

**EXPLORING THE POSSIBILITIES OF ENHANCING THE
YIELD OF MUSHROOM AND INTRODUCING IT
AS A SELF EMPLOYMENT AVENUE**

By

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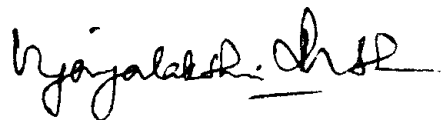
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CERTIFICATE

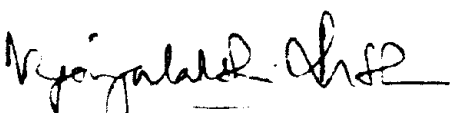
This is to certify that this thesis entitled, "**Exploring the Possibilities of Enhancing the Yield of Mushroom and Introducing it as a Self Employment Avenue**" submitted to the Avinashilingam Institute for Home Science and Higher Education for Women, Deemed University, Coimbatore, for the award of the degree of Doctor of Philosophy in Family Resource Management is a record of original research work done by M.R. Thilakam during the period of her study in the Department of Family and Community Science, Avinashilingam Institute for Home Science and Higher Education for Women, Deemed University, Coimbatore, under my supervision and guidance and the thesis has not formed the basis for the award of any Degree/Diploma/Associateship/Fellowship or similar title to any candidate of any University.

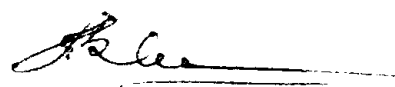


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DECLARATION

I hereby declare that the matter embodied in this thesis is the result of investigation carried out by me in Family Resource Management, Avinashilingam Institute for Home Science and Higher Education for Women, Deemed University, Coimbatore, under the supervision of **Dr. Vijayalakshmi Purushothaman**, Dean, Community College, Professor and Head, Department of Family and Community Science, Avinashilingam Institute for Home Science and Higher Education for Women, Deemed University, Coimbatore and it has not been submitted for the award of any Degree/Diploma/Associateship/ Fellowship etc., of any other University or Institute.


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Signature of the Candidate

CONTENTS

Chapter No.	Title	Page No.
	LIST OF TABLES	
	LIST OF FIGURES	
	LIST OF APPENDICES	
I	INTRODUCTION	1
II	REVIEW OF LITERATURE	13
2.1.	Evolution of Mushroom as a Food Commodity	14
2.2.	Mushroom as Food and Medicine	21
2.3.	Mushroom Cultivation as an Entrepreneurial Activity in India	27
2.4.	Influence of Substrates on the Yield of Mushroom	46
2.5.	Enhancing Yield of Mushroom	51
2.6.	Preservation and Storage of Mushroom	54
III	EXPERIMENTAL DESIGN	63
3.1.	Conduct of Surveys on Methods of Cultivation of Mushrooms, Mode of Marketing and Extent of use in Restaurants and Households	64
3.2.	Identification of Commonly used Substrates	69
3.3.	Identifying the Supplements which may Enhance Yield of Mushroom	69

Chapter No.	Title	Page No.
3.4.	Incorporation of the Identified Supplements into the Selected Substrates and Assessing the Yield	72
3.5.	Comparison of the Keeping Quality, Acceptability and Nutritive Value of Oyster, Milky and Button Mushrooms	84
3.6	Cultivating Oyster and Milky Mushroom and Introducing the same as a Self Employment Avenue	88
IV	RESULTS AND DISCUSSION	92
4.1.	Findings of the Surveys on Cultivation of Mushrooms, Marketing and Extent of Use by Consumers	94
4.2.	Impact of Supplements on Cultivation of Oyster Mushroom	124
4.3.	Analysis of the Substrates for their Cellulose, Lignin and Hemi cellulose Content, its Bioefficiency and NPK	145
4.4.	Impact of Supplements on Cultivation of Milky Mushroom	151
4.5.	Cultivation of Button Mushroom	153
4.6.	Comparing the Keeping Quality, Acceptability and Nutritive value of Oyster, Button and Milky Mushrooms	154
4.7.	Suitability of Mushroom Cultivation as a Self Employment Avenue	159
V	SUMMARY AND CONCLUSION	164
	REFERENCES	
	APPENDICES	

LIST OF TABLES

TABLE NO.	TITLE	PAGE NO.
1.	THE COMPARISON OF THREE COMMON TYPES OF MUSHROOMS IN TAMIL NADU	35
2.	EXPECTED MUSHROOM YIELD BY UTILIZING ONE TENTH OF THE WASTE	43
3.	AREAS SELECTED FOR THE SURVEY AND TARGET GROUP	66
4.	DETAILS OF THE SUPPLEMENTS USED	76
5.	BACKGROUND INFORMATION OF MUSHROOM CULTIVATORS	95
6.	DETAILS RELATING TO THE CULTIVATORS	97
7.	DETAILS ON TRAINING AND EMPLOYMENT OF LABOURERS	99
8.	SPACE UTILIZED FOR THE MUSHROOM SHEDS	100
9.	MUSHROOM SPECIES SELECTED FOR CULTIVATORS	101
10.	PROFIT REALIZED BY THE MUSHROOM CULTIVATION	107
11.	PROBLEMS FACED IN MUSHROOM CULTIVATION	108
12.	DETAILS ON SHOPS, SPECIES OF MUSHROOM AND THEIR DEMAND	112
13.	DETAILS ON GENERAL FAMILY BACKGROUND	115
14.	FOOD HABITS AND MUSHROOM CONSUMPTION PATTERN	118
15.	DETAILS ON PROCUREMENT OF FRESH MUSHROOMS BY THE SELECTED RESTAURANT OWNERS	121

TABLE NO	TITLE	PAGE NO
16.	QUANTITY AND SPECIES OF MUSHROOM PURCHASED BY THE SELECTED RESTAURANTS	122
17.	COST INCURRED IN PREPARING THE BEDS USING SELECTED SUPPLEMENTS ON SELECTED SUBSTRATES	124
18.	COMPARISON OF YIELDS OF MUSHROOM CULTIVATED BY THE INVESTIGATOR DURING SUMMER	125
19.	YIELD OF OYSTER MUSHROOM DURING WINTER	127
20.	COMPARISON OF YIELD OF MUSHROOM CULTIVATED BY INVESTIGATOR IN WINTER USING SELECTED SUBSTRATES AND SUPPLEMENTS	128
21.	MUSHROOM OBTAINED DURING WINTER AND SUMMER	129
22.	PROFIT/LOSS REALIZED BY CULTIVATING OYSTER MUSHROOM ON PADDY STRAW WITH AND WITHOUT THE SUPPLEMENTS	133
23.	PROFIT/LOSS REALIZED BY CULTIVATING OYSTER MUSHROOM ON BANANA LEAF WITH AND WITHOUT THE SUPPLEMENTS	134
24.	PROFIT/LOSS REALIZED BY CULTIVATING OYSTER MUSHROOM ON BANANA STEM WITH AND WITHOUT THE SUPPLEMENTS	135
25.	PROFIT/LOSS REALIZED BY CULTIVATING OYSTER MUSHROOM ON SUGARCANE BAGASSE WITH AND WITHOUT THE SUPPLEMENTS	136
26.	PROFIT GAINED BY CULTIVATING OYSTER MUSHROOM DURING WINTER	137
27.	TIME REQUIRED FOR COMPLETING DIFFERENT STAGES IN MUSHROOM GROWTH IN SUMMER	140
28.	TIME REQUIRED FOR COMPLETING OF DIFFERENT STAGES IN MUSHROOM GROWTH IN WINTER	142

TABLE NO.	TITLE	PAGE NO.
29.	SIZE OF THE HARVESTED MUSHROOM IN SUMMER	144
30.	SIZE OF THE HARVESTED MUSHROOM IN WINTER	145
31.	CELLULOSE, LIGNIN AND HEMICELLULOSE CONTENT OF FRESH AND SPENT SUBSTRATES (IN PERCENTAGE)	147
32.	BIOEFFICIENCY OF THE SUBSTRATES	148
33.	NPK CONTENT OF THE SPENT SUBSTRATES	151
34.	PROFIT IN CULTIVATING MILKY MUSHROOM	152
35.	PROFIT IN CULTIVATING BUTTON MUSHROOM	153
36.	NUTRIENT CONTENT OF FRESH AND DRIED MUSHROOMS	158
37.	YIELD FROM THE OYSTER MUSHROOM AND PROFIT REALIZED BY THE ENTREPRENEURS	160
38.	YIELD FROM THE MILKY MUSHROOM AND PROFIT REALIZED BY THE ENTREPRENEURS	162

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE NO.
1.	PROBLEMS FACED BY MUSHROOM CULTIVATORS	109
2.	YIELD OF MUSHROOM IN WINTER AND SUMMER	131
3.	PROFIT/LOSS REALIZED BY CULTIVATING OYSTER MUSHROOM DURING SUMMER	132
4.	PROFIT GAINED BY CULTIVATING OYSTER MUSHROOM DURING WINTER	138
5.	CELLULOSE, LIGNIN AND HEMI CELLULOSE CONTENT OF FRESH AND SPENT SUBSTRATES	146
6.	BIOEFFICIENCY OF THE SUBSTRATES	149

LIST OF PLATES

PLATE NO.	TITLE	PAGE NO.
1.	SUBSTRATES AND SUPPLEMENTS USED	71
2.	STAGES IN CULTIVATION OF OYSTER MUSHROOM	79
3.	STAGES IN CULTIVATION OF MILKY MUSHROOM	83
4.	FRESH AND STALE MUSHROOMS	156
5.	FRESH AND DRIED FORMS OF MUSHROOMS	157

LIST OF APPENDICES

Appendix No.	TITLE
I	QUESTIONNAIRE TO FIND OUT PROBLEMS AND PROSPECTS OF MUSHROOM CULTIVATION AMONG MUSHROOM GROWERS
II	QUESTIONNAIRE TO COLLECT DETAILS ON SELLING PATTERN OF MUSHROOMS IN THE SELECTED SHOPS
III	QUESTIONNAIRE TO COLLECT DETAILS ON THE PREPARATION OF MUSHROOM RECIPES IN SELECTED RESTAURANTS
IV	QUESTIONNAIRE TO FIND THE USE OF MUSHROOM IN SELECTED HOUSEHOLDS
V	COMPARISON OF YIELDS OF MUSHROOM CULTIVATED BY THE INVESTIGATOR DURING SUMMER
VI	THE COST INCURRED FOR PREPARING VARIOUS RECIPES USING SELECTED VARIETY OF FRESH MUSHROOMS
VII	PERCENTAGE OF SCORES OBTAINED BY MUSHROOM RECIPES OF FRESH AND DRIED FORM OF SELECTED VARIETIES
VIII	PROCEDURES FOR ANALYSIS OF SELECTED NUTRIENTS

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INTRODUCTION

INTRODUCTION

India is enviably rich in its cultural heritage and natural resources. After independence the nation stepped out from darkness to light, and chose the path of formalised planning, in order to increase the production of goods and services, using the available resources. Thus, for more than five decades it has embarked on the path of planned economic, social, intellectual and spiritual development aimed at attaining a high and sustained rate of growth and a progressive improvement in the standard of living of the people by fighting against problems of unemployment, under employment, poverty and malnutrition and building up a strong and self-reliant egalitarian society. In spite of all the efforts taken, the nation is still confronted with a variety of formidable problems.

An ever increasing population has been one of the major constraints in India's overall developmental process. The rapid increase in population from 548 million to 958 million approximately has nullified the beneficial effects of the substantial increase in food grain production from 108 million tonnes in 1970-71 to 192 million tonnes in 1990-96 and 198 million tonnes in 1997 (Rao, 1998, Manorama Year Book, 1999). According to the India Year Book (1999) at present the population has exploded to 975.8 million. More food and other agricultural commodities will have to be produced from less per capita arable land and irrigation water, first, to meet the needs

of the growing population and second, to combat the under nutrition and malnutrition currently prevailing among 250 million children, women and men. To raise the production of food grains it is essential to expand the area under cultivation and identify, cultivate and popularize new foods which can augment the food availability and also enhance the food quality (Khader, 1997).

According to Swaminathan (1996), productive improvement in agriculture is both an economic and ecological necessity in predominantly agricultural developing countries like India. It is an economic necessity because, under conditions of small holdings, the income of a farm family can be enhanced only through greater marketable surplus and through multiple sources of income. These multiple sources are an ecological necessity, otherwise the remaining forests may be cleared for crop cultivation.

Urbanization of rural areas and migration of the rural population seeking greener pastures have had a serious impact on agricultural production mainly because of reduced availability of land and labour.

Unemployment has been another chronic problem to Indian economy which has reduced people to poverty and malnutrition. Reddy et al (1993) affirm that the problem of malnutrition stems from poverty, ignorance and uncontrolled population growth. Malnutrition in terms of protein deficiency is becoming a major hazard in developing countries like India. The problem of protein hunger has become more and more acute and the best source of protein is beyond the reach of the poor who form a large proportion of the population (Chakravarthy, 1993).

Various developmental efforts have started yielding results and there is now a much greater understanding of both the nature of rural poverty and the characteristics of the poor. Lakshminarasiah (1993) points out that, in general, the majority of the poor are landless agricultural workers and small farmers. Sekar et al (1995) opine that the poor in India are frequently found in areas where dry land farming is practised. Dryland comprises 10 million hectares or about 70 per cent of the total arable land of 14.8 million hectares. According to Rao (1998), from the available land 198 million tonnes of food grain is obtained. But, to feed every hungry mouth, 270 million tonnes of food grains are necessary (Basu, 1997). Increase in food production is expected to increase agricultural wastes simultaneously, which are presently estimated to be about 600 million tonnes (Samanta and Patro, 1996). These residues are resistant to degradation because they contain mainly cellulose, hemicellulose and lignin (Chadha and Sharma, 1995). Hence, Prakasam et al (1998) suggest the starting of agriculture related entrepreneurship activities using agricultural wastes as the raw material in order to improve the status of living of the agriculturists, so that they need not be totally dependent upon cultivation of crops alone.

Dhanda and Kakkar (1996) stress that it is also imperative and relevant to improve the technology for increased biological efficiency of the agricultural wastes so as to make use of available resources.

The standard and quality of life depend upon the fundamental process of managing both human and non-human resources. Bharathi

and Jacintha (1994) view resources as means for achieving goals. Rice and Tucker (1986) classify resources as human resources, economic resources and environmental resources.

According to Varghese et al (1994) family resources are the means for meeting the demands of the family system. Money, which is a significant resource among non-human resources, economic or material resource, serves as a measure of the value of resources and is a resource by itself. Deacon and Firebaugh (1988) state that money has a strategic role when decisions are made about total resources. They are the fibres from which much of a person's life style is woven. For better and healthy homes one should have a balance between income and expenditure (Reddy and Venkataraman, 1995). When the income flow is uneven, it causes greater management difficulties to meet daily necessities. The management problem of families with irregular employment and uncertain wages is that they push goals aside and needs forward. Among the several sectors of unorganised workers, agricultural workers constitute a major section.

Thus, the need of the hour is to formulate an effective, efficient and result-oriented strategy which can divert the resources and the energy of agricultural workers to develop alternative sources of employment and ensure quality food production by utilizing the agro-wastes. Anything which does not demand too much land, costly seeds, fertilizer, irrigation input, should be the choicest approach in the village (Madan, 1994).

