auricoma*

26. *Clitocybe nebularis*

Gills: Free from the stem or nearly so, close or nearly distant, whitish at first, becoming dark gray and eventually black.

Stipe: 3.5-6 cm long, up to 3 mm thick, more or less equal, fragile, hollow, bald or very finely silky, whitish to yellowish, without a ring.

Microscopic features: Spores 10-16 x 6-9  $\mu\text{m}$ , ellipsoid (Plate 8:25).

#### **4.2.1.26**    *Clitocybe nebularis*

Habitat: Saprobian, growing alone, scattered, or gregariously under conifers.

Pileus: 4-25 cm, convex, flat, shallowly depressed, or irregular and distorted, dry or moist, hoary, finely hairy, or relatively smooth, gray to brownish gray, the margin inrolled at first and later wavy, sometimes lined.

Gills: Broadly attached to the stem or beginning to run down it, close, creamy.

Stipe: 5-15 cm long, up to 4 cm thick, with an enlarged base, dry, fairly smooth, or with tiny brownish fibers, white to cream.

Spore Print: Pale yellowish

Microscopic features: Spores 5.5-8.5 x 3-4.5  $\mu\text{m}$ , more or less elliptical (Plate 8:26).

#### **4.2.1.27**    *Collybia confluens*

Habitat: Saprobian, growing scattered or gregariously on soil, in grass.

Pileus: 2-6cm across, convex with incurved margin, then soon flattened, thin, often wavy margin, dull reddish brown fading to pale buff, glabrous.

Gills: Almost free, very crowded, narrow, pallid.

Stipe: 5-100 x 2-6mm, often flattened, reddish beneath a dense whitish pubescence, tough, base densely hairy.

Spore: Spores ellipsoid, smooth, 6-8 x 2-4 $\mu$ m (Plate 9:27).

#### **4.2.1.28** *Schizophyllum commune*

Habitat: Saprobic on dead wood or occasionally parasitic on living wood, growing alone or, more frequently, gregariously to clustered.

Fruiting body: 1-5 cm wide, fan-shaped when attached to the side of the log, irregular to shell-shaped when attached above or below, upper surface covered with small hairs, dry, white to grayish or tan, under surface composed of gill-like folds that are split down the middle, whitish to grayish, without a stem.

Spore print: White

Microscopic features: Spores 3-4 x 1-1.5  $\mu$ m, cylindrical to elliptical, smooth (Plate 9:28).

#### **4.2.1.29** *Cantharellus subalbidus*

Habitat: Growing alone or scattered mycorrhizal with conifers.

Pileus: 5-14 cm, broadly convex to flat, developing a central depression and becoming irregularly shaped in age, the margin becoming uplifted and wavy to lobed, bald or nearly felty

27



28



29



30



Plate-9 Detected species of fleshy fungi

27. *Collybia confluens*

28. *Schizophyllum commune*

29. *Cantharellus subalbidus*

30. *Clavulina cristata*

when young, sometimes becoming cracked or finely scaly with age, dry, white to whitish.

Gills: False gills that run down the stipe, elaborately corrugate and irregular, white.

Stipe: 2-5 cm long, 1-2 cm thick, tapering to base, solid, white.

Spore print: White.

Microscopic features: Spores 7-9 x 5-5.5  $\mu$ , smooth, ellipsoid (Plate 9:29).

#### **4.2.1.30 *Clavulina cristata***

Habitat: Presumed to be mycorrhizal with conifers and perhaps with hardwoods, growing alone, gregariously, or in clusters.

Fruiting Body: 2-10 cm high, 3-10 cm wide, sparingly to (more commonly) repeatedly branched.

Branches: 2-5 mm thick, smooth, white.

Microscopic features: Spores 7-11 x 6.5-10  $\mu$ m (Plate 9:30).

#### **4.2.1.31 *Calocera cornea***

Habitat: Saprobic, growing scattered to gregariously on the barkless wood.

Fruiting Body: Cylindric, with rounded to sharpened tips, occasionally shallowly forked near the tip, to about 2 cm high and 3 mm thick, smooth and silk, firm but gelatinous, orangish yellow.



Plate-10 Detected species of fleshy fungi

31. *Calocera cornea*

32. *Ganoderma applanatum*

33. *Polypore cannelle*

34. *Irpex lacteus*

Microscopic features: Spores 3-4 x 1.5-2  $\mu\text{m}$  (Plate 10:31).

#### **4.2.1.32 *Ganoderma applanatum***

Habitat: Saprobic and sometimes parasitic, growing alone or in groups on decaying logs and stumps, or from the wounds of injured, living trees.

Pileus: 5-35 cm across, more or less fan-shaped, semicircular, or irregular, with a dull, unvarnished outer crust, often furrowed in "zones", brownish to grayish brown.

Pore surface: White, becoming dirty yellowish or dingy brownish to olive in age, bruising brown, with 4-6 tiny (nearly invisible to the naked eye) circular pores per mm, tubes in layers, separated by brown tissue.

Stipe: Usually absent, if present, lateral and stubby.

Microscopic features: 8-12 x 6.5-8  $\mu\text{m}$ , more or less elliptical, with a truncated end (Plate 10: 32).