Sharma and Chand (1992) point out that mushroom cultivation is one of the most promising enterprises capable of recycling agricultural waste, generate new employment opportunities, augment income without competing for large land space and produce highly nutritious food which has a place in the domestic market. In this context, popularising mushroom, widely known as "vegetable meat", "indoor blooming" and "wonder vegetable", is of paramount importance (Lakshmanan, 1997 Sarala, 1997 and Kannan et al., 1993).

Mushrooms are large reproductive structures of edible fungi belonging to the class either Ascomycotina or Basidiomycotina (Chadha and Sharma, 1995). They are non-green fungal plants occurring seasonally all over the world in various habitats, being one of nature's marvels with their attractive umbrella-like structure and stalk. They occur in open fields, meadows, marsh edges, farm yards, in fact widely seen in every available corner of land. The mycelium can be dormant for years and only when conditions are suitable mushrooms prop up suddenly, specially in the winter seasons.

Mushrooms comprise a large heterogeneous group occurring in various shapes, sizes and colours-all quite different in character, appearance and edibility. On account of a very high domestic demand and over exploitation of natural flora and fauna, the reserves of wild mushrooms are not only fast turning to a rarity but also are facing the threat of extinction from the fragile ecosystem. However, all mushrooms are not edible, and some are

highly poisonous too. The toxic/poisonous species have led to fear, distrust, inhibition and a certain amount of taboo towards mushroom-eating. Hence, mushroom-eating could not be popularized till artificial cultivation was successful (Verma, 1998). Mushrooms are now cultivated under controlled conditions and are in great demand for human consumption.

More than 2000 edible species of mushrooms are known to be available all over the world, out of which about 200 species belonging to 70 genera are reported from India and about 80 have been grown experimentally, 20 cultivated commercially and four to five species produced on large scale throughout the world (Chadha and Sharma, 1995). Among these species, three mushrooms namely, white button (*Agaricus bisporus*), oyster (*Pleurotus*) and paddy straw (*Volvariella*) mushrooms are cultivated in India on a commercial scale (Lalkaushal and Sharma, 1995).

Of the few varieties stated above, button mushroom is more popular in hilly regions and constitute 85 per cent of the mushroom produced in India (Chadha and Sharma, 1995). The cultivation of paddy straw mushroom started five decades ago in India, yet its pace of development has not accelerated, in spite of favourable tropical and subtropical conditions for its cultivation.

The oyster mushroom is grown in heat resistant plastic bags containing pasteurized substrates such as saw dust, cotton waste, rice straw, sugarcane bagasse, banana stem, banana leaf and water hyacinth. The robust and delicious oyster mushroom is known for its adaptability and can be

grown with less care when compared to button mushroom (Satyasundaram, 1995). Oyster mushrooms are also ideal for cultivation in tropical and subtropical regions having a short life span and maximum bioefficiency (Seetharaman et al, 1998).

In Tamil Nadu, a new variety of mushroom *Calocybe indica* commonly known as milky mushroom APK 2, has been released in Aruppukottai during 1998. It has attracted the attention of many mushroom growers in India particularly in the plains because of robust size, colour, taste, simple cultivation technology, low cost of production, high market value, long shelf life and high nutritive value. It is speculated by Mitra and Purkayastha (1995) that *Calocybe indica* will certainly occupy a unique position in the ever growing arena of mushroom industry in the plains of India in future due to its suitability for cultivation throughout the year, abundant availability of varieties of substrate, simple cultivation technology, higher productivity and economic returns. Verma (1996) declares that as a result of increase in the production of mushrooms under controlled conditions and the knowledge about their nutritional qualities, the addition of mushroom in the regular diet is becoming popular now.

Since mushroom cultivation cannot be completely automated, it requires a work force which India has in plenty in the form of unemployed youth, women and dry land farmers. Thus, it will create ample scope for generation of self employment among all segments of population. It may also

help to cope with under-employment, malnutrition and poverty. Gurumoorthy (1994) affirms that popularising mushroom cultivation in the rural areas as a viable entrepreneurial activity and a subsidiary occupation to the agriculturists, will greatly help in improving the income, health and general economy of the rural people. Singh and Sarhadi (1997) opine that mushroom cultivation will provide work for farmers during winter months when the farming activities are light. Savithri et al (1993) state that mushroom cultivation is a suitable entrepreneurship especially for unemployed rural women, as they are concentrated in the lowest paid occupation and are more vulnerable to unemployment than men, provided, efficient technical guidance, timely initial support and proper motivation are given to them. According to Khader (1997), mushroom cultivation can be taken up by rural women to have a supplementary income, as the technology is simple and requires low investment and space.

Mushrooms have rightly been recommended by the Food and Agricultural Organization (FAO) as a food, with delicious flavour and biting texture with good sources of vitamins and minerals. They are low caloric, cholesterol free, high fibre and good quality ash food. These attributes make mushroom a dieter's delight.

Mushroom cultivation produces more food per unit area and gives higher productivity than any other form of agriculture at present available (Singh et al, 1992). Being an indoor crop, it has the added advantages of utilizing the aerial space and does not compete with agricultural land (Das, 1997). Moreover, mushroom cultivation, which is based on recycling of

agricultural residues, leads to the utilization of accumulated agricultural waste. Madan (1994) points out that mushrooms break down the complex substrates like lignin and cellulose by the wide range of enzymatic activities. With the help of biotechnical approaches the agrowastes can be recycled for the production of food, feed, fuel and fertilizer. Harendarraaj (1988) is of the view that if only 0.5 per cent of the organic materials are utilized they could be converted into 3,00,000 tonnes of nutritious table delicacies, leaving the residue to be used as organic manure. Medicinal uses of mushrooms are also worth mentioning. A large number of edible and cultivated mushrooms have gained much importance in modern medicine for their various pharmacological qualities like antibacterial, antifungal and antiviral. As a food, as a tonic and as a medicine the entire creation is precious, according to Chang (1994). Tiwari (1993) reiterates that there is a very high domestic demand for mushroom because of relatively low price, high nutritional value, delicious taste and medicinal value. Thus, in recent days, mushroom as a vegetable has caught the imagination of the elite society. Without the inclusion of mushroom no menu is considered to belong to a five star culture (Raj, 1988).

To cater to the increasing demand for mushrooms, more and more entrepreneurs are taking up its cultivation. Besides being a short duration crop it brings handsome returns with minimum investment. Thus, mushroom cultivation on a commercial basis may be highly profitable. Despite the availability of raw material, suitability of agro-climatic conditions and employment possibilities, mushroom growers are facing problems due to low

productivity, non-availability of credit, quality spawns, infection by insects and moulds, fluctuating temperature and humidity, inadequate knowledge of the technology, improper marketing network, and short shelf life of mushrooms (Satyasundaram, 1998).

Mushrooms being perishable in nature, are to be disposed off or consumed within a day or two. If stored in perforated polythene bags in a refrigerator they remain fit for another day. Growers often find it difficult even to recover the cost of production if not immediately sold (Sharma, 1995). Kohlii (1991) and Saxena (1998) also indicate that guidance is not available from researcher/training institutions about the handling of the produce to make it reach the market in an attractive form. Hence, Kohlii (1991) stresses the need for some suitable system to be developed, wherein fresh mushrooms at the shortest time interval after harvest, could be collected and made available, either fresh for consumption or for processing, thereby ensuring remunerative price to the grower. Dehydration by sun-drying is considered to be appropriate for our country. The fruit bodies can be sun-dried when the temperatures are high with relatively low humidity.

India, primarily being an agricultural country, offers vast potential for mushroom cultivation due to suitable climate, availability of raw materials and cheap labour. Hence, it can be profitably started by landless farmers, unemployed youth, women and other entrepreneurs. It requires less land and even air space can be utilized for its production. It is basically an indoor activity (Vijay and Gupta, 1994). Savithri et al (1993) also stress the

fact that mushroom cultivation can even be taken up by resource-poor illiterate rural women if they can be backed up with efficient technical guidance, timely initial support and proper motivation. Besides the available standard substrates like paddy straw, mushroom cultivators do not make any attempt to utilize other types of available wastes as substrates such as banana stem, leaf, sugarcane bagasse or try to enhance its yield by adding various supplements to the substrates. Hence the investigator has taken up this study with the following objectives:

1. Collecting information regarding methods of cultivation, expenditure involved, preference for variety, extent of sale and utilization by selected cultivators, shopkeepers, restaurants and households located in the cities of Coimbatore and Erode
2. Finding out the possibilities of increasing the yield of mushroom using agrowastes like paddy straw, banana stem, banana leaf and sugarcane bagasse and selected supplements
3. Analysing the bioefficiency, NPK (nitrogen, phosphorus and potassium content) of the spent substrates and cellulose, lignin and hemi cellulose content of fresh and spent substrates
4. Evaluating the keeping quality, nutrient content and acceptability of mushrooms and
5. Introducing mushroom cultivation as an income generating activity among selected women and assessing their profit margin

Thus the study envisages bringing to the lime light the existing bottle necks in mushroom cultivation to help potential cultivators to overcome the constraints, identify the best substrates and supplements along with cost effective marketing techniques. It is also hoped that this research will pave the way for self employment among women by recycling agrowastes to turn nature's delight into a table delicacy.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

The study on, "Exploring the Possibilities of Enhancing the Yield of Mushroom and Introducing it as a Self Employment Avenue" is reviewed under the following titles:

2.1. Evolution of mushroom as a food commodity

- 2.1.1. Mushroom in ancient times
- 2.1.2. Emerging trends in mushroom cultivation
- 2.1.3. Present status of mushroom cultivation and consumption

2.2. Mushroom as food and medicine

- 2.2.1. Acceptability of mushroom as food
- 2.2.2. Nutritive value of mushroom
- 2.2.3. Role of mushroom in alleviating certain health problems

2.3. Mushroom cultivation as an entrepreneurial activity in India

- 2.3.1. Types of mushroom
- 2.3.2. Techniques involved in cultivating mushroom
- 2.3.3. Constraints in the production of mushroom
- 2.3.4. Availability and utilization of agrowaste for mushroom cultivation
- 2.3.5. Economics of mushroom cultivation

2.4. Influence of substrates on the yield of mushroom

- 2.4.1. Requirement of substrates for cultivating mushroom
- 2.4.2. Substrates used for cultivating mushroom

2.5. Enhancing yield of mushroom

- 2.5.1. Supplements used in white button mushroom cultivation
- 2.5.2. Supplements used in oyster mushroom cultivation
- 2.5.3. Supplements used in milky mushroom cultivation

2.6. Preservation and storage of mushroom

- 2.6.1. Need for preservation
- 2.6.2. Quality parameters in mushroom preservation
- 2.6.3. Physical changes of mushroom on maturation
- 2.6.4. Methods of extending the storage life of mushroom

2.1. Evolution of mushroom as a food commodity

2.1.1. Mushroom in ancient times

Tiwari (1993) and Singh et al (1995) state that, the word “Mushroom” is thought to be derived from the French word ‘mushroom’, ‘mouse’ or ‘moss’, meaning a fungi. Mushroom as a food for the elite has been known since a long time (Tiwari, 1993 and Rai, 1995). Evidence on the use of mushrooms as food and medicine has been found in the inscriptions, sculptures and scriptures of many ancient civilizations. The Greeks believed that mushrooms gave strength to the warriors (Seetharaman et al, 1997). According to Prasad (1997) and Verma (1998) the ancient Greeks and Romans, considered mushroom as a royal dish and as 'divine flesh'. The Pharoahs of ancient Egypt evinced a keen liking for mushrooms. Chinese and Japanese chronicles indicate that the mushroom collected in the wild forest was given to emperors as a tribute (Peter Oei, 1991).

The knowledge about the use of mushroom in India dates back to the very early Vedic times, when it was thought to possess super natural powers and a holy means of communication with God (Lakhanpal, 1994 and 1995). Soma pana, a juice mentioned in the ancient Indian literature 'Rig Veda' was an extract of mushroom (Lakhanpal, 1995). The vedas have also exalted them as "Food for the Gods" (Raj, 1988). Chandra (1992) quotes from Valmiki Ramayana, where Lakshman broke the bow just like "Chatra from field " chatra is the sanskrit name for mushroom.

2.1.2. Emerging trends in mushroom cultivation

From ancient times mushrooms have been harvested from nature (Tiwari, 1993 and Rai, 1995). Their edibility was known through experience or word of mouth (Quimo, 1985). Cultivation of mushrooms on wooden logs was first started in Japan about 2000 years ago. Almost at the same time it was started on straw in China and other Asian countries (Kohlii, 1990). Around 1650 A.D., a French man also cultivated mushrooms in caves and lime stone pits, where suitable dampness and darkness and minimum temperature fluctuation were maintained (Harendarraaj, 1988). However, the cultivation of button mushroom (*Agaricus bisporus*) did not begin until the 17th century, (Tiwari, 1998). The accidental observation of a melon grower in France in the 17th century when a crop of mushroom appeared on melon beds fertilized with horse manure and irrigated with water, used for cleaning of mushroom harvested from nature, was the beginning of mushroom growing

in open fields under natural conditions. Mushroom cultivation rapidly spread after the Second World War when reliable spawn was readily available in a number of countries (Rai, 1995).

Kohlil (1990) states that mushroom cultivation developed in India during the late 17th century while methods of cultivation developed at a slow pace until before the middle of 20th century. India started organised efforts towards mushroom cultivation in 1939 in the Madras region. Chandra (1992) and Sharma (1998) indicate that paddy straw mushroom cultivation was first attempted in India at Coimbatore in 1943 by Thomas and his associates. Since then “straw mushrooms” have been cultivated in Tamil Nadu. In 1961 the Indian Council of Agricultural Research (ICAR) started a scheme to develop mushroom cultivation in Himachal Pradesh at Solan. The developmental effort was later extended to the whole country (Kohlil, 1990).

In India, *Pleurotus flabellatus* (oyster mushroom) cultivation was first standardized by Bano and Srivastava in 1962. The first domesticated species of this mushroom was *P.ostreatus* followed by *P.sajor caju*, (Balakrishnan and Nair, 1995 and Verma 1998).

After 1950 there was a fast growth in the cultivation technology of button mushrooms and that of other mushrooms in 1970's (Kohlil, 1991). In 1970's scientists standardized the procedure for mushroom cultivation and in November 1977 the Government of Himachal Pradesh, in collaboration with United Nations Development Programme (UNDP), established a Mushroom Centre at Solan to provide technical know-how to emerging potential

entrepreneurs. Commercial cultivation picked up later and cultivated mushrooms found their way into the market (Tewari and Kapoor, 1988). It is now possible to grow white button mushroom (*Agaricus bisporus*) at any elevated place (Dhar, 1998).

Singh et al (1995) estimate around 38,000 mushroom varieties in existence. According to Chadha and Sharma (1995), among them of more than 2000 edible species, 300 species belonging to 70 genera are reported from India. Out of 2000 species about 80 have been grown experimentally, 20 cultivated commercially on small scale while four to five species are produced on industrial scale throughout the world. Among the edible varieties white button, oyster and paddy straw mushrooms are popular (Chang and Miles, 1991 and Prasad, 1997). However, commercial cultivation of paddy straw mushroom is yet to become a reality in India (Verma, 1998). In India *Calocybe indica* or milky mushroom was artificially cultivated first by Purkayastha and Chandra in 1974 and then by Doshi in 1987 (Sharma et al., 1994 and Upadhyay, 1998).

The fleshy, spongy button like umbrella-shaped members of fungi kingdom are being used with great penchant in cuisines all over the world today. The connoisseurs of food, love mushrooms for its fine, distinct taste and versatility of usage among a variety of food items. Mushrooms command a high price in the market today, and growing mushrooms at the household level today has indeed become a lucrative business (Prasad, 1997).

2.1.3. Present status of mushroom cultivation and consumption

Mushrooms are one of the most mysterious life forms (Lakhanpal, 1995). Globally speaking the past thirty years [1960-1990] have brought amazing changes and development in the mushroom industry, in terms of size, technology, productivity, product and market acceptance.

According to Chadha and Sharma (1995) mushrooms are being cultivated in about 100 countries with an annual production of 3.763 million metric tonnes per year. United States of America is the largest producer with 21 per cent of the world production, while China and France accounted for about 14 per cent and 12 per cent respectively (Indian Food Packer, 1994). While mushrooms are cultivated in almost every country today, Europe, North America and Eastern Asia produce 97 per cent of the button mushrooms grown in the world. Production of button mushroom ranks high followed by oyster mushroom, shitake, auricularia and paddy straw mushroom (Singh et al., 1995).

Chandra (1992) Singh et al (1992) and Phutela and Gupta (1995) affirm that mushroom cultivation in India has witnessed a tremendous change during the last two decades, in terms of types and strains of mushroom cultivated, scale of cultivating, geographical regions, growing period, technology and growing systems. Besides a large number of small and medium sized seasonal mushroom growers, big commercial units have commenced production. Thus, the production of mushroom has gone up significantly

from 100 tonnes in 1970 to 1000 tonnes in 1981, 12,000 tonnes in 1992 and 15,000 tonnes in 1995 and at present it is about 3,93,000 tonnes. However, India does not figure on the International scene (Singh et al., 1995 and Sharma, 1998).

At present three types of mushrooms namely, white button (*Agaricus*), oyster (*Pleurotus*) and paddy straw (*Volvariella*) are cultivated in India on a commercial scale. According to Vijay and Gupta (1995), button mushroom was mainly cultivated in the states of the Northern hills, Jammu and Kashmir and Himachal Pradesh upto 1985 while many growers now in the Central and Southern India especially Tamil Nadu, Karnataka, Kerala, Andhra Pradesh and Maharashtra have shown keen interest in the cultivation of mushroom on a large scale. Bangalore, Chennai, Coimbatore, Hyderabad, Munar and Ootacamund are the mushroom producing centres in South India as indicated by Chadha (1994) and Chadha and Sharma (1995). Paddy straw mushroom are cultivated out doors in India following primitive production technology with very low biological efficiency (Sharma, 1998)

According to statistics, India has now four mushroom farms with access to modern technology and having a combined capacity of producing 8,050 metric tonnes per year. Four more farms having a total capacity of 10,600 metric tonnes per year will be set up while 20 more companies have registered for mushroom cultivation (Food Digest, 1993).

Krishnamoorthy and Muthuswamy (1996) reveal that button mushrooms are cultivated in Tamil Nadu by two big industries namely, Ponds

India Limited at Ooty and Saptharishi Agro Products at Chennai. The majority of the produce is exported and only very little is sold in the local market. At present, white button mushroom constitutes about 85 to 90 per cent of the local mushroom production in the country, followed by oyster and paddy straw mushroom. Jandaik et al (1993) report that cultivation of *Pleurotus* (oyster mushroom) had increased dramatically during past five years and presently occupies the second position accounting for about 24 per cent of the global production. According to the report given by Indian Food Packer (1993) and Chadha and Sharma (1995), production of oyster mushrooms in Tamil Nadu alone has been estimated to be about 3500 metric tonnes per annum. However, according to Sharma (1998) paddy straw mushrooms are cultivated outdoors in India following primitive production technology with very low biological efficiency. Metha (1993) highlights the need to channelize the production and marketing and to assess the export potential for mushroom from India.

The consumption pattern of mushroom is also very interesting because six countries, U.S.A., France, Italy, Germany, U.K. and Canada account for 85 per cent of world wide consumption. The rest of the world consumes the balance 15 per cent (Bullman, 1993). The average per capita mushroom consumption in major countries in 1990-varied from 2.42 kg to 7.06 kg while in India it is below 20 grams (Indian Food Packer, 1993 and Chadha and Sharma, 1995). Thus, Rai (1993) opines that mushroom erroneously dubbed as an exotic delicacy for the cuisine of the elite, has not reached the poor man's pot.

2.2. Mushroom as food and medicine

2.2.1. Acceptability of mushroom as food

Mushroom consumption is increasing rapidly due to its remarkable taste, flavour and nutritive value. Mushrooms have become the most popular non-conventional food accepted all over the world today. The increased consumer demand over the years has made its production escalate in large proportion (Singh et al., 1995 and Thakur, 1995). Vandana (1993) reveals that in India its demand is steadily increasing. As mushrooms are regarded as vegetarian meat they are ideal for inclusion both in vegetarian and non vegetarian diets. Bhandari (1996) reveals that glutamic acid present in mushroom imparts the meaty taste. Thus they are already popular in the big fast food chains and restaurants all over India.

Today, mushrooms are available in fresh and canned forms in the market. Fresh mushrooms are sold in transparent polythene bags. Mushroom that does not meet the visual requirements of size, uniformity and unblemished appearance is hardly ever accepted by the consumers (Miller, 1994 and Rodwell, 1990). Generally, the younger fruiting bodies are preferred for consumption (Lakhanpal, 1994). The maturity of mushroom is assessed, by the length of the veil or pileus and not by the largeness of the mushroom (Khader, 1996).

According to Krishnakumar (1997) and Jayaprakash (1998) mushrooms should be used immediately after harvesting and buying of decayed mushroom with offensive odour should be avoided. While purchasing

mushrooms, perforation for air circulation in the polythene bags should be examined. The fresh mushrooms should be stored in a cool place and used within 24 hours or kept in refrigeration if it is to be used a little later.

Mushrooms are becoming popular in the Indian menu with people realising their flavour and food value (Food Digest, 1993). According to Khader and Pandya (1997) mushrooms find a place even in weaning food formulations.

2.2.2. Nutritive value of mushroom

As mushrooms possess significant nutritional and medicinal properties they are being referred as nutraceuticals. The nutrient content of fresh *Agaricus* (button) and *Pleurotus* (oyster) mushroom, as stated by Chadha and Sharma (1995), include moisture (90.1 and 90.2 per cent), fat (0.3 per cent and 0.2 per cent) carbohydrate (5 per cent and 5.2 per cent), fibre (0.91 per cent and 1.3 per cent) ash (0.8 per cent and 0.6 per cent) and energy 36 and 35 calories respectively. The protein content of dried *Agaricus* (button) and *Pleurotus* (oyster) mushroom, according to Rai (1995), range between 19.4 and 37.1 per cent and 10.5 and 36.94 per cent. Calcium, phosphorus and potassium content in oyster mushroom range between 20 and 40 mg, 565 and 1850 mg and 2240 and 4660 mg per 100 g dry weight of mushroom. Yakin and Terkinson (1993) reveal that calcium and phosphorus present in button mushroom range between 1.64 and 1.86 mg, 0.52-1.01 mg per 100 g of fresh mushroom.

According to Krishnamoorthy et al (1998) *Calocybe indica* (milky mushroom) contains 32.3 per cent of protein, 0.7 per cent fat, 9.9 per cent carbohydrate and 41.1 per cent of fibre in 100 g of its dry weight.

According to Karunanithi and Santha (1996) and Prasad (1997) fresh mushrooms have a protein content of 3.2 to 3.7 per cent. However, in dried mushrooms when the moisture level gets reduced the protein level ranges between 20 to 40 percent. Pandey and Tiwari (1993) and Singh et al (1995) further emphasize that protein in mushroom is better as compared to vegetable protein. Its digestibility is about 90 per cent which is higher than that of spinach protein (7.3 per cent) but poorer than that of meat protein (99 per cent). Hence, it may be an answer to the protein malnutrition prevalent among the general population in most of the developing and under developed countries.

Afyon et al (1996) Karunanithi and Santha (1996) and Prasad (1998) emphasise that the protein of mushrooms is of high quality and rich in various essential amino acids except tryptophan. Peter Oei (1991) and Lakshman and Dharmalingam (1995) point out that oyster mushroom, besides its high protein content, has significant amounts of lysine and methionine, considered very valuable. Although mushroom ranks below most animal meat in crude protein content, its protein has greater biological efficiency.

Peter Oei (1991) Vyas et al (1994), Poongodi and Sakthisekaran (1995) point out that mushrooms are low in carbohydrate (4-5 g/100 g) and fat (200 to 800 mg/100 g) content. However, they contain significant amounts

of vitamins including thiamin, riboflavin, niacin, biotin, ascorbic acid, folic acid, pyridoxin and minerals like potassium, and phosphorous. Singh et al (1995) state that mushrooms have no cholesterol and are almost fat free (0.02 g/100 g). Mushrooms also contain copper and iron in abundance and they are generally in an available form (Sohi, 1996 and Verma 1996). The vitamins are well retained during cooking, canning, drying and freezing (Sohi, 1996). Their calorific content is only 30 to 50 per 100 g and as such could well be included in the daily menu for people who work more with their minds than with their hands (Balakrishnan, 1992).

2.2.3. Role of mushroom in alleviating certain health problems

Current trends in the cultivation of mushrooms emphasise their importance not only as food but also for its medicinal value and may be used in pharmaceuticals and even cosmetics (Chang, 1994). Chandrasekhar (1996) also reiterates that mushroom are valuable food, antibodies and producers of enzymes.

Of the 10,000 known species of mushrooms about 200 may have medicinal values (Saxena, 1998). *Lentinus edodes* (Shitake) contains antitumour, antibacterial, antifungal, antiviral and hypolipidemic agents (Moore et al., 1985, Balakrishnan, 1992 and Mascarenhas, 1994). Mushrooms also have anticholesterol and anti thrombic effects. Khanna et al (1993) prove that mushroom intake significantly decreases cholesterol and glyceride levels in plasma. Shitake mushrooms can help in preventing high blood pressure,

atherosclerosis, kidney ailments, diabetes, cataract, neuralgia, gall stones, numbness of the hands and feet, haemorrhoids and also improve sexual power. Subramanian, (1995) and Ganeshkumar et al., (1997) reveal that the crude fibre content in mushroom helps in digestive problems such as constipation. Mushrooms are used to extract mushroom flavours, mycoprotein, proteolytic enzymes, extraction of some medicinal compounds, preparation of tonics, cosmetic products and health drinks (Kapoor, 1989, Chang and Miles, 1993, Chaudary, 1993 and Singh et al., 1995). Mehta (1994) indicates that black ear mushroom (*Auricularia*) has been used in Chinese medicine for curing sore throat, anaemia and digestive disorders like piles. Kobe (1995) and Jayaprakash (1998) state that a mushroom known as *Lentinus edodes*, which is very expensive, (Rs. 6000/ kg) controls the virus causing AIDS.

At present, China manufactures twenty commercial medicines from mushrooms of which, anticancerous, liver protective agents, recuperating agent for stomach and intestine, medicine for stimulating the bile secretion, sedative and antiradiation drugs are widely used. Ayurvedic practitioners of Kerala use preparations of *Nila manga*, an underground mushroom as an effective medicine for ailments like ear ache and jaundice (Balakrishnan, 1992).

Lakshmanan and Dharmalingam (1995), Lakshmanan (1995) and Karunanithi and Santha (1996) opine that due to the high fibre content, mushrooms can be recommended for people suffering from piles. Calcium and phosphorus content help to reduce the chances of dental diseases and the

high amounts of folic acid and iron help to reduce anaemia. Karunanithi and Santha (1996) and Lakshmanan and Dharmalingam (1996) consider edible mushroom as safe and complete food, as they do not have residues of pesticides which are hazardous to health. Due to its high calcium and phosphorous content it is recommended for even tuberculosis.

Peter Oei (1991) state that *Hericum erinaceus* stimulates immune responses and strengthens the patients after an operation. An extract from the mycelium of *Ganoderma lucidum* decreases the excitement of the nervous system. The patients will sleep better, feel healthier and have a better appetite after taking *Ganoderma* pills.

Thus, mushroom is believed to be a treasure chest of immune regulating compounds. Mushroom is known as the “mushroom of immortality” in Japan and the “longevity mushroom” in Korea. It is effective in curing progressive malnutrition of muscles and muscular atrophy (King, 1993).

Inclusion of mushrooms *Agaricus bisporus*/*Pleurotus florida* at 5 per cent or 10 per cent level in hyper cholesterolemic diet for rats resulted in lowered plasma total lipid cholesterol and glyceride levels without any effect on phospholipids (Soni et al, 1994).

The maitake mushroom (*Gifola frondosa*) indigenous to Japan known as “Chicken of woods” is promising to be very effective in preventing and treating malignant tumours and HIV. (Asanovic, 1996). Horio and Ohtsuru (1995) proved that the blood glucose levels, water consumption, urine volume

and glucosuria significantly decreased in diabetic rats fed on maitake mushroom. Bobek et al (1994) revealed that fresh and dried oyster mushroom extracts significantly decreased the concentration of cholesterol and triacyl glycerols in serum and liver.

2.3. Mushroom cultivation as an entrepreneurial activity in India

2.3.1. Types of mushroom

There are about 20 genera of mushrooms being cultivated throughout the world as a food. In India, only three, viz., white button or European mushroom (*Agaricus bisporus*), oyster or tropical mushroom (*Pleurotus* species) and paddy straw or Chinese mushroom (*Volvariella volvacea*) are grown commercially (Chinnadurai, 1994, Lal Kaushal and Sharma, 1995). Milky mushroom APK-2, an entirely different species namely, (*Calocybe indica*) was released on 8th January, 1998 as Pongal gift (harvest festival) for the farmers (Krishnamoorthy et al, 1998).

Oyster mushroom, popularly known as “dhingri” in India is one of the most suitable fungal organisms for producing protein rich food from various agro-wastes without composting (Upadhyay, 1998). The fruit body or shell are oyster-shaped with different shades of white, cream, grey, yellow, pink or light brown depending upon the species (Verma, 1998). According to Mathai (1996) the different oyster mushroom species have been identified and introduced among which, some appear to be very promising and suitable for large scale cultivation. They are *Pleurotus sajor caju*, *P. florida*, *P. citrinopileatus*, *P. platypus*, *P. ostreatus* and *P. opuntiae*. *P. sajor caju* which have a high yield, are highly palatable and nutritious, have a long shelf life and

are tolerant to high temperatures, when compared to other species. Tamil Nadu Agricultural University (TNAU), Coimbatore, has introduced a new high yielding oyster mushroom (Ooty 1) for commercial cultivation by the farmers in the hilly region (The Hindu, 1998). In new edible variety P.djamor boedjin, collected from wastes of oil palm bunch with large sporocarp, high nutritive value has been identified (Geetha et al, 1995). Its colour, odour texture and acceptability are better than C01 introduced by TNAU, Coimbatore (Sivaprakasam and Seetharaman, 1997).