#### **4.2.1.33 *Polypore cannelle***

Habitat: Growing alone or small group under hardwood in packed soil. Infrequently dead wood.

Pileus: 1-5 cm, more or less round in outline in flats or vase shaped, dry, silky-shiny when fresh, cinnamon brown colour.

Pore surface: Yellowish brown to brown. Running down in stem. Pores are angular or circular (Plate 10:33).

#### **4.2.1.34 *Irpex lacteus***

Habitat: Saprobic, spreading across the bottoms and sides of fallen hardwood logs.

Fruiting body: A spreading patch of whitish pore surface with 2-3 pores per mm, soon becoming tooth-like rather than poroid, except near the margin, developing shelf like edges or even pileus when growing on the sides of logs, caps when present kidney-shaped to irregular, with a whitish to grayish (often zoned), velvety to hairy upper surface, flesh thin, whitish, and tough, without a stipe (Plate 10:34).

#### **4.2.1.35 *Russula aeruginea***

Habitat: Mycorrhizal with hardwoods or conifers, growing alone, scattered, or gregariously.

Pileus: 5-9 cm, convex when young, becoming broadly convex to flat with a shallow depression, dry or slightly moist, smooth, or minutely velvety over the center, grayish green to yellowish green, the margin often lined by maturity.

Gills: Attached or running slightly down the stipe, close, often forking near the stem, creamy to pale yellow.

Stipe: 4-6 cm long, 2-3 cm thick, whitish, dry, smooth, discoloring brownish in places, especially near the base.

Spore print: Pale yellow.

Microscopic features: Spores 6-8.5 x 5-7  $\mu\text{m}$  (Plate 11:35).

35



36



37



Plate-11 Detected species of fleshy fungi

35. *Russula aeruginea*

36. *Phellodon confluens*

37. *Dictyohora indusiata*

#### **4.2.1.36 *Phellodon confluens***

Habitat: Mycorrhizal with hardwoods or conifers, growing alone or gregariously.

Pileus: Single or (frequently) fused with other caps, 3-13 cm wide, planoconvex, becoming flat or shallowly depressed, velvety, sometimes pitted or roughened whitish to pale grayish on the growing margin, becoming tan to brown toward the center, bruising dark brown to blackish.

Undersurface: Running down the stem, covered with crowded spines that are 1-2 mm long, whitish at first, becoming brownish.

Stipe: 1-4.5 cm long, 0.5-1 cm thick, smooth or finely velvety, coloured like the cap.

Microscopic features: Spores 3.5-6 x 3-4  $\mu\text{m}$ , globose to subglobose, echinulate with spines (Plate 11:36).

#### **4.2.1.37 *Dictyohora indusiata***

Habitat: Grows in woodlands and gardens in rich soil and well-rotted woody material.

Mature fruit bodies are up to 25 cm tall with a conical to bell-shaped cap that is 1.5–4 cm wide. The cap is covered with a greenish-brown spore-containing slime, which attracts flies and other insects that eat the spores and disperse them. Immature fruit bodies are initially enclosed in an egg-shaped to roughly spherical subterranean structure encased in a peridium. The "egg" ranges in colour from whitish to buff to reddish-brown, measures up to 6 cm in diameter (Plate 11: 37).

From the collected 111 samples, fleshy fungi having similar morphology were sampled in a single group collected from sampling location. This sampling resulted in identification of 37 species. Among them *Auriularia polytricha*, *Schizophyllum commune*, *Xylaria carpophila*, *Ganoderma applanatum*, *Macrolapiota proera*, *Clavulina cristata*, *Psathyrella candolleana* were most dominant species, found in Waghai, Kudkachh, Kukadnakhi, Chichingavtha and Bhenshkantri places. *Daldinia concentric*, *Marasmius siccus*, *Marasmius sulivantti*, *Marasmius felix*, *Coprinus atramentaria*, *Coprinus lagopides*, *Parasola auricoma*, *Clitocybe nuda*, *Clitocybe nebulars*, *Dictyohora indusiata* and *Canthrellus subalbidus* were found as dominant during the survey. *Auleria aurantia*, *Pleurotus populinus*, *Pluerotus tuber-regium*, *Lapiota ignivolvata*, *Armillaria mellia*, *Collybia confluence*, *Calvatia cynthiformis*, *Corticium evolvens*, *Agaricus hondensis*, *Agaricus praeclaresquamosus*, *Lucocoprinus cepaestipes*, *Lucocoprinus brebissonii*, *Irpex lacteus*, *Russula aeruginea*, *Coltrica cinnamonea* were rare in their occurred. *Ascobolus furfuraceus*, *Calocera cornea*, *Crepidotus variabilis*, *Phellodon confluence* were very rarely collected during the survey (Table 2).

The present investigation detection of mushroom morphology was in agreement with earlier reports of several scientists. Dehariya *et al.* (2010) found 18 species of mushrooms in Sagar forest of Madhya Pradesh and described morphologically. Dwivedi *et al.* (2012) reported 16 species of mushroom with their

morphological characters from Amarkantak forest. Vishwakarma and Bhatt (2013) studied macrofungal biodiversity in Khirsu forest of Garwal Himalaya, where they detected 15 species of mushrooms based on morphology.