The paddy straw mushroom which belongs to the genus *Volvariella* is an edible mushroom of the tropics and sub-tropics. More than 100 species, sub-species and varieties of *Volvariella* have been described throughout the world, but four species, namely *V. esculenta*, *V. bakeri*, *V. displasia* and *V. volvacea* are reported to be cultivated in Asia and Africa. In India 13 species of *Volvariella* have been recorded. Of these, only three species namely, *V.volvacea*, *V. displasia* and *V. esculenta* have been cultivated (Khanna, 1995). The straw mushroom can be raised on a number of crop residues but the most suitable substrate is paddy straw. It has a short shelf life of a day at ambient temperature but can be easily sun-dried and stored for six months, without greatly compromising on its taste, flavour and aroma (Phutela and Gupta, 1995). Prakash and Tejaswini (1991) point out that though India has an ideal climatic condition, availability of plenty of raw material and simple cultivation technology, to-date there is hardly any farm which has taken up straw mushroom cultivation on a commercial scale.

Krishnamoorthy and Muthusamy (1996 and 1997) state that mushroom cultivation in Tamil Nadu has witnessed a tremendous change in recent times in terms of newer types and strains of mushrooms and cultivation techniques.

White button mushrooms (*Agaricus bisporus*) account for more than ninety per cent of production in India (Sethi et al 1991). Places like Chaile, Shimla, Manali and Himachal Pradesh in North India are suitable for cultivation. Similar possibilities exist in Nilgiris and Pulney hills in South India (Seth, 1987). *Agaricus bitorquis* a high temperature tolerant white button mushroom, highly resistant to virus, with a higher concentration of CO₂ in the cropping room and having superior shelf life was successfully tried at Solan, Himachal Pradesh (Dhar, 1998).

Cultivation of milky mushroom was introduced by Purkayastha and Nayak in 1981. Later on Doshi et al (1988) identified improved cultivation technology. While in 1993 its cultivation techniques were further simplified and tested at grower's level with good biological efficiency. Doshi and Sharma (1995) and Mitra and Purkayastha (1995) hope that this mushroom has a very good scope for further cultivation and can replace the other tropical mushrooms like *Pleurotus* spp. and *Volvariella* spp. in future.

Apart from the commercially popular mushrooms stated above, Gokulapalan (1994) adds other edible mushrooms namely shaggy ink cap (*Corpinus* spp.) strophaire mushroom (*Stropharia rugosoannulata*) and

enokitake (*Flammulina velutipes*) which are amenable to cultivation. Doshi and Sharma (1995) add *Auricularia polytricha* (black ear) and *Lentinus edodes* (Shitake) to the list. The mushroom called shaggy ink caps is typically characterised by its short-lived pileus or cap which liquifies into an inky fluid within hours of its maturity. This mushroom can be cultivated on a wide variety of substrates in a temperature regime of 35-40° C. The *Strophaire* mushroom is also called “Garden Giant” or “Giant mushroom” because of its large size and is a very popular mushroom in many European countries due to its ease of cultivation and resistance to pest and disease. *Flammulina velutipes* known as the winter mushroom is mainly cultivated in Japan and Taiwan. The mushroom cap is usually yellowish-brown with a light brown margin.

Morchella, commonly referred to as Guchhi in India, is the costliest and most sought after edible fungus in the world. It has been consumed by man because of their excellent and pleasant flavour and gastronomical qualities. In India, till date there is no report on the production of fruit bodies under experimental condition. However, scanning of literature revealed that many researchers have succeeded in its production under experimental conditions (Jandaik and Sharma, 1995).

Shitake (*Lentinus edodes*) has been grown for thousands of years in Asia. It is the third largest mushroom cultivated for its unique taste and flavour (Jandaik and Sharma, 1995 and Sharma, 1998).

2.3.2. Techniques involved in cultivating mushroom

Mushroom cultivation is usually divided into indoor and outdoor growing techniques. Outside cultivation requires low investment, but has little control over environmental factors, while indoor cultivation is expensive. The techniques to be followed in cultivation of mushrooms are as follows:

Production of mushroom on wood log is very similar to the growth of the Shitake mushroom in nature. Inter-cropping of mushrooms with other crops is also possible. Auricularia is grown in rows between sugarcane in China (Peter Oei, 1991).

A simple shed with metal pipe and plastic cover and concrete building can also be used for this process (Peter Oei, 1991). Production of button mushroom (*Agaricus*) consists of composting, spawning, casing and harvesting (Tiwari, 1993). *Agaricus* are cultivated on fermented substrate, consisting of carbon, phosphorus, sulphur, potassium, iron and vitamins such as thiamine and biotin for its growth (Vijay and Gupta, 1995). All the nutrients are mixed and fermented to form a substrate called composting. The compost is a mixture of animal manure, carbohydrate nutrients, nitrogenous fertilizers and concentrate meals such as wheat or rice bran, meals of cotton seed, soya, castor, mustard and linseed (Gupta and Vijay, 1992). In order to rectify the mineral deficiencies fertilizers such as potash, super phosphate, gypsum and calcium carbonate and other trace elements are also added. Composting can be done either by long method of composting (28 days) or short method of composting 14-18 days. Button mushroom can be cultivated either in shelves

made of polythene sheets spread on bamboo frames (known as shelf system) or in wooden trays or in polythene bags. These bags are most popular because they are low cost, easily disposable, and have minimum chance of contamination (Shandilya 1988 and Upadhyay and Vijay, 1988).

Ravishankar et al (1997) surmise that in order to prepare spawns, other than using maize corn, wheat and bajra immatured paddy which is a waste could also be used.

Mixing of spawn (seed) in fully prepared compost is called spawning. During spawn-run (growth of mushroom mycelium), higher concentration of carbon-dioxide is desirable and ventilation is kept at the minimum. An optimum temperature of $23 \pm 2^{\circ}\text{C}$ should be maintained with a relative humidity of 85-90 per cent during this stage (Vijay and Gupta, 1995).

Once the spawn-run is complete, the compost surface is covered with a layer of casing soil. The material used for covering the compost is not nutritionally as rich as compost, but conditions of stress necessary for induction of fruit bodies are created (Vijay and Gupta, 1995). It should have high porosity and very high water holding capacity (Gupta, 1998). During this stage control of air temperature (16°C - 20°C), relative humidity (85-95 per cent) and carbon dioxide (0.08-0.15 per cent) in the cropping room is important.

The first small mushroom pin heads are usually spotted 7-10 days after casing and first picking of the crop is done between 8-10 days later (Binani, 1993 and Tiwari, 1993).

Production of oyster mushroom involves preparation of substrate, spawning and harvesting. The substrates which are cut into small pieces are prepared either by steam pasteurisation, hot water treatment or chemical treatment, using formalin and bavistin in substrate soaking water (Balakrishnan and Nair, 1995). Chitale and Singh (1995) noticed significant increase in the yield by treating the substrates with 0.1 per cent bavistin. Different types of containers such as earthen pots, wooden trays, bamboo basket, gunny bags and polythene bags are common. Among these polythene bag was found to be the best. Spawning is done simultaneously when the substrate is filled in polythene bags.

After completion of the spawn-run (growth of mycelium) in the substrate (usually 10-25 days) the polythene bags are removed and congenial temperature ($25 \pm 5^{\circ}\text{C}$) and proper humidity (80-90 per cent) are maintained. The beds are either stacked in shelves or hung on a rope. Cross but not very heavy ventilation is required at this stage. Light is also very essential for the fruit body formation. Small fruit bodies begin to appear within a week of providing aeration and light in the room. The optimum time for picking is just before the margins of the sporocarp roll inwards (Balakrishnan and Nair, 1995).

In India straw mushroom is exclusively cultivated on paddy straw. In South India atleast 10-12 crops can be taken throughout the year. The beds are spawned in between the layers of paddy straw with spawns. No

ventilation is required in the room till the small buttons appear. However, the beds are watered regularly till the end of the crop by sprinkling water once or twice a day all around depending upon the weather. Mushroom buttons start to appear in clusters from all the sides after 8-10 days and are harvested by about the third week (Khanna, 1995).

For cultivating milky mushroom, sterilized wheat/paddy straw is used. It can be easily grown in temperature ranging between 25-35° C and requires a humidity level of 80 per cent (Doshi and Sharma, 1995). After 10 to 12 days of spawning, mycelial growth on the bed will be seen. Then it is cut in the centre and in each 1-2 cm height of casing soil (garden soil, rich in calcium content) is covered. A moisture content of 50-60 per cent is maintained. Within 8-10 days the buds start appearing and will be ready for harvest within 6-8 days. The comparison of three common species of mushroom presented by Krishnamoorthy et al (1998) is given in Table 1.

TABLE 1
THE COMPARISON OF THREE COMMON TYPES OF MUSHROOMS
IN TAMIL NADU

Characteristics	Oyster mushroom (<i>Pleurotus</i> spp.)	Button mushroom (<i>Agaricus bisporus</i>)	Milky mushroom (<i>Calocybe indica</i>)
Raw material required	Dried straw	Dried straw and compost	Dried straw
Temperature required	20-30° C	15-25° C	25-35° C
Crop cycle	30-45 days	85-100 days	45-50 days
Time taken for initial harvesting	10-25 days	60-70 days	25-28 days
Bioefficiency	80-180 %	30-35 %	143 %
Production cost/kg	Rs. 15	Rs. 30	Rs. 20
Selling price/kg	Rs.40	Rs.80	Rs.80
Approximate profit/kg	Rs.25	Rs.50	Rs.60

Besides the three commonly cultivated mushrooms in the country, Doshi and Sharma (1995) suggest taking serious efforts to evolve low cost production technology for other types of mushroom also.

2.3.3. Constraints involved in the production of mushroom

While it is generally felt that mushroom cultivation can stabilize the farm income through an Integrated Farming System, closure of many existing mushroom farms is noticed due to lack of finance, poor quality spawns, abiotic factors, biotic factors and difficulties in marketing (Sivaprakasam and

Seetharaman, 1995, Pandian et al., 1996 and Lakshman and Dharmalingam, 1996). However, emergence of new farms are also increasing rapidly (Pandian et al., 1996).

2.3.3.1. Non-availability of credits

Mushroom growers often experience a lot of difficulty in obtaining the financial support for cultivation of mushroom. Banks and other agencies do not take the risk of financing growers. Hence, Sivaprakasam and Seetharaman (1995) suggest that the financial agencies work out feasible norms in promoting short-term and long-term investment credit to promote the mushroom industry on a sound footing. Sandhu (1994) recommends that the venture be subsidised to get the entry of more entrepreneurs and to enrich the indigenous technology on mushroom cultivation by creating research and development faculty. Financial Express (1993) Mahalingam (1991) and Mahalingam (1994) reveal that in order to remove these constraints the Government has drawn up a new scheme to provide financial assistance for setting up spawn laboratories, and pasteurisation centres for compost, production and processing facilities.

2.3.3.2. Non- availability of quality spawn

One of the major problems which the mushroom growers face is the reduced availability of quality 'spawn'. Though there are a number of private agencies producing large quantities of spawn, they sell it at an exorbitant price. This forces the grower to step back from the field of mushroom business (Mahalingam, 1991).

Nair (1991) suggests that efforts should be made for easy availability of quality spawn. Singh and Bhatt (1997) feel that private business firms should come forward to make mushroom seeds widely available. Government agencies should also take the responsibility of preparing high quality spawn and supply it to small growers at a subsidised rate. To overcome the problem Pakela and Eicker (1997) developed dehydrated spawn which could be used after hot water treatment and incubation.

2.3.3.3. Biotic factors

Oyster mushroom cultivation is seriously affected by weed moulds which inhibit the spawn-run at various stages of growth, often resulting in failure of sporophore production (Sivaprakasam and Seetharaman, 1995). Sciarid flies, Phorid flies, Cecid flies, Spring tails and Staphylinid beetle, infest cultivated mushroom in India (Krishnamoorthy et al., 1991 and Sadhu, 1994 and 1995). Besides, insects and nematodes also play an important role in destroying mushroom (Thapa, 1994).

Mushrooms are also extremely sensitive to various biotic enemies like fungi, bacteria and viruses. Remedial measures comprising sanitation, cultural and chemical control, biological control and developing resistant strains may be of immense value (Kaul, 1994).

Pandian et al (1996) recommend provision of insect proof net in the windows, spraying of 10 ml malathion and 10 gm mancozeb dissolved in 10 litres of water around the house, safe disposal of infested and spent beds

far away from the place of cultivation. Selection of contamination free spawns, handling of disinfected materials, sprinkling of water collected from hygienic source, avoidance of excess watering, removal of affected or discoloured patches from the beds and swabbing with 0.15 per cent carbendiazin or 0.1 per cent mancozeb are also suggested.

Sometimes rodents destroy the mushrooms. Hence, Lakshmanan (1995) suggests the beds to be hung instead of arrangement in wooden racks, which not only reduces the investment but also controls the attack of other fungal diseases.

2.3.3.4. Abiotic factors

Since mushrooms are grown indoors on specific substrates, their productivity and quality is adversely affected by a large number of abiotic factors. Ecological factors such as temperature, humidity, ventilation and light, influence the yield of mushroom (Sharma, 1995 and Sivaprakasam and Seetharaman, 1995). Harendarraj (1988) points out that high energy consumption with high electricity tariffs and frequent breakdown are the factors that deter entrepreneurs from venturing into mushroom production. Hence, Sandhu (1994) suggests bringing down of electricity tariff on par with the rates exercised for other agricultural activities.

More than 70 per cent of the mushroom cultivators face loss in cultivation by not showing adequate attention to the maintenance of the prepared beds. It is always essential to keep damp the gunny bags hung on the sides of

the mushroom huts and the sand spread below. On no account should water be sprinkled until buds appear on the bed. If the polythene bags are not removed after the appearance of buds 30–40 per cent of the yield is increased and there will not be any spread of fungal disease and attack by flies (Lakshmanan, 1995).

2.3.3.5. Lack of technical know-how

According to Harendarraj (1988) the main reasons for, the shutting down of several mushroom cultivation units is the haste in establishing them without adequate knowledge of the technology. Mehta (1993) feels that the highly complicated and much sophisticated technology needed for its cultivation and the day-to-day escalating cost of its cultivation often makes even the most enthusiastic and optimistic button mushroom growers suspect the prospects of this entrepreneurship. Therefore, in order to make the mushroom industry flourish indigenous technology should be promoted and updated (Sandhu, 1994).

Kohlil (1991) points out that the available technology is defective and with problems, as it gives a fair crop the first time and the second crop is invariably problematic and by the third crop failure is imminent. This he feels is mainly due to ignoring the precautionary measures which are necessary to ensure a successful crop.

Hence, the professionals and the scientists should explore avenues in supplying proper production technology. There is considerable need for training of mushroom growers at different stages (Singh and Bhatt, 1997).

2.3.3.6. Marketing

The delicate and highly perishable mushrooms produced are marketed both locally and in different cities outside the production centres. The growers experience difficulties in the disposal of their produce due to lack of adequate market facilities. An integrated marketing system is useful to safe guard the interests of both the producers and consumers (Anitha, 1993 and Sivaprakasam and Seetharaman, 1995). Padmanabhan (1994) suggests that if mushroom growers form a co-operative society and produce and market mushroom as a joint venture, they could get maximum benefit out of it. Gurumoorthy (1994) feels that if a proper marketing network is developed for mushroom, it will occupy the highest percentage in farm exports.

The most important constraint in the production and marketing of mushrooms, according to Chadha (1994) is that the shelf life of mushrooms is very short and the post harvest metabolic changes cause irreversible changes within hours of storage, which results in rapid deterioration and the consumer acceptability of mushrooms is affected. Kohlii (1991) and Saxena (1993) note that guidance is not available from researchers/training institutions about handling and transporting the produce to the market in an attractive form.