### **4.3 Taxonomic position of collected fleshy fungi**

During the survey 37 species of mushrooms were identified. Out of the 37 species, 4 species were grouped taxonomically under the phylum Ascomycota and 33 species under phylum Basidiomycota. In Ascomycota, 2 species in order Pezizales and 2 species in Xylariales were described. In Basidiomycota, 1 species in order Auriculariales, 23 species in order Agaricales, 2 species in order Canthrellales, 2 species in order Polyparales, 1 species in order Phallales, 1 in order Russulales, 1 in Hymenochaetales, 1 in order Thelephorales and 1 in order Dacrymycetales were described (Table 3).

The taxonomy position described by Anonymous (2007), Geoffrey (1982) and Hard (1961) were matching with our observations and hence the mushrooms were confirmed as particular species. Peksen and Karaca (2003) reported 169 species of macrofungi, out of which 19 belonged to the Ascomycota, 149 to the Basidiomycota and one to the Myxomycota.

**Table: 3 Taxonomic position of collected mushrooms in Dang district**

S r. n o.	King dom	Phylum	Class	Order	Family	Genus	Species
1.	Fungi	Ascomycota	Pezizomycetes	Pezizales	Pyrenomataceae	<i>Auleria</i>	<i>aurantia</i>
2.					Ascobolaceae	<i>Ascobolus</i>	<i>furfuraceus</i>
3.			Sordariomycetes	Xylariales	Xylariaceae	<i>Daldinia</i>	<i>concentrica</i>
4.						<i>Xylaria</i>	<i>carpophila</i>
5.		Basidiomycota	Heterobasidiomycetes	Auriculariales	Auriculariaceae	<i>Auricularia</i>	<i>polytricha</i>
6.					Agariaceae	Agariales	<i>Agaricus</i>
7.			<i>Agaricus</i>	<i>praeclaresquamosus</i>			
8.			<i>Lucocoprinus</i>	<i>cepaestipes</i>			
9.			<i>Lucocoprinus</i>	<i>brebissonii</i>			
10.			Crapidota ceae	Agaricales	Agariales	<i>Crepidotus</i>	<i>variabilis</i>
11.						Coprinae ae	Coprinales
12.			<i>Coprinus</i>	<i>lagopides</i>			

Cont....

Sr. no.	King dom	Phylum	Class	Order	Family	Genus	Species
13.	Fungi	Basidiomy cota	Agricomycetes	Agaricales	Laprotaceae	<i>Macrolaprot a</i>	<i>procera</i>
14.						<i>Laprotia</i>	<i>ignivolvata</i>
15.					Lycoperdaceae	<i>Calvatia</i>	<i>cynthiformis</i>
16.					Marasmiaceae	<i>Marasmius</i>	<i>siccus</i>
17.							<i>sulivantti</i>
18.							<i>felix</i>
19.					Marasmiaceae	<i>Armillaria</i>	<i>mellia</i>
20.					Pleurotaceae	<i>Pleurotus</i>	<i>populinus</i>
21.							<i>Pluerotus</i>
22.					Physalacriaceae	<i>Corticium</i>	<i>evolvens</i>
23.					Psathyrellaceae	<i>Psathyrella</i>	<i>candolleana</i>
24.							<i>Parasola</i>
25.					Tricholomataceae	<i>Clitocybe</i>	<i>nuda</i>
26.							<i>nebulars</i>
27.	<i>Collybia</i>	<i>confluence</i>					
28.	Schizophyllaceae	<i>Schizophyll un</i>	<i>commune</i>				

Cont....

<b>Sr. no.</b>	<b>King dom</b>	<b>Phylum</b>	<b>Class</b>	<b>Order</b>	<b>Family</b>	<b>Genus</b>	<b>Species</b>
29.	Fungi	Basidiomy cota	Agaricomy cetes	Cantharellales	Canharellaceae	<i>Canthrellus</i>	<i>subalbidus</i>
30.					Clavulinaceae	<i>Clavulina</i>	<i>cristata</i>
31.				Dacrymycetale s	Dacrymycetaceae	<i>Calocera</i>	<i>cornea</i>
32.				Hymenochaeta les	Hymenochetaceae	<i>Polypore</i>	<i>cannelle</i>
33.				Polyparles	Ganodermataceae	<i>Ganoderma</i>	<i>applanatu m</i>
34.					Steccherinaceae	<i>Irpex</i>	<i>lacteus</i>
35.				Phallales	Phallaceae	<i>Dictyohora</i>	<i>indusiata</i>
36.				Russulales	Russulaceae	<i>Russula</i>	<i>aeruginea</i>
37.				Thelephoreles	Bankeraceae	<i>Phellodon</i>	<i>confluence</i>

#### **4.4 Grow dominant species of collected fleshy fungi at Navsari condition**

The experiments on possibility of growing *Auricularia polytricha*, a dominant edible mushroom, observed in Dangs district was collected and an attempt was made to grow them under Navsari conditions.