Sarkar (1992) suggests that Agricultural Marketing Federations should provide appropriate transport, logistic support and other service facilities for procurement of mushrooms produced at several centres and help to channelise marketing of the produce.

A few important recommendations given by Nair (1991) to overcome the bottlenecks in mushroom cultivation are, organization of periodic training by experts, development of a package of technical and prophylactic measures for combating disease and pests, production of quality spawns, designing of mushroom growing houses on small, medium and commercial scales, evolving low cost technology in cultivation of oyster mushroom, easy availability of incentives and concessions extended by government to farmers and development of determination and will by all those who are engaged in this programme.

2.3.4. Availability and utilization of agrowaste for mushroom cultivation

In order to produce the best quality protein, one of the best and cheapest method is cultivating mushrooms by utilizing biological wastes effectively. In India, the total quantities of agriculture by-products or wastes which are cellulose in nature account for nearly 25 million tonnes a year. These materials can become the perennial source of raw materials for mushroom cultivation. The important ones include cereal straw, sugarcane bagasse, cotton waste, jute, coir pith, cocoa pods, mango seed kernels, different oil cakes, sunflower straw, ground nut pod shell, tapioca starch waste, water hyacinth, certain other dry and wet land weeds and banana and its market wastes (Balakrishnan and Nair, 1995).

Bahl (1995) states that India produces a higher quantity of waste than food stuff or other useful products. If 50 per cent of crop residue is used in the production of mushroom, the expected yield will be 27.3 million

tonnes/annum. The quantity of fruit wastes (mango, banana, apple, pineapple and guava) is 6.018 million tonnes/annum. Oyster mushroom can be grown on fruit wastes and if 50 per cent of above waste is taken for production the oyster mushroom produced out of it is expected to be 0.752 million tonnes/annum.

According to Chadha and Sharma (1995) more than 300 million tonnes of agricultural wastes are available annually in India and about half of this residue remains unused. Some quantity is allowed to decompose in the field and an appreciable quantity is burnt in the field.

Sivaprakasam and Seetharaman (1995) expect that in Tamil Nadu the available Agricultural wastes, rich in cellulose, hemicellulose and lignin will continue to accumulate due to intensive cultivation of major crops like rice, millets, pulses and cotton. In the state, the available amount of crop residues best suited for oyster mushroom cultivation like paddy straw, maize cobs (extracted), groundnut shells, cotton stalks and sugarcane bagasse is estimated by Sivaprakasam and Seetharaman (1995) as 178 lakh metric tonnes annually. The availability of crop residues in Tamil Nadu (annually) and expected mushroom yield by utilizing one tenth of the waste is given in Table 2.

TABLE 2
EXPECTED MUSHROOM YIELD BY UTILISING ONE
TENTH OF THE WASTE

Crop residue	Lakh tonnes		Expected mushroom yield (lakh tonnes)
	Total	10 % of the total	
Paddy straw	84	8.4	4.2
Maize cobs	4	0.4	0.2
Groundnut shells	6	0.6	0.3
Cotton stalks	10	1.0	0.5
Pulse stalks	9	0.9	0.45
Sugarcane bagasse	65	6.5	3.25
Total	178	17.8	8.9

Murugesan et al (1996) estimate that in Tamil Nadu, about 20 million tonnes of various crop residues become available every year. If 25 per cent of it is diverted for mushroom production, about five million tonnes of crop residues can be made available to produce one million tonne of mushroom annually.

2.3.5. Economics of mushroom cultivation

Marimuthu et al (1989) and Rajan (1996) believe that the economics of mushroom cultivation depend on the materials used, their

cost and yield performance. Availability of round-the-year cheap substrates, sufficient water and electricity, skilled labour, marketing of produce at reasonable rates, and availability of favourite variety of the consumers are the basic requirements for success in mushroom cultivation (Upadhyay, 1998). Mushroom cultivation, which is a highly technical and skilled activity involves investment, depending upon the size of the unit and production targets (Singh and Chaube, 1995). Lakshman and Dharmalingam (1996) ascertain that oyster mushroom cultivation requires relatively simple techniques and small investments. If it is cultivated continuously in an area of 5-10 cents, the net profit might be ten times more than that of continuous cropping of vegetables in one acre. Oyster mushroom cultivation can be started with just 100 sq.ft of space according to Kaviarasan (1993). Mohan (1998) is of the view that an individual can harvest 15 to 20 kg of mushroom per year per sq.mt. According to Nagarajan (1997) an investment of Rs. 10 can produce a kilogram of mushroom in about 45 days. Besides it grows independent of sunlight and feed on organic matter without requiring the fertile soil (Vyas, 1999).

Paddy straw mushroom for which paddy straw and spawn are the main inputs can be grown in thatched huts easily. In cultivating paddy straw mushroom the growers face problems like erratic production and repeated crop failure. Since this mushroom is grown either in the open or under thatched hut condition, there is no installation expense, only recurring expenditure may be involved (Jandaik, 1995).

Jagadish Kumar et al (1995) point out that even the mushroom producers in the hills of Uttar Pradesh were getting an average income of Rs.1635.04/year. Returns from mushroom cultivation can be further enhanced by developing cost effective techniques in production and processing. Sarkar (1992) states that availability of low cost technology, short gestation period for cropping, possibility of intensive indoor production with scope for vertical proliferation and less labour deployment make mushroom cultivation a profitable agro-business item, particularly for small and marginal farmers, landless labourers, unemployed youth, women and young entrepreneurs. Besides, it is a good self employment avenue for women in rural areas and even urban housewives (Murugesan et al., 1996).

Phutela and Gupta (1995) have worked out the economics of paddy straw mushroom cultivation involving a net profit of Rs.2,675 by investing Rs.2,500 as capital costs and Rs.3,000 working cost in a growing house of 20" x 12" x 10" for 5 crops of 20 beds/crop. It is obvious from the above given figures that mushroom cultivation is quite profitable and can serve to improve the financial conditions of growers, provided the risk factors are looked into carefully (Jandaik, 1995).

Species of *Pleurotus* are the cheapest and they are easier to grow as they can tolerate a wide range of temperatures (15^o-28^o C) and can be easily dried either in the sun or mechanically (Jandaik, 1995). Tentative cost economics for cultivation of oyster mushroom, as calculated by Jandaik (1995) is Rs. 14,300 for fixed cost, Rs. 2,955 for recurring expenditure and

Rs. 7,875 gross income with a net profit of Rs. 4,920 per crop. Krishnamoorthy et al (1998) state that in order to increase the income of people involved in agriculture production, they could be advised to produce mushrooms which is an ideal income generating activity. Details on economic benefit of cultivating 5 kg milky mushroom is given below.

a.	Fixed capital investment	Rs.	10,500
b.	Recurring expenditure for 3 months	Rs.	7,000
c.	Gross income for 3 months (Selling cost Rs. 80/kg)	Rs.	36,000
d.	Production cost for 3 months	Rs.	9,000
e.	Net income per month	Rs.	9,500

Mushroom cultivation represents the only profitable biotechnological process for conversion of waste plant residues (Wood, 1985). The protein conversion efficiency per unit of land and per cent of time is far superior, compared to animal sources of protein. They also play a vital role in the ecology of carbon cycle in nature, thus reducing the accumulation of organic plant material (Chadha and Sharma, 1995).

2.4. Influence of substrates on the yield of mushroom

2.4.1. Requirement of substrate for cultivating mushroom

2.4.1.1. Compactness, absolute water content and water holding capacity

If a substrate is either too tight or too loose the mycelium will have difficulties in colonising. If it is too loose the mycelium needs more energy to reach the next bit of substrate. If it is too tight the mycelium cannot breathe; slowing down its growth rate. Roughly, the same applies to the

water content of the substrate. Too high a water content results in clogging of the air flow. While low water content prevents growth because of lack of water. Free water activity has to be regarded in relation to the water holding capacity. When the substrate is squeezed just a few drops should be released with some pressure.

2.4.1.2. Activity of medium

Most cultivated mushroom prefer a slightly acidic medium to grow in. The acidity (pH value) can drop considerably during the growth of mycelium.

2.4.1.3. Mixing

An even distribution of materials, such as supplements, is very important as lump-formation may lead to contamination.

2.4.1.4. Fermentation

For some species of mushroom the substrate needs fermentation (decomposing) in order to become suitable. The process will make the substrate more appropriate for the desired mushroom by degrading easily accessible components.

2.4.1.5. Heat treatment

Heat treatment is an important measure to control pests and diseases. It could be employed by (a) sterilization under high pressure (b) sterilization under low pressure (c) pasteurization by steam or by immersion in hot water (Peter Oei, 1991).

2.4.2. Substrates used for cultivating mushroom

According to Careera and Saavedra (1989) edible mushrooms are cultivated on a variety of ligno cellulosic material where major components are lignin, cellulose and hemicellulose. Different agricultural and industrial by-products can now be used as substrates for commercial production, because they are normally available in big quantities in many countries. The most suitable substrate should be chosen according to each region and based on its availability throughout the year, low cost of production, mushroom yield and easy transportation from the farm.

Prakash and Tejaswini (1991) suggest that the vast amount of agricultural wastes coupled with climatological diversity can be successfully exploited for the cultivation of mushrooms.

A lot of work has been done in India on the suitability of various substrates for *Pleurotus* (oyster mushroom) production. *P.sajor caju* and *P. flabellatus* are found to grow on various substrates namely rice straw, wheat straw, ragi straw, hulled maize cob, waste cotton, banana pseudo stem and waste paper (Jandaik, 1974). Bano et al (1978) , Sivaprakasam et al (1979) and Thilagavathi et al (1991) observed a maximum yield of *P.sajor caju* from banana pseudo stem. Sangwan and Saini (1995) have revealed that sugarcane bagasse when mixed with various substrates increased the biological efficiency of *sajor caju*. Similarly, various workers have suggested different substrates for *Pleurotus* cultivation. Some of them are jowar straw

and groundnut pod for *P. florida* (Khandar et al., 1991), wheat straw (Gupta and Langer, 1988), rubber wood waste and saw dust or rubber (Mathew et al 1991), oil palm, mesocarp waste (Babu and Nair, 1991), (*Eupatorium odoratum*) water hyacinth (Das et al 1988), fermented coffee pulp for *Pleurotus cullusta* (Upadhyay and Sohi, 1988) and Sugarcane trash (Singh et al 1995).

Murugesan et al (1995 & 1996) successfully utilized water hyacinth (*Elchhorina crassipes*) as a substrate for oyster mushroom cultivation. Gangulli and Chanakya (1994) have revealed the feasibility of using, spent biomass feed stock from biogas plants for cultivation of oyster mushroom (*Pleurotus flabellatus*). The greater availability of protein in spent biomass feed stock and straw mixture appears to be responsible for over 150 per cent increase in mushroom yield. Chanda et al (1993) opine that the mixture of rice straw and the leaf fibres of *Seasbania grandiflora* produced the highest yield of fruit bodies of *P. sajor-caju*. Kumuthakavalli and Paliwal (1997) successfully used castor stalk along with paddy straw in different combinations as an alternative substrate for oyster mushroom (*P. Citrinopileatus*). Kalaiselvi and Vijayalakshmi (1997) recommend paddy chaff, an agrowaste for the same. The spent substrate when subjected to vermi compost was converted to a very good bio-fertilizer. Karthikeyani et al (1996) suggest vermi compost along with sterilized paddy straw for good quality mushroom within a short period.

Chadha and Sharma (1995) declare that a large number of substrates including wheat straw, paddy straw, sugarcane bagasse, mentha stalks, corn cobs, used tea leaves, apple pomace, banana pseudo stem, wood logs, saw dust, coconut waste, cotton stalks and various other agro and industrial wastes have been evaluated for cultivating different *Pleurotus* spp. by different workers all over the country and cereal straws have consistently yielded good yields. Mathai (1996) opines that oil palm spent bunches, spent lemon grass, are also suitable. In addition dried leaves and stalks of silk cotton, sunflower, green gram and even dried banana leaves can be used for cultivation of mushroom. Other substrates suggested were bleached draft-pulp mill wastes, stalks of maize and sorghum, paper waste, parthenium (Mathew et al 1991 and Gnanambar, 1995) bagasse, coir pith and saw dust (Sivaprakasam and Ramaraj, 1991 and Nallathambi and Marimuthu 1993), poultry waste, tree bark and leaves, flax etc. by Curvetto et al (1997). Fallen arecanut leaves, arecanut bunch waste and dried arecanut husk were effectively used (Madhusudhanan and Chandra mohan, 1997). An equal mixture of wood chips and cotton waste, supplemented with 10 per cent wheat bran was recommended by Abate (1998). Mehetre et al (1996) reveal soy bean straw as the best agro waste medium for cultivation of oyster mushroom. Upadhyay (1998) suggests cereal straw as ideal due to its simple substrate preparation technology. However, Zandrazil (1997) and Khalar and Doss (1987) state that the cost of paddy straw is not low and its availability is not uniform throughout the year.

The white button mushroom (*Agaricus bisporus*) has unusual substrate requirements compared to other commercially grown mushrooms. Preparing a suitable composted substrate for growing *Agaricus* is vital for a successful crop. If the compost is good, a successful crop is usually possible, but with a poor compost only poor results can be expected. Hence, economic efficiency of a mushroom farm is largely determined by compost quality (Miller, 1994).

Mitra and Purkayastha, (1995) report a significant influence on the size of sporocarp production of *Calocybe*, when rice straw, saw dust, wheat bran were used as substrates. About one kg of fresh mushroom was obtained from one kg of dry weight of substrate.

2.5. Enhancing yield of mushroom

In recent years it has been found that mushroom production can be further enhanced with the supplementation of substrates at various stages of cultivation. The factors considered for supplementation are (a) nutritional requirement (b) time of application and (c) benefits.

The supplements should provide carbohydrates, proteins and fats. Various ground grains like sorghum, wheat and maize as the source of carbohydrate, oil extracted seed meals and whole seed meals rich in protein have been used to increase yield. Cotton, soyabean and groundnut seed meals are widely used as a source of protein (Teware and Pandey, 1994). Rodwell (1987 and 1990) observed changes in the flavour of mushrooms according to the constituents of the compost used for their cultivation.

2.5.1. Supplements used for button mushroom cultivation

Supplements used for button mushroom cultivation can be both of animal as well as plant origin which may be carbohydrate-rich, protein-rich or oil-rich substances. However, protein-rich materials give better results. In India, cotton seed meal and soyabean meal have been tried with a fair amount of success. Other supplements tried/worth trying include corn gluten meal, cracked soybean, de-oiled soybean, mustard cake, groundnut cake, cotton seed cake, wheat bran, rice bran and sunflower meal. Mostly, supplements are added in the compost at spawning or at casing. Supplementation at spawning has been found to be successful. The required quantity of supplement is thoroughly mixed in the properly colonized compost just before casing (Garcha et al, 1987 and Vijay and Gupta, 1995).

A study undertaken by Alhawat and Rai (1997) has revealed that use of two commercial biofertilizers namely, *Azotobacter* and *Phosphotica*, on mycelial growth at the time of spawning stimulated spawn-running, advanced fortification and increased the yield of button mushroom.

2.5.2. Supplements used for oyster mushroom cultivation

In order to make the substrates nutritious certain supplements are added. Kumar et al (1992) remark that the normal yields of oyster mushroom (500 to 700 g/kg dry weight straw) can be doubled if the straw is supplemented at the time of spawning with 5 per cent rice flour i.e. 125 g of rice flour for 2.5 kg of dry straw. Mathai (1996) states that paddy straw

supplemented with rice bran has shown an increase in the yield (68.9 per cent) of mushroom. Dhal powder and starch can also be added. The addition of fertilizers, such as super phosphate and urea or chemicals, to water used for wetting the mushroom beds also helps in increasing the yield. The rate recommended is 100g urea and 10-100 g super phosphate mixed in 10 litres of water.

Supplementation of the substrate before spawning with various agro-based materials is recommended by Bahukhandi (1990) for obtaining higher yields. Horse gram powder, cotton seed powder, yeast mud, groundnut cake and rice bran have been tried in cultivation and the best results were obtained with groundnut cake. Various oil-seed meals and cakes, powdered pulses, wheat and rice brans have also been experimented in India. However, Dhanda et al (1995) preferred unfermented and unsupplemented paddy straw for proper growth of *Pleurotus* species.

The use of sterilized chicken manure has been suggested by Vijay and Upadhyay (1989). Jandaik (1974) recommends addition of oat meal. Supplementation of mushroom beds with horse gram after the spawn-run increased the yield significantly (Bano et al 1978). Starch at 10 g/kg substrate improved the biological efficiency (Easwaramoorthy et al 1983), wheat bran, cotton meal, brewers grain (barley), wood dust and chicken manure at 14 per cent level (Seth, 1976), rice bran (Gunasegaran and Graham, 1987) addition of cotton seed to paddy straw (Bisaria et al 1987), wheat bran and

soybean flour (Bahram, 1989), wheat bran and brewers grain (Jandaik, 1989) and rice bran at 4 per cent level (Rao, 1991), were recommended by various workers. According to Mostafa et al (1991) supplementing mushroom beds at spawning with extra organic N., at concentrations ranging from 0.30 to 0.60 per cent of dry substrate increased mushroom yield as well as the highest net protein yield.

2.5.3. Supplements used for milky mushroom cultivation

With regard to milky mushroom, supplementing wheat straw, supplemented with rice husk, maize meal and coconut husk, at the time of spawning, increased its yield when supplemented. However, wheat bran and cotton seed, performed well when added at the time of casing. Some salts such as ferrous sulphate and zinc sulphate, when added to the substrates, increased the biological efficiency significantly (Sharma et al., 1994).

2.6. Preservation and storage of mushroom

2.6.1. Need for preservation

Mushrooms are highly perishable because of their high moisture content and delicate nature, and cannot be stored for more than 24 hours at ambient temperature. Once the fruiting body matures, degradation process starts and it becomes unconsumable after a short time. In order to minimise deterioration of fresh mushrooms, they have to be carefully handled and utilized quickly (Subbaraja and Subramaniam, 1994 and Lal Kaushal and Sharma, 1995).

In India more than 75 per cent of the annual production reaches a limited market area and sold within a short duration of 2-3 days at varying prices. Some suitable system has to be developed in which fresh mushrooms could be collected and made available either for immediate consumption or for processing, thereby ensuring remunerative price to the growers (Chadha, 1992 and Chadha and Sharma, 1995). Bano et al (1992) feel that while extending the shelf life, the processor should look into the delicate aspect of maintenance of texture and flavour also.

2.6.2. Quality parameters in mushroom preservation

2.6.2.1. Button Mushroom

Fresh mushrooms are white or light buff without dark marks on either cap (Pileus) or stem (Stipe). The veil is closed and the gills (Lamellae) are not visible. The upper surface of the cap should be strongly convex and the stem should be plump, rather than elongated. The post harvest maturation of the fruit body during storage causes deterioration in the quality. Discoloration is caused by drying, physical damage and enzymatic browning (Lal Kaushal and Sharma, 1995). Lescano (1994) reiterates that physiological and morphological changes lead to breaking of veil, expansion of the cap, elongation of the stem and darkening of the gills, making mushrooms, unacceptable for consumption.

The “button” “cup” and “open” denote three stages of growth of the cultivated mushroom but are often mistaken for different species. White button mushroom grows into a large closed cup, then the skin stretches and

veil breaks, revealing the pink gills. The mushroom continues to ripen until it is “flat” with fine darkened gills completely exposed (Binani, 1993).

2.6.2.2. Oyster mushroom

Oyster mushroom is harvested when the fruit body has curled under edges with well formed gills (i.e., wringled stage of umbrella), because fully matured fruit body is fragile and difficult to handle. As the maturity advances the fruit body loses water and shrinkage occurs. The loss in turgidity is followed by darkening of colour and liquescent margins. After 3-4 days at ambient temperature, the texture of the fruit bodies also becomes slimy and spores are shed. This leads to a foul smell and obnoxious appearance (Lal Kaushal and Sharma, 1995). Fruit bodies of oyster mushroom are morphologically different and the degree of whiteness, the texture and nature of fruit body margins are considered to be the major characteristics which define quality spectrum (Chadha, 1992).

2.6.2.3. Milky Mushroom

Milky mushroom is umbrella-like and resembles button mushroom in shape and appearance. The cultivation technology is very simple and is less costly, as it does not need special compost. It grows well at temperatures ranging between 25-35° C and relative humidity of more than 80 per cent. It accounts to 143 per cent bioefficiency with a mean yield of 356 g/bed. On an average, single mushroom weighs 55-60 g. It has a maximum shelf life of 3-5 days under normal conditions (Krishnamoorthy et al 1998).

2.6.3. Physical changes in mushroom on maturation

Singh and Sarhadi (1997) explain that mushroom lack the protective covering of suberin or citin, unlike most of the fresh fruits and vegetables. Thus, they are prone to fast deterioration due to loss of moisture content at room temperature. The rate of deterioration is further activated by their fast rate of respiration. Lal Kaushal and Sharma (1995) stress that once the fruiting body matures, degradation process starts and it becomes unconsumable after sometime. Development of brown colour is the first sign of deterioration and is a major factor contributing to quality loss. The enzyme polyphenol oxidase, in the presence of oxygen and the substrate catalyses the oxidation of colourless phenolic compounds into quinones which combine with amino acid derivatives to form highly coloured complexes thus, making them highly unacceptable and therefore, should be disposed off as soon as possible. Prolongation of stalks, opening of veils, toughening of texture and loss of whiteness are deteriorative changes observed during prolonged storage. Peter Oei (1991) reveals that wilting, ripening, liquifaction, change of flavour, texture and constitution decrease the value of mushrooms significantly.

2.6.4. Methods of extending the storage life of mushrooms

Mushrooms have very short shelf life and efforts should be made to sell them fresh as quickly as possible (Rai, 1998). Rendering the mushrooms fit for consumption, export and import, obviously requires the involvement of processing to extend its shelf life. Thus, mushroom processing

is a vital phase of the mushroom science, to tie up its production with the marketing, to earn considerable foreign exchange (Bano and Rajarathinam, 1994).

.While attempting any technique for processing, one should look into the possibilities of retaining the biting texture and pleasant aroma of the fresh produce (Bano and Rajarathinam, 1994). Scientists are working to discover genetically modified mushrooms to retain their freshness. (The Hindu, 1999). Peter Oei (1991) lists the preservation methods employed in the conservation of mushroom such as canning, air drying, brining (salting), freeze-drying and freezing.

Bano and Rajarathinam (1994) declare that the degradative and deteriorative changes can be decelerated to a great extent by holding fresh mushroom at 5° C in 25 μ m polythene bags with a pin hole, by which shelf life of oyster mushroom can be extended upto 8-10 days without the loss of consumer acceptability. The deterioration slowed down for *Agaricus* mushrooms by coating immediately after harvest with an edible, biodegradable hydro colloid film. This film tends to reduce transpiration and evaporation and to control respiration during transport, storage and marketing.

Ajlouni et al (1993) and Flegg (1993) recommend trimming the stipe of cultivated mushrooms - *Agaricus bisporus* from 35mm to 5mm from the cap immediately after harvest for improved shelf life.

Dhar (1992) found that treatment of fruit bodies with potassium meta bisulphate (0.05 per cent) made the mushrooms remain fresh with less

deterioration in both perforated and non - perforated packs. Annamalai (1994) remarks that mushrooms kept in the refrigerator can last for at least three days.

Singh et al (1995) suggest controlled atmospheric storage as a novel preservation technique where the concentrations of CO₂ and O₂ are altered in the environment when the product is packed. Due to this, the brown discoloration is reduced and the shelf life is extended. Irradiation with gamma rays, using Cobalt-60, reduced the contamination and extended the shelf-life of mushrooms and maintained good market value (Lescano, 1994 and Prasad, 1997).

2.6.4.1. Drying

Drying of mushrooms refers to the removal of water by heat to such a level that the biochemical and microbial activity is checked. *Pleurotus* spp. could easily be dried in the sun or mechanical-dehydrators at 50° C and rehydration without loss of flavour. The fruit bodies, dried either in the sun or mechanically at 45° C, were acceptable organoleptically (Lal Kaushal and Sharma, 1995). Jandaik and Goyal (1995) acknowledge that the dried mushroom can be easily rehydrated when soaked in slight warm water for a firmer texture, than the canned one.

A study conducted by Suguna et al (1993 and 1995) on the dry characteristics of oyster mushroom under sundrying, thin layer drying and fluidized drying revealed that fluidized bed drying gave a better quality end product than sun-drying and thin layer drying with respect to rehydration ratio and browning. It was also proved to be economical and highly efficient.

Yapar et al (1990) suggest the air temperature range of 60 - 70°C for optimum quality of the dried product.

Dehydrated mushrooms are found to be a good source of protein and dietary fibre in addition to micro nutrients which are also in abundance. Dehydrated mushrooms have longer storage life (Singh et al 1996). Mushrooms need not have to be crisp to touch after drying, but should still be slightly flexible. Longer drying at low temperature is safer than faster drying on high heat (Nehru et al 1995).

2.6.4.2. Refrigeration

Storing the fresh mushroom in perforated polythene bags at 5° C extends the shelf life of the mushroom by 8-10 days. Pin hole on the package serves to expel the CO₂ built-in. Refrigeration serves to prevent the loss of water content, retards the enzymatic activities and dramatically reduces the rate of respiration (Bano et al 1992).

2.6.4.3. Freezing and Freeze drying

It is a good way to preserve taste, flavour and consistency for at least 3 months. However, it requires high investment and special equipment (Peter Oei, 1991, Kompany and Rene, 1995, Singh and Sarhadi, 1997).

2.6.4.4. Chemical treatment

In order to develop a low cost preservation method, Nehru et al (1995) adopted three different treatments such as treating with 0.5 per cent potassium metabisulphate, 0.5 per cent sodium benzoate, blanching for three minutes and compared with untreated mushrooms. All the four were

dried in a solar drier and the quality of mushroom was evaluated. The sample dried with 0.5 percent KMS treatment was found to be superior with respect to colour, appearance, flavour and texture followed by 0.5 per cent sodium benzoate treated samples.

2.6.4.5. Canning

Canning is a widely practised technique all over the world. White button mushrooms are canned either whole, sliced or in smaller pieces. The efficiency of canning is highly affected by loss in weight of raw material due to shrinkage during processing. Bano et al (1992) reveal that mushrooms can be successfully canned in brine and stored upto 12 months at 37° C. It is an easy method of retaining the original shape and texture of the mushroom and can be used for all mushrooms.

The processed product requires a suitable package to sustain its quality over a determined length of storage life to suit the consumers acceptability and market. The cost feasibility of the processed mushroom also assumes the ultimate importance to market the processed products. However, different mushroom varieties already in commercial production lend themselves to different means of processing and storage (Bano and Rajarathinam, 1994).

Indigenous technology of pickling is an economical and easy method of post harvest processing (Saxena, 1993). Joshi et al (1991) had standardized a sweet chutney from edible mushroom, which could be stored over a year without spoilage and had better sensory qualities.

Thus while so much of research has been done on mushroom there are still areas which warrant research, justifying, the present work that has been undertaken.

EXPERIMENTAL DESIGN

III EXPERIMENTAL DESIGN

The study on “Exploring the Possibilities of Enhancing the Yield of Mushroom and Introducing it as a Self Employment Avenue” consisted of surveys and experiment.

The surveys were carried out among mushroom cultivators, sale outlets, households and restaurants at Coimbatore and Erode. Experiments were carried out initially to identify supplements to enhance mushroom production, using four different substrates and four supplements in different proportions. Oyster mushroom (*Pleurotus florida*) was cultivated to find out the ideal supplements and substrates. Milky mushroom (*Calocybe indica*) could be cultivated only with one substrate and supplement due to time limitation. Supplementation could not be done for button mushroom as it could not be cultivated in the plains for the same reason. Oyster and milky mushroom were introduced for self employment among selected women. As button, oyster and milky mushrooms were widely available in the market, the keeping quality, acceptance and nutritive value were found out in fresh and dried forms for all these three varieties.

The various steps involved in the conduct of the study are given below:

- 3.1. Conduct of surveys on methods of cultivation of mushrooms, mode of marketing and extent of use in restaurants and households.
- 3.2. Identification of the commonly used substrates

- 3.3. Identification of the supplements which may enhance the yield of mushroom
- 3.4. Incorporation of the identified supplements into the selected substrates and assessment of the yield
- 3.5. Comparison of the keeping quality, acceptability and nutritive value of oyster, milky and button mushrooms
- 3.6. Cultivation of oyster and milky mushroom, introduction of the same as a self employment avenue and finding out its economic benefits

3.1. Conduct of surveys on methods of cultivation of mushrooms, mode of marketing and extent of use in restaurants and households

In order to obtain the required information on methods of cultivation, mode of marketing and use of mushrooms in households, surveys were conducted among mushroom cultivators, sale outlets and mushroom consumers. The conduct of the surveys included the following steps:

- 3.1.1. Selection of the area and target groups
- 3.1.2. Selection of the method
- 3.1.3. Formulation of tools
- 3.1.4. Conduct of surveys and
- 3.1.5. Consolidation of the collected data

3.1.1. Selection of the area and target groups

A pilot survey was conducted to find out the areas where mushrooms were cultivated, marketed and used in and around Coimbatore. The survey revealed that mushroom was widely cultivated, marketed and used in cities rather than in rural areas. Hence, the survey was restricted to three places namely Coimbatore, Erode and Ooty and their immediate surrounding areas.

The target groups included 80 mushroom cultivators, 70 sale outlets, 300 homemakers and 70 restaurants situated in Coimbatore and Erode. A purposive sampling method was adopted, as the study involved purposive or deliberate selection of certain units of the universe for constituting a sample which represents the universe. Based on information obtained from Tamil Nadu Agricultural University (TNAU), Coimbatore and Ooty, the investigator located 80 mushroom cultivators from Coimbatore, Erode and Ooty from whom information regarding mushroom cultivation was gathered.

Seventy sale outlets were identified based on factors like ease of approach, availability of mushrooms in the shops and the cooperation extended by the shop owners.

The investigator also identified 70 restaurants which prepared mushroom recipes, in the busy centres of Coimbatore and Erode district. Willingness extended by owners to respond to the survey was taken into consideration while selecting the restaurants. Three hundred households were identified at random in Coimbatore city and Erode Taluk.

Table 3 gives the details relating to the specific areas and the number selected from each area in the three cities for the conduct of the study.