To evaluate its growth, different substrates like paddy straw, wheat straw, coconut coir pith, cotton waste, and sugarcane baggase were selected (Plate 13&14)

##### **4.4.1 Days to spawn run**

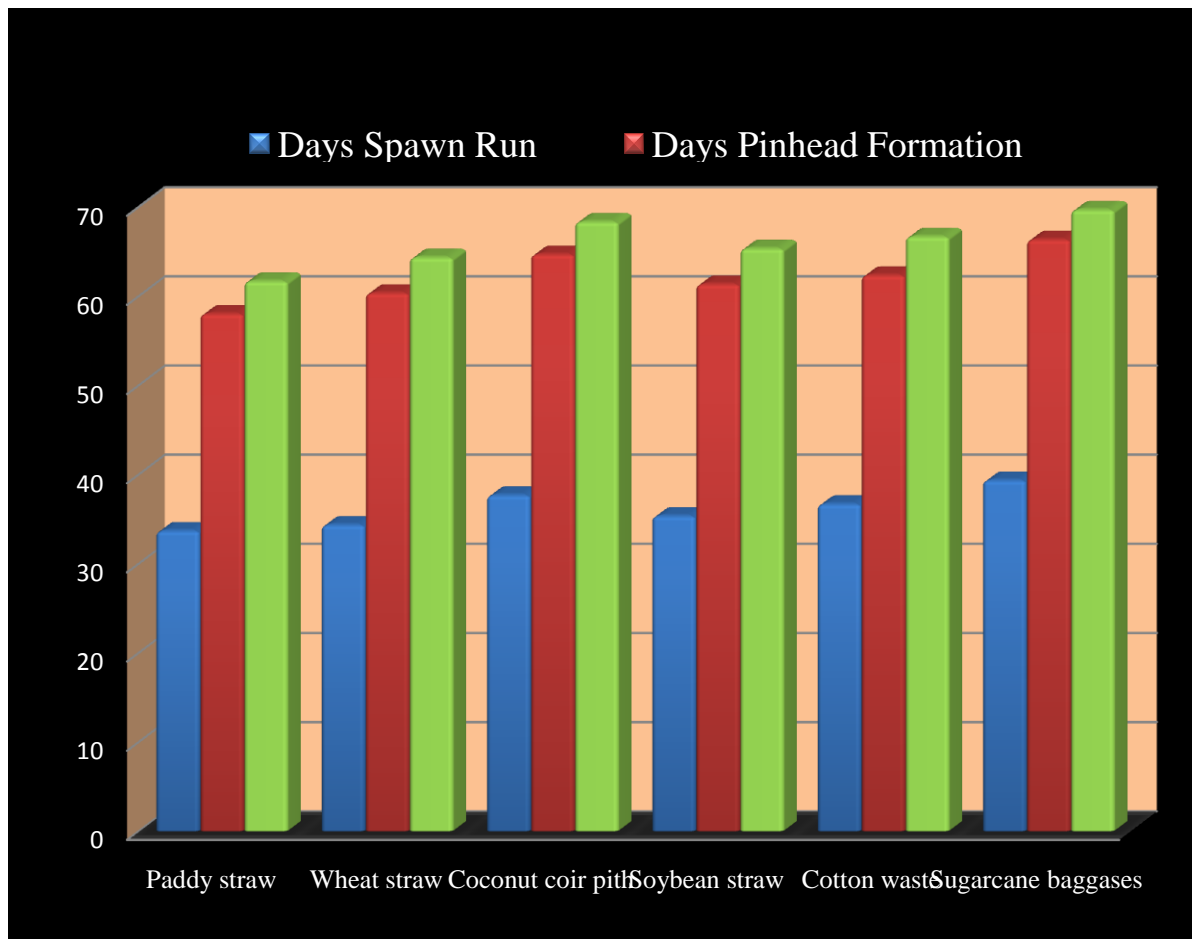
The days required for spawn run on different substrate ranged from 33.67 to 37.69 days (Table 4 and Fig. 2). Minimum days were (33.67 days) required for spawn run in treatment T<sub>1</sub> (Paddy straw) which were at par with treatment T<sub>2</sub> (wheat straw) with 34.33 days. The next best in the order of merit was treatment T<sub>4</sub> (Soybean straw) with 35.33 days. Maximum days were required (39.33 days) for spawn run in treatment T<sub>6</sub> (sugarcane baggase).

##### **4.4.2 Days for pinhead formation**

Results on the days required for the pinhead formation with different treatments on substrate are presented in (Table 4 and fig. 2). The results revealed that 58.00 to 66.33 days were required for pin head formation. Minimum of 58.00 days were required for pin head formation in treatment T<sub>1</sub> (Paddy straw). T<sub>2</sub> (wheat straw) performed better in next order (60.33 days) which was at par with

**Table: 4 Evaluation of substrates for cultivation of *Auricularia polytricha***

Sr. No.	Treatment	Days			Average no. of fruit bodies
		Spawn Run	Pinhead Formation	First Harvest	
1	Paddy straw	33.67	58.00	61.67	78.33
2	Wheat straw	34.33	60.33	64.33	74.00
3	Coconut coir pith	37.67	64.67	68.33	62.33
4	Soybean straw	35.33	61.33	65.33	70.00
5	Cotton waste	36.67	62.33	66.67	65.67
6	Sugarcane baggases	39.33	66.33	69.67	60.00
	<b>C.D.@5%</b>	1.03	1.10	1.03	2.81
	<b>C.V.%</b>	1.59	1.07	0.87	2.31



**Fig.2. Evaluation of different substrates for cultivation of *Auriularia polytricha***

1



2



3



Plate-12 Growth of *A. polytricha* on different substrate

1. Paddy straw
2. Wheat straw
3. Coconut coir pith

treatment T<sub>4</sub> (Soybean straw) 61.33 days. Maximum days (66.33 days) were required for pinhead formation in the treatment T<sub>6</sub> (sugarcane baggase).