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TABLE 3
AREAS SELECTED FOR THE SURVEY AND TARGET GROUP

Type of target groups	Coimbatore	N	<u>Areas selected</u>	N	Ooty	N
Mushroom cultivators	Peelamedu, Vadavalli, Press Colony, Poosaripalayam, Selvapuram, Ganapathy, P.N.Pudur, Thennamanalur, Jothipuram Koundampalayam	50	Chettipalayam, Ganapathypalayam Kuloor Modakuruchi, Palakod, Palliyuthu, Sivagiri	25	Buttfire, Theetukal, Oakwood Cottage, Arundel farm.	5
Sale outlets	Saibabacolony, Townhall, R.S Puram Perianaickenpalayam, Koundampalayam	50	Chettipalayam, Mariammankoil Street, Paneer Selvam Park, Periyar Nagar, Telephone nagar	20	Nil	Nil
Restaurants	Townhall, Gandhipuram, R.S Puram, Sivananda Colony, Oppanakara street	50	Marriammankoil Street, Chettipalayam, Paneer Selvam Park, Periyar nagar	20	Nil	Nil
Households	Saibaba colony, R.S Puram, Sivananda colony Gandhi park, Koundampalayam,	200	Ganapathy palayam, Moolapalayam, Poondurai, Panner Selvam-park, Mariamman Koil Street, Modakuruchi	100	Nil	Nil

Other than the mushroom cultivators from Coimbatore and Erode five mushroom growers from Ooty were also surveyed so as to find out information on button mushroom cultivation. Since a majority of the mushroom cultivated are marketed in Coimbatore city, surveys were not conducted for sale out lets, restaurants and households at Ooty.

3.1.2. Selection of method

Interview method was chosen for collecting information from mushroom cultivators, sale outlets , restaurants and households because of its convenience, comprehensiveness and possibility of obtaining genuine first hand information. An interview is a two way method which permits exchange of ideas and information. It is a unique method in that it involves the collection of data through direct verbal interaction between the interviewee and the interviewer. Interview is defined as a face to face contact with the person from whom the information is to be obtained (Gupta, 1996).

3.1.3. Formulation of tools

Four separate questionnaires were framed to collect the information from mushroom cultivators, sale outlets, restaurants and households. Technical details elicited from mushroom cultivators included procedures for mushroom cultivation, storage, marketing, size of mushroom sheds, species of mushroom cultivated, profit realized, problems faced and innovative measures adopted. Details relating to the types of mushrooms sold, quantity sold, cost, storage and sale of mushrooms were obtained from the sale outlets. Information on type of mushroom purchased, place and quantity

3.1.5. Consolidation of the collected data

The data collected by using the questionnaires were consolidated, tabulated and findings discussed in Chapter IV.

3.2. Identification of the commonly used substrates

Mushrooms can be cultivated usually on a substrate that has high cellulose and lignin content. *Pleurotus* species grow on various substrates such as wheat straw, sugarcane bagasse, paddy straw, banana stem, dried leaves and stalk of silk cotton. Hence, paddy straw, dried banana stem, banana leaf and sugarcane bagasse were selected for the study as they were available in abundance as farm/market waste. Here after wards dried banana leaf and banana stem have been indicated as banana leaf and banana stem. The selected substrates are shown in Plate. 1.

3.3. Identification of the supplements which will enhance yield of mushroom

Oyster mushroom is cultivated on substrates poor in nitrogen (0.5-0.8 per cent). It is a common practice to add some food supplements rich in nitrogen to the substrates while spawning for higher yields (Upadhyay, 1998). Spawn is equivalent to the vegetative seed of the mushroom crop. Sprinkling of spawns uniformly over the substrates one layer after the other is called spawning. Supplementation of the substrate with different materials, is recommended prior to spawning for enhanced yield of oyster mushrooms. Various oil seed meals and cakes, powdered pulses, wheat, rice bran, sterilized chicken manure, oat meal, horse gram powder, cotton meal, brewers grain

(barley) and wood dust could be used for supplementing the substrate (Balakrishnan and Nair, 1995). According to Tewari and Pandey (1994) and Peter Oei (1991) the supplements should provide carbohydrates, proteins and fats required for the growth of mushroom.

Chadha and Sharma (1995) report that the *Pleurotus* species (Oyster mushroom) has been known to react differently for different supplements. In order to identify the potential supplements to be used, a preliminary study was conducted and oyster mushroom was cultivated by supplementing 40g each of rice flour, thur dhal flour and horse gram flour separately on paddy straw as suggested by Kumar et al (1992). Three trials were conducted for each supplement. It was found that the bed supplemented with rice flour produced 812g of mushroom, about 136g more than the unsupplemented samples. The mushroom produced on the bed supplemented with thur dhal flour had a light yellow tinge and produced almost the same quantity of mushroom as the unsupplemented bed. With this data as a base other supplements easily available such as groundnut cake, rice bran, defatted soya flour and cotton seed powder which contain good amount of carbohydrate, protein and fat were selected and tried out with rice flour in different proportions (3:1, 2:2, 1:3). (Defatted soya flour have been stated as soya flour throughout). Thus 17 different combinations of supplements were identified to be used along with one unsupplemented standard sample making a total of 18 samples to identify the benefits of supplementation. The five major supplements selected are shown in Plate 1.

Substrates Used

PLATE I



Banana Leaf



Banana Stem



Sugar Cane Bagasse



Paddy Straw

Supplements Used



Soya Flour



Cotton Seed



Groundnut
Cake



Rice Flour



Rice Bran

3.4. Incorporation of the identified supplements into the selected substrates and assessment of the yield

This part of the study included the following aspects:

- 3.4.1. Selection of mushroom species to be cultivated
- 3.4.2. Cultivation of oyster mushroom and assessing the yield
- 3.4.3. Cultivation of milky mushroom and assessing the yield and
- 3.4.4. Assessing the yield of button mushroom

3.4.1. Selection of mushroom species to be cultivated

In India only three mushroom species are grown commercially. They are *Agaricus* (button mushroom), *Pleurotus* (oyster mushroom) and *Volvariella* (Paddy straw mushroom). Milky mushroom is the fourth one which has been grown commercially for the first time and has become popular recently. According to Saini (1994) cultivation of *Pleurotus* species is increasing all over the world as they have high biological efficiency and are easy to produce with better keeping quality. More than twenty five varieties of *Pleurotus* species have been identified in different parts of the country and about a dozen out of this are under cultivation. Bano et al (1993) suggest *Pleurotus florida* as a species ideal for cultivation in the plains with a maximum yield at 30°C. Based on these findings *Pleurotus florida*, (oyster mushroom) and *Calocybe indica* (milky mushroom) were chosen for cultivation in the present study.

3.4.2. Cultivation of oyster mushroom and assessing the yield

In order to cultivate mushroom and assess their yield during summer and winter the following steps were adopted.

1. Preparation of bed
2. Spawning and maintaining the bed
3. Harvesting the mushroom
4. Assessing the yield of mushroom
5. Assessing the quality of the cultivated mushroom
6. Calculation of the cost and profit and
7. Calculation of bioefficiency and NPK content of the spent substrates.

The investigator approached various mushroom cultivators and located an experienced mushroom cultivator who had been cultivating mushrooms for many years for commercial purposes. Existence of ideal conditions like cool environment (25 ± 5 C), adequate humidity (80-90 per cent), availability of water, proper ventilation, availability of space (1500 sq. ft) and cooperation extended by the cultivator helped the investigator to cultivate mushroom in his farm.

3.4.2.1. Preparation of bed

Fresh paddy straw, banana stem, sugarcane bagasse and dried banana leaves were chopped into 3-5 cm pieces. According to Mathai (1996) chemical sterilisation has been found to be economical and effective. Hence, the substrates were dipped in chemical solution containing formalin and bavistin overnight. The dilution suggested was 5 ml formalin and 1g bavistin in 10 litres of water. The sterilized materials were removed and allowed to lose excess moisture by leaving it in shade. (An indication for optimum

moisture is that if the substrate is squeezed water should not drip down while the substrate is still moist to touch). In the polythene bag of 60 x 30 cm size, two or three holes of one cm diameter were made in the bottom and on each side for aeration. The bottom of the bag was tied with jute thread. This provided a flat circular bottom for the bed when prepared. The polythene bag was then filled with the sterilised substrates with optimum moisture.

3.4.2.2. Spawning and maintaining the bed

Prasad (1997) explains spawn as the preparation of the seedling material grown on substrates such as half cooked maize (Available with some cultivators and at research stations). For spawning maize grains were soaked in water and cooked for 60 minutes until half-cooked and excess water drained out and spread over a clean cloth so as to allow water to evaporate. For every one kg of grain 20g of calcium carbonate was mixed and approximately 250g of grain was filled in clean plastic covers. The covers were tightly plugged with sterile cotton, and kept in a pressure cooker at 20 PSI (pounds per square inch or 1.45 Kg/sqcm) for 2 hours and cooled to room temperature.

Transfer of the inoculum from the mother spawn to new bottles were done in an inoculation room while holding the spawn bottle in the left hand, the plug was opened with the right hand by keeping the mouth of the bottle near the flame. With the help of a hooked, sterilized 5 mm rod the mother spawn was stirred and approximately 10g of grains with fungus were

transferred to the sterilized bottles. The mouth of the spawn bottle was quickly closed and incubated at room temperature for 15 days. Within 18 to 20 days spawn was ready. From a single mother spawn bottle (the first generation fungal culture) 30 spawn bottles could be prepared.

The spawns from each bottle were divided into two halves. One half of spawn was apportioned into four equal parts (30-35g) after mixing with the selected supplement. The first layer of the sterilized substrate was filled in the polythene bag to a height of about 5 cm and one part of the spawns was mixed with the supplement and sprinkled uniformly along the periphery. The second layer of substrate was filled to a height of another 5 cm and the spawns sprinkled once again along with the supplement. Again the substrate was filled to a height of 5 cm and the spawns were spread at the periphery like before for the third and the fourth layers and the top of the bag was tied with jute thread. The beds were then hung using nylon thread one below the other. Three to four beds were arranged in each row. Temperature was maintained at 24-27° C inside the mushroom shed by sprinkling water frequently on the gunny bags lining the sides of the hut and the sand on floor. The growth of the fungus was observed daily by the investigator.

The same procedure was adopted for the different supplements. The combination of supplements selected by the investigator are given in Table 4.

TABLE 4
DETAILS OF THE SUPPLEMENTS USED

S.No.	Supplements	Weight in grams
1	Riceflour	40
2	Soya flour	40
3	Groundnut cake	40
4	Cotton seed powder	40
5	Rice bran	40
	Soya flour and Rice flour combination	
6	a. 3:1	30:10
7	b. 2:2	20:20
8	c. 1:3	10:30
	Groundnut cake and Rice flour combination	
9	a. 3:1	30:10
10	b. 2:2	20:20
11	c. 1:3	10:30
	Cotton seed powder and Rice flour combination	
12	a. 3:1	30:10
13	b. 2:2	20:20
14	c. 1:3	10:30
	Rice bran and Rice flour combination	
15	a. 3:1	30:10
16	b. 2:2	20:20
17	c. 1:3	10:30
18	Unsupplemented	Nil

Selected supplements were used on four different substrates viz, paddy straw, banana leaf, banana stem and sugarcane bagasse. Three

trials were carried out. Thus a total of 216 beds were prepared (18x4 substrates = 72) (72x3 trials = 216)

In order to keep infestation under control, both the interior and exterior of the mushroom shed was sprayed with Malathion (5ml for one litre of water) once a fortnight. The fungus grew as a white mycelium permeating the entire bed within 18-26 days (spawn-running). Several pin heads appeared all around the bed. Two days after the appearance of pin heads, water was sprinkled on the beds regularly twice a day, using a sprayer until the completion of three harvests.

3.4.2.3. Harvesting the mushroom

Mushrooms pierced through the polythene bags. The ideal time for picking is before the margins of the sporocarps start inward rolling. Fully grown fruit bodies were harvested by hand twisting them early in the morning before spraying water on the beds.

After harvesting the first flush of mushrooms, the polythene bag was removed while the bed remained intact even after removing the cover. One centimeter deep layer of substrate was scrapped off all around and removed from the entire surface of the bed. Spraying of water on the bed was continued every day until the second flush of mushroom appeared which happens normally in another 6-8 days. After the completion of second harvest, again 1-2 centimeter deep layer of substrate was scrapped off and removed from the bed and watering of the bed continued. The third flush of mushroom appeared within 4-6 days. The time taken for maturation of mushroom during

all the three harvests in different beds was recorded. Oyster mushroom was also cultivated during winter. Due to time constraints production of oyster mushroom during winter could be carried out in all the four substrates and on four randomly selected supplements. The stages in oyster mushroom cultivation are shown in Plate 2.

3.4.2.4. Assessing the yield of mushroom

The weight of the mushroom harvested in each of the three pickings was recorded carefully by the investigator. The number of days taken to reach each stage namely, spawn-running, pin head appearance, first, second and third picking, were carefully noted and the total yield recorded.

3.4.2.5. Assessing the quality of the cultivated mushrooms

For securing a good price for mushrooms physical factors like size, shape and colour along with flavour, texture, nutritive value and keeping-quality are important (Subbaraja and Subramaniam, 1994). Hence, the cultivated mushrooms were assessed for their physical appearance.

a. Physical appearance

In order to assess the physical appearance of the harvested mushroom its size and thickness were taken into consideration. To find out the size of the mushroom, the biggest size of mushroom in first picking was collected and based on graphical method the size was recorded (Tom, 1977). (The mushroom was kept flat on a graph paper and the out line was drawn. The number of squares inside the out line was counted and recorded for its size). The thickness of the mushroom is not normally uniform, hence

PLATE.2



Spawning

Stages in cultivation of Oyster Mushroom



White Mycelial growth



Pinhead appearance



Matured mushroom



Harvested mushroom

the same was recorded for stalk portion (stipe), centre and edge of the mushrooms collected for the biggest sporocarp in the first picking.

3.4.2.6. Calculation of the cost and profit

The cost of preparing each bed was calculated considering cost of spawn, polythene bags, substrate, chemicals used (for sterilising the substrates and spraying in and around the mushroom shed) and the supplements. The cost of mushroom obtained from each bed for all the three pickings was calculated and profit/loss was estimated.

3.4.2.7. Calculation of bioefficiency and NPK content of the spent substrates

The most accurate and scientific method of calculating the bioefficiency according to Peter Oei (1991) is dry weight of mushroom versus dry weight of substrate. Another commonly used measure is wet weight of mushroom versus the wet weight of the substrate. However, the convenient method of calculating the bioefficiency for the cultivators is wet weight of the mushrooms versus dry weight of the substrate. The investigator adopted the first two methods to calculate the bioefficiency since they were felt to be more logical.

Nitrogen, phosphorus and potassium content of the spent substrate was calculated so as to find out the availability of these nutrients to the soil on application.. The investigator also found that cellulose, lignin and hemi-cellulose contents of the spent substrates reduced on using the substrate for cultivation of mushroom.

3.4.3. Cultivation of milky mushroom and assessing the yield

This part of the study was carried out by following the steps given below:

1. Preparation and spawning of the bed
2. Casing and maintaining the bed
3. Harvesting the milky mushroom
4. Assessing the yield of milky mushroom and
5. Calculation of cost and profit

3.4.3.1. Preparation and spawning of the bed

Preparation and spawning of the bed were done by following the same steps as for the oyster mushroom. Only paddy straw was used as substrate by supplementing with rice flour alone. Due to the limitation of time the investigator could not use various substrates and supplements as milky mushroom had been introduced only by January, 1998. The prepared beds were placed on the ground.