#### **4.4.3 Days for first harvest**

Results of days required for first harvest with different treatments were presented in Table 4 and Figure 2. The results showed that 61.67 to 69.67 days were required for the first harvest. Minimum, 61.67 days were required for the first harvest in T<sub>1</sub> (Paddy straw). T<sub>2</sub> (wheat straw) performed better in next order (64.33 days) which was at par with T<sub>4</sub> (Soybean straw) 65.33 days. Maximum days (69.67 days) required for the first harvest were recorded with treatment in T<sub>6</sub> (sugarcane baggase).

#### **4.4.4 Total number of fruit bodies**

Results of total number of fruit bodies were presented in Table 4. Significantly highest number of fruit bodies (78.33) observed in the treatment T<sub>1</sub> (Paddy straw). T<sub>2</sub> (wheat straw) performed better in the next order (74.00 days). The substrate sugarcane baggases yielded lowest number of fruit bodies (60.00).

#### **4.4.5 Cap diameter**

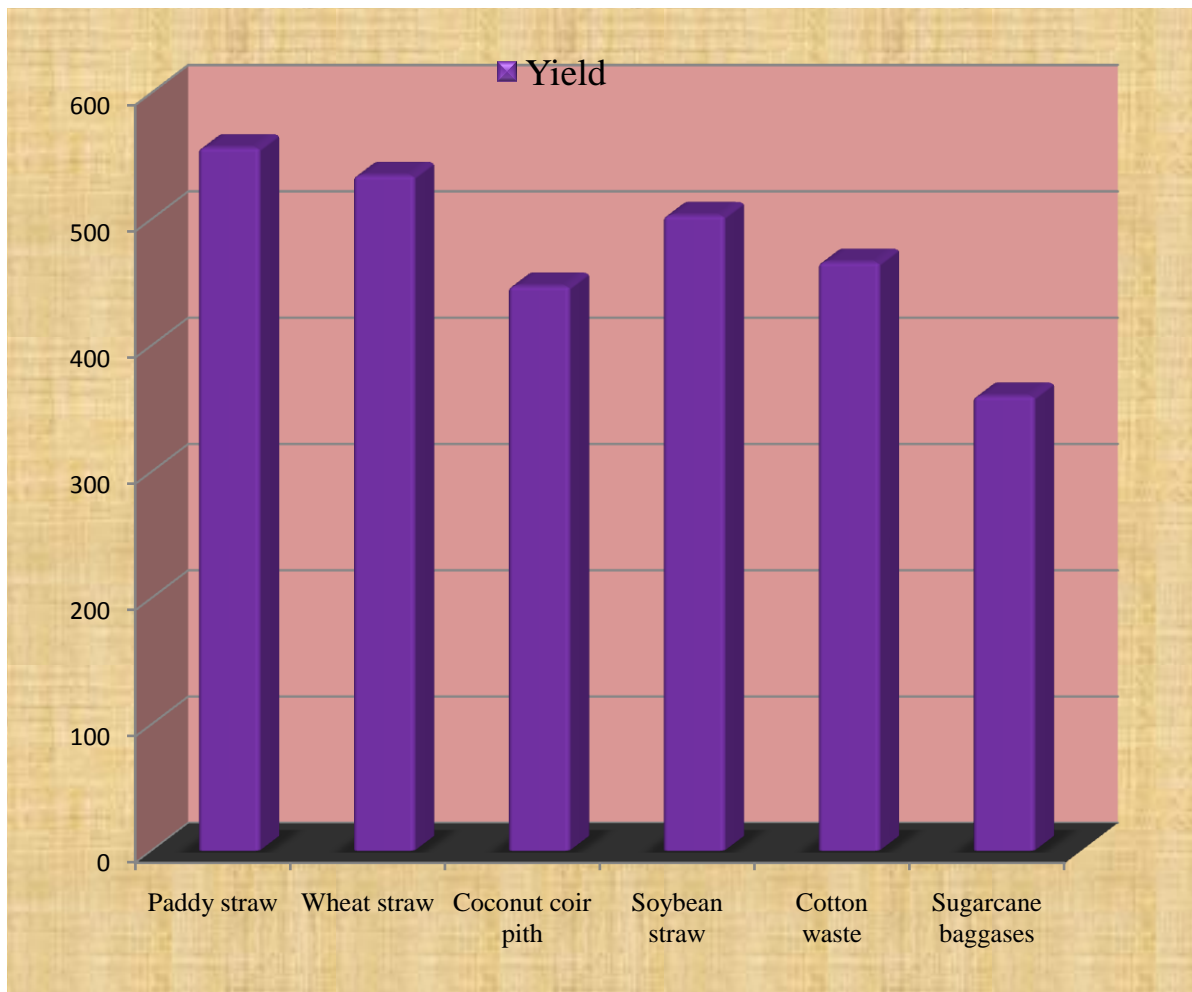
Results (Table 5 and fig. 3) revealed that of cap diameter of fruiting body in different treatments ranged from 5.30 cm to 3.20 cm. The diameter of cap was significantly highest (5.30 cm) on T<sub>1</sub> (Paddy straw). The next best treatment was T<sub>2</sub> (wheat

**Table: 5 Effect of different substrates on yield of *Auricularia polytricha***

<b>Sr. No.</b>	<b>Treatment</b>	<b>Cap Diameter (cm)</b>	<b>Yield (gm)</b>	<b>Biological efficiency (%)</b>
1	Paddy straw	5.30	556.71	55.67
2	Wheat straw	4.77	534.71	53.47
3	Coconut coir pith	3.70	447.08	44.70
4	Soybean straw	4.60	503.04	50.30
5	Cotton waste	4.73	466.04	46.60
6	Sugarcane baggases	3.20	360.04	36.04
	<b>C.D.@5%</b>	0.19	14.11	1.41
	<b>C.V.%</b>	2.47	1.66	1.66



**Fig. 3: Cap diameter of *Auricularia polytricha* on different substrates**



**Fig.4. Yield performance of *Auricularia polytricha* on different substrate**

4



5



6



Plate-13 Growth of *A. polytricha* on different substrate

4. Soybean straw

5. Cotton stalk

6. Sugarcane bgrasse

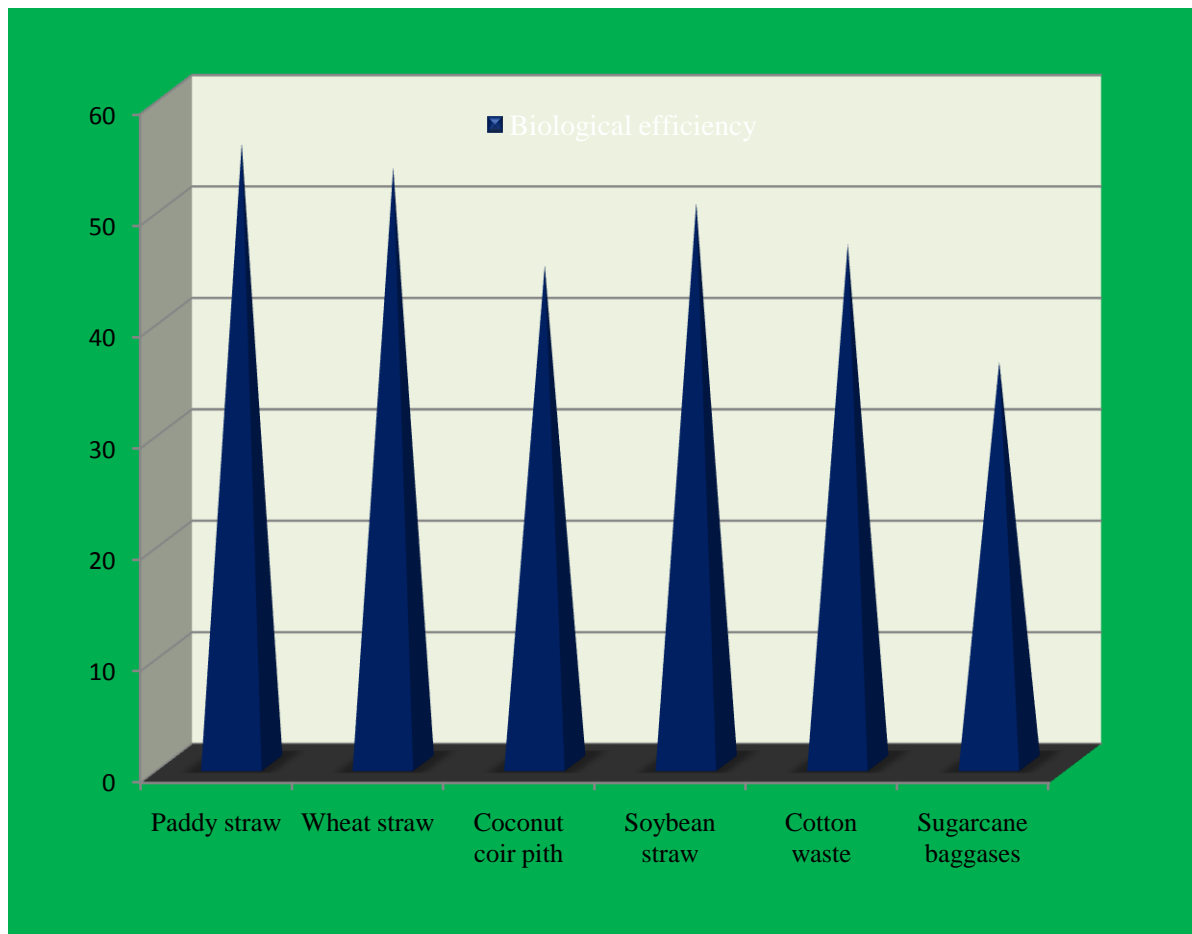
straw) with 4.77 cm. The minimum cap diameter (3.20 cm) was found in the case of T<sub>6</sub> (sugarcane baggase).

#### **4.4.6 Yield**

The results on yield of *A. polytricha* on different substrates are presented in Table 5 and Figure 4. Overall, the yield was ranged from 360.04 to 556.71 g. Significantly highest yield (556.71 g/kg dry substrate) was recorded in substrate T<sub>1</sub> (Paddy straw). The next best substrates was wheat straw (534.71 g/kg dry substrate). Whereas , Soybean straw, cotton waste, coconut coir pith yielded 503.04 g, 466.04 g, 447.08 g/kg dry substrate respectively. Lowest yield was recorded with sugarcane baggase (360.04 g/kg dry substrate).

#### **4.4.7 Biological efficiency**

The results on biological efficiency (%) of different substrates used for the cultivation of *A. polytricha* are presented in Table 5 and fig. 5. Overall, biological efficiency was ranged from 36.00 to 55.67 %. The highest biological efficiency (55.67%) was observed in treatment T<sub>1</sub> (Paddy straw). The next best substrate was wheat straw (53.47%). Whereas, soybean straw, cotton waste, coconut coir pith gave the biological efficiency of 50.30%, 46.60%, 44.70%, respectively. The lowest biological efficiency (36.04%) was recorded on sugarcane baggase.



**Fig.5. Biological efficiency of *Auricularia polytricha* on different substrates**

Various mushrooms were cultivated in different localities by various workers depending on the natural availability of fleshy fungi and substrates (Singh *et al.*, 2007); Mishra and Kushwaha 2011. In the present investigation, paddy straw was found to be a good substrate for the cultivation of *A. polytricha* mushrooms which is in the agreement with earlier reports of several scientists. Highest yield performance, spawn run and pinhead formation of mushrooms were reported on paddy straw (Maheswari *et al.*, 2007; Pani, 2010).



**SUMMARY**  
**&**  
**CONCLUSION**



## V. SUMMARY AND CONCLUSION

Mushroom is a general term used mainly for the fruiting body of the macrofungi (Ascomycota & Basidiomycota) and represents only a short reproductive stage in their life cycle. The most common type of mushrooms are umbrella shaped with pileus and stipe, other species additionally may have volva or annulus or with both of them. Furthermore, some mushrooms are in the form of pliable cups, while others are round like golf ball. Some are in the shape of small clubs, some coral, other is yellow or orange jelly like globes and some even much resemble the human ear. Infact, there are countless varieties of mushrooms.

In present investigation on “Studies on morphological characterization of fleshy fungi from Dangs district” includes survey, detection, morphological characters and taxonomic position. The *Auricularia polytricha* was dominant edible mushroom observed in Dangs district which was collected and used for further studies to grow them under Navsari conditions. Paddy straw, wheat straw, coconut coir pith, cotton waste, and sugarcane baggase were used as substrate for the cultivation of *A. polytricha*. Growth and yield attributes were studied during the cultivation. The results obtained in present investigation are summarized and concluded in this chapter.

To find out the distribution and occurrence of fleshy fungi in a particular area, survey was conducted in 6 months, July

2012 to December 2012 at the locations of Waghai, Cookadnakhi, Chichingavtha, Coodkachh and Bhenskatri. A total of 111 samples of mushrooms were collected during the survey. Maximum of 28 samples were collected from Waghai region and minimum of 17 samples from Kudkachh region. The samples collected were from decaying wood, leaf litter, woody debris, organic debris, wood chips, soil inhabiting, pastures and lawns habitats.

The collected samples were further grouped and identified as 37 species, on the basis of morphological characters like pileus colour, diameter, shape, stipe colour, length, diameter, gills colour and attachment. A brief note of distinguishing macroscopic and microscopic features was studied under microscope.

During the survey *Schizophyllum commune*, *Auriularia polytricha*, *Xylaria carpophila*, *Ganoderma applanatum*, *Macrolapiota proera*, *Psathyrella candolleana* were observed as dominant species of mushroom in Dangs district. While, *Auriularia polytricha*, *Pleurotus populinus* and *Pleurotus tuberregium* were also observed in Dangs district, because of the favourable environmental factors like temperature, light, relative humidity, soil type and wind which greatly influenced the growth and development of macrofungi.

Within the taxonomic position the phylum Ascomycota reported with 2 orders. They were Pezizales and Xylariales (*Auleria aurantia*, *Xylaria carpophila* etc). Among the phylum Basidiomycota, 9 orders reported were Agaricales, Cantharellales,

Dacrymycetales, Auriculariales, Thelephoreles, Polyparles, Phallales , Russulales , Hymenochaetales with the macrofungi viz., *Schizophyllum commune*, *Clavulina cristata*, *Calocera cornea*, *Auricularia polytricha*, *Ganoderma applanata*, *Phellodon confluence*, *Dictyohora indusiata*, *Russula aeruginea*, *Coltricia cinnamomea* etc.

Evaluation of different substrates for cultivation of *Auricularia polytricha* revealed that the no. of days required for spawn run, pin head formation and first harvest were 33.67 to 37.69 days, 58.00 to 66.33 days and 61.67 to 69.67 days, respectively. The average no of fruit bodies, cap diameter, yield and biological efficiency were 78.33 to 60.00, 5.30 cm to 3.20 cm, 360.04 to 556.71 g and 36.00 to 55.67 %, respectively. Among the different substrates, paddy straw substrate recorded minimum days for spawn run (33.67 days), pin head formation (58.00 days) and first harvest (61.67 days) with highest number of fruit body (78.33) and highest cap diameter (5.30 cm). Paddy straw as a substrate also recorded maximum yield (556.71 g) and highest biological efficiency (55.67 %). The wheat straw was next superior in term of spawn run, pinhead formation and first harvest which recorded 34.33days, 60.33 days and 64.33 days, respectively, and wheat straw was also next superior in term of average no of fruit bodies, cap diameter, yield and biological efficiency which recorded 74.00, 4.77 cm, 534.71g and 53.47%, respectively.

From this study it can be concluded that survey of fleshy fungi from Dangs district, a total 111 samples were

collected and 37 species were identified morphologically as well as taxonomically. During the survey, *Auricularia polytricha* was found most dominant edible mushroom in Dangs district which was collected and isolated for its cultivation at Navsari conditions. Among the 6 selected substrates, paddy straw recorded minimum days for the growth and gave highest yield.



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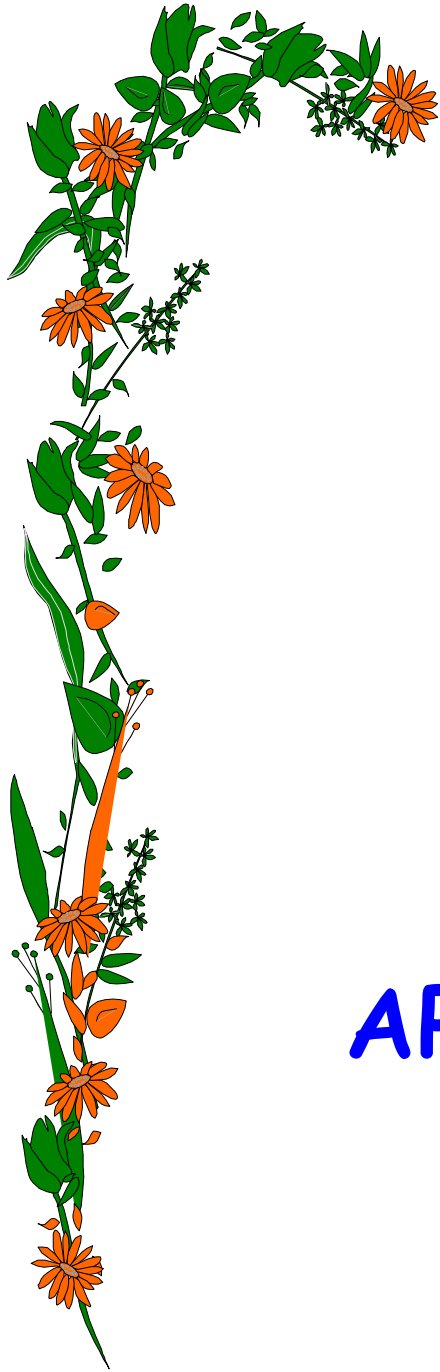
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\*Originals are not seen



# APPENDIX



## Identification keys for collected fleshy fungi from Dangas district (Basidiomycota)

**Irregular structure jelly-like** ----- *Auricularia , calocera*

**Fruit bodies are conical or bell shaped**-----*Dictiohora*

**Sparingly, repeatedly branches**-----*Clavulina*

**Small delicate brackets**-----*Corticium*

**Bracket like- several layers of spores** -----*Ganoderma, polypore*

### **Pileus with stipe**

**Hymenium on spines**----- *Phellodon*

### **Hymenium on gills**

### **Stipe are eccentric or lateral**

**Spores white**----- *Schizophyllum*

**Spores pink**----- *Crepidotus*

### **Stipe central**

### **Spore white**

**Rings only**----- *Armillaria, Lapiota*

### **No ring or volva**

**Gills brittle**-----*Russula*

**Gills are decurrent**----- *Canthrellus, Clitocybe*

**Gills delicate** -----*Marasmius*

**Gills andante or free**----- *Collybia*

### **Spores are purple or black**

**Gills deliquescent**----- *Coprinus, Parasola*

**Gills are free** ----- *Agaricus*

**Gills adnate or free, no ring**-----*Psathyrella*

# C E R T I F I C A T E

This is to certify that I have no objection to supply one copy of any part of this thesis at a time to any scientist through reprographic process for rendering reference services in a library or documentation center.

**Place:** Navsari.

**Date:** 29 July, 2013

**(RAVAT HIRENDRASINH R.)**