3.4.3.2. Casing and maintaining the bed

On completion of spawn-running, the cylindrical beds were cut horizontally into two equal halves and casing soil (sterilised garden soil and clean loamy soil) was applied to a height 1.2 cm on the exposed part of the cut bed.

3.4.3.3. Harvesting the milky mushroom

After casing, water was sprayed regularly on the beds to retain moisture level in the casing medium, at a given time. Pin heads appeared in

the upper surface within 10-12 days after casing. The first harvest was made on 6-8th day after pin heads were formed. After obtaining the first harvest the casing medium was gently ruffled, slightly compacted back and sprayed regularly with water. The second and third harvest were carried out within 35-40 days and 45 - 50 days of bed preparation, respectively. The stages in milky mushroom cultivation are shown in Plate 3.

3.4.3.4. Assessing the yield of milky mushroom

The harvested milky mushrooms were weighed and recorded. The number of days taken for completion of different stages was also noted down.

3.4.3.5. Calculation of cost and profit

The cost involved in the production of milky mushroom was found out by calculating the cost incurred for the substrate, spawn, polythene bags, insecticides and supplements used. The profit obtained from the mushroom, was calculated based on the cost involved in production and amount realized by selling the mushroom.

3.4.4. Assessing the yield of button mushroom

Cultivation of button mushroom require carbon, phosphorus, sulphur, potassium, iron and vitamins. Hence, the ingredients such as agricultural waste that contain these compounds are mixed in a fixed proportion to form a substrate known as compost (Vijay, 1998). It takes 28-30 days to accomplish composting. The compost is filled in a bag and spawning done. Optimum environmental conditions like air, temperature and humidity are

PLATE.3

Prepared bed

**Stages
in
cultivation
of
milky
mushroom**

Spawn run bed

Matured mushroom

Casing done

**Appearance
of pinhead**



provided for a successful crop. Once the spawn - run is complete, a layer of sterilised casing soil of 3-4 cm thick is applied on the bag. This process is known as casing. Pin head on surface later develops into a full grown mushroom. Five to eight pickings can be obtained from each bed. Since button mushroom could not be cultivated on plains, information on cost and profit incurred by the cultivators was gathered and presented in Chapter IV.

3.5. Comparison of the keeping quality, acceptability and nutritive value of oyster, milky and button mushrooms

This part of the study included the following steps:

- 3.5.1. Comparing the keeping quality of different species of fresh and dry mushrooms
- 3.5.2. Drying of oyster, milky and button mushrooms and recording its dry weight.
- 3.5.3. Comparing the nutrient content of fresh and dry mushrooms
- 3.5.4. Preparing recipes using fresh and dry mushrooms
- 3.5.5. Evaluating the acceptability of prepared mushroom recipes
- 3.5.6. Assessing the cost of the prepared items.

3.5.1. Comparing the keeping quality of different species of fresh and dry mushrooms

Since the keeping quality of oyster mushroom is comparatively poor, it was subjected to various treatments in an attempt to increase the keeping quality. For this purpose fresh oyster mushroom was obtained from a popular sale outlet and 25g of oyster mushroom samples were soaked in 0.5 per cent

sodium benzoate and 0.5 per cent potassium meta bi sulphate separately for half an hour as suggested by Rai (1998). A third sample of 25g was soaked in lime juice, fourth sample left in a stainless steel vessel while the fifth sample was left untreated. All the samples were kept on a filter paper after treatment to remove excess water.

After this initial process, one set of treated samples was left in the refrigerator while another set was left at room temperature in a sealed perforated polythene bag. It was found that the untreated sample scored better when compared to treated samples as indicted by Dhar (1992).. Hence, the selected mushrooms (oyster, milky and button) were put in a sealed perforated polythene bag and in a closed stainless steel vessel. One set was left at room temperature while another in the refrigerator to determine the spoilage rate.

The samples were examined every 24 hours for five days, for changes in colour, texture, odour and weight. According to Lal Kaushal and Sharma (1995) development of off colour, opening of veil, toughening of texture, shrinkage, becoming slimy and developing of foul smell are some of the changes that occur as maturity advances in mushroom. Dried mushrooms stored in the refrigerator for a period of three months were analysed for changes in their colour, flavour and texture.

3.5.2. Drying of oyster, milky and button mushrooms and recording their dry weight

Dehydration is a method adopted for long term storage of any product. Nehru et al (1995) in their study on solar drying characteristics of

oyster mushrooms found that dipping the mushroom in 0.05 per cent potassium meta bisulphate for 15 minutes and drying was the most ideal method. Hence 50 g each of oyster, button and milky mushrooms were cut into small pieces of size approximately 1 cm and then dipped in 0.05 per cent potassium meta bisulphate for 15 minutes. The excess fluid was squeezed out gently and the mushroom were spread on a filter paper so as to remove the excess water and then dried by traditional sun drying, hot air oven drying and solar drying. Mushroom was dried to the extent that it was not crisp but slightly flexible as per the guidelines given by Nehru et al (1995). The time taken for drying was noted down. The three species of dried mushrooms were then weighed accurately using a beam balance. This was repeated thrice and the data was recorded. The mushrooms were then stored in sealed covers for further use. The quality of dried mushroom was evaluated by assessing the rehydration ratio, protein, ascorbic acid, and fibre content and the organoleptic qualities such as colour, flavour and retention of texture.

3.5.3. Comparing the nutrient content of fresh and dry mushrooms

The nutritive value analysis with respect to energy, protein, fat, fibre, ascorbic acid, and calcium content of fresh and dried form of oyster, milky and button mushrooms were carried out using the methods given in NIN Manual (1983). The procedures adopted are given in Appendix V.

3.5.4. Preparing recipes using fresh and dry mushrooms

When fresh mushrooms are dried, there is a marked reduction in their weight. Some percentage of the weight may be regained during

the rehydration process. Preliminary study revealed that soaking dried mushroom for half an hour in hot water and boiling it for five minutes, the most ideal method, as 10 g of oyster, milky and button mushroom regained 18 g, 21.2 g and 16.8 g of weight respectively. The texture thus obtained was found to be satisfactory.

Eight standardized recipes were selected and mushroom recipes were prepared using fresh and dried forms of oyster, milky and button mushrooms. Recipes selected represented two items each for breakfast, lunch, tea and dinner respectively. The items prepared were as follows:

Breakfast	-	Mushroom fantasy and mushroom omelette
Lunch	-	Mushroom pulav and mushroom poogath
Tea time	-	Mushroom sandwich and mushroom bonda
Dinner	-	Mushroom soup and mushroom noodle delight

3.5.5. Evaluating the acceptability of prepared mushroom recipes

The acceptability of the mushrooms were evaluated adopting the following steps:

3.5.5.1. Testing environment and panel selection

3.5.5.2. Selection and preparation of items and finding out their acceptability

3.5.5.1. Testing environment and panel selection

Testing environment should be in a convenient area. The panel members should have their individual taste. The venue selected for the preparation of these recipes was, the Foods lab of the Avinashilingam

University. Ten postgraduate students of the age group 20-22 years were requested to come at the required time to evaluate the preparations.

3.5.5.2. Selection and preparation of items and finding out their acceptability

Standardised recipes were selected and prepared using both fresh and dried samples. Each item was prepared thrice to avoid any possible error in the preparations. The products prepared from fresh and dried forms of mushroom were subjected to sensory analysis on the basis of various quality attributes like taste, texture, flavour and appearance. Sensory analysis is the most widely used form of routine food quality evaluation. The ranking of the products was done by the selected panel members. Water was given during the sensory evaluation for the removal of any after taste carried over from one item to the other. The views of the panel were consolidated from the score cards given and the acceptability of the items established.

3.5.6. Assessing the cost of the prepared items

The cost of the mushroom recipes prepared was calculated, based on the cost of the individual food items used in the recipe and the details are in Appendix VI and VII.

3.6. Cultivating oyster and milky mushroom introduction of the same as a self employment avenue and finding out its economic benefit

Mushroom cultivation appears to have enormous scope in agricultural farming. With a little training and investment, one can earn a respectable income to become more self sufficient (Banik, 1996). The present study made an effort to assess the economic benefits accrued by selected

women entrepreneurs who were motivated to take up mushroom cultivation for self employment.

The study included

- 3.6.1. Selection of women entrepreneurs
- 3.6.2. Training the women in mushroom cultivation
- 3.6.3. Initiating the enterprise and
- 3.6.4. Assessing the profit margins

3.6.1. Selection of women entrepreneurs

Ten homemakers in Coimbatore and twenty homemakers in Erode, who were anxious to increase their income, by taking up some kind of entrepreneurial activity, were selected. Options were given to them to choose the cultivation of either oyster or milky mushroom.

3.6.2. Training the women in mushroom cultivation

The selected homemakers in Coimbatore, were living within the city and were willing to take up only oyster mushroom cultivation due to limitation of space. A meeting was organised in a central place and the women were oriented about the steps involved in mushroom cultivation, such as preparation of mushroom bed, supplementation and harvesting. Queries pertaining to cultivation were clarified.

Women entrepreneurs at Erode, had place to cultivate milky mushroom. This species of mushroom is more in demand at Erode compared to Coimbatore and could be cultivated even during summer, unlike oyster mushroom, which required a cooler climate. Hence, all the selected

homemakers at Erode opted for cultivating milky mushroom. For effective transfer of technology they were divided into two groups and a training was arranged using the services of a cultivator who had been cultivating milky mushroom in his farm on a large scale at a place called Palakod in Erode district. Demonstration and technical knowledge on various aspects viz., method of cutting paddy straw, type and quantity of chemicals used to sterilize the substrate, preparation of bed, casing, harvesting, cleaning and packing of cultivated mushroom, were explained systematically. Though addition of supplements was given as an option to them, none of them made an attempt to add to the substrate due to fear of infection of the bed if not sterilized properly.

3.6.3. Initiating the enterprise

For cultivating oyster mushroom, the spawns were purchased from Tamil Nadu Agricultural University and the investigator guided the women to prepare 20 beds each initially to kindle their interest as well as to make them aware of the technique. Similarly, the investigator helped the selected women for preparation of beds for cultivating milky mushroom. The spawns were procured from an experienced large scale mushroom cultivator. The number of beds prepared by the women varied between 40 and 60. The women were assisted in harvesting and marketing the cultivated mushroom by the investigator. The quantity of mushroom produced was recorded.

3.6.4. Assessing the profit margins

The cost of spawn, polythene bag, chemicals, substrate were calculated for each sample and the economic benefit gained by the entrepreneurs from cultivating oyster mushroom and milky mushroom in twenty beds were calculated. The number of beds prepared by each entrepreneur varied. Hence, 20 beds were decided upon, as a mushroom cultivator could normally prepare 20 beds within 1-1½ hours without much strain and also could obtain reasonable returns from it.

RESULTS AND DISCUSSION

IV RESULTS AND DISCUSSION

The results of the study on “Exploring the Possibilities of Enhancing the Yield of Mushroom and Introducing it as a Self Employment Avenue” are discussed under the following heads.

4.1. Findings of the surveys on cultivation of mushrooms, marketing and extent of use by consumers

4.1.1 Cultivation of mushrooms

1. Background information relating to mushroom cultivators
2. Mushroom cultivation procedures
3. Problems in mushroom cultivation

4.1.2. Marketing of mushrooms

1. Shops marketing mushrooms, species marketed and their demand
2. Sale of mushrooms by shopkeepers

4.1.3. Use of mushrooms in the households

1. General background of selected households
2. Availability of mushrooms and purchasing habits
3. Consumption of mushrooms
4. Attitude of homemakers towards mushrooms

4.1.4. Use of mushrooms in restaurants

1. Purchase of fresh mushrooms
2. Recipes prepared with mushroom

4.2. Impact of supplements on cultivation of oyster mushroom

4.2.1. Cost of cultivating oyster mushroom

4.2.2. Profit/loss realized by the investigator in cultivating oyster mushroom

4.2.3. Time required for completion of different stages in mushroom growth

4.2.4. Size of harvested mushrooms

4.3. Analysis of the substrates for their cellulose, lignin and hemi cellulose content, its bioefficiency and NPK

4.4. Impact of supplements on cultivation of milky mushroom

4.4.1. Yield of milky mushroom, cost of cultivation and profit margin realized

4.5. Cultivation of button mushroom

4.5.1. Yield from button mushroom and profit margin realized by mushroom cultivators

4.6. Comparing the keeping quality, acceptability and nutritive value of oyster, button and milky mushrooms

4.6.1. Keeping-quality of the three species of mushroom in fresh form

4.6.2. Time taken for drying the three species of mushroom

4.6.3. Acceptability of the mushroom recipes using the three species fresh and dried forms

4.6.4. Nutrient content of fresh and dried mushrooms

4.7. Suitability of mushroom cultivation as a self employment avenue

4.7.1. Yield from oyster mushroom cultivated and profit margin realized by the women entrepreneurs

4.7.2. Yield from milky mushroom cultivated and profit margin realized by the women entrepreneurs

4.1. Findings of the surveys on cultivation of mushrooms, marketing and extent of use by consumers

4.1.1. Cultivation of mushrooms

4.1.1.1. Background information relating to mushroom cultivators

Background information of selected mushroom cultivators is given in Table 5.

TABLE 5
BACKGROUND INFORMATION OF MUSHROOM CULTIVATORS

Background details	Location						Total	
	Coimbatore		Erode		Ooty			
	N-50	Percent	N-25	Percent	N-5	Percent	N-80	Percent
1. Sex								
a. Male	38	76	19	76	5	100	62	78
b. Female	12	24	6	24	Nil	Nil	18	22
2. Educational status								
a. Illiterate	2	4	3	12	Nil	Nil	5	6
b. School level	32	64	17	68	3	60	52	65
c. College level	16	32	5	20	2	40	23	29
3. Employment status								
a. Mushroom cultivation alone	22	44	13	52	2	40	37	46
b. Mushroom cultivation as part- time job	28	56	12	48	3	60	43	54
4. Economic status *								
Low (Rs.2001-4500)	18	36	7	28	Nil	Nil	25	31
Middle (Rs.4501-7500)	21	42	10	40	3	60	34	43
High (Rs.7501and above)	11	22	8	32	2	40	21	26

* HUDCO Classification (1997)

Among the mushroom cultivators there were 22 per cent of women entrepreneurs. Six per cent of the cultivators were illiterates, 65 per cent had education upto school level and 29 per cent upto college level. Thus, most of the mushroom cultivators had some educational background. Fifty four per cent were cultivating mushroom on part-time basis, as they had jobs outside, while 46 per cent were full time cultivators. Thirty one per cent belonged to low income group, 43 per cent to middle income group and the remaining 26 per cent came from high income families.

Among the mushroom cultivators 64 per cent got help from their family members for preparing the bed, watering the shed and mushroom bed, harvesting, packing and marketing the mushroom while the rest engaged labourers and were managing the business. All the women entrepreneurs stated that their husband helped in marketing the mushrooms. Thus, the whole process of cultivation was a family business.

Information on type of ownership, factors that motivated mushroom cultivation, motivators and extent of financial commitments are presented in Table 6.

TABLE 6
DETAILS RELATING TO THE CULTIVATORS

Details	Location						Total	
	Coimbatore		Erode		Ooty			
	N-50	Percent	N-25	Percent	N-5	Percent	N-80	Percent
1. Type of ownership								
a. Sole proprietor	39	78	17	68	5	100	61	76
b. Partnership	11	22	8	32	Nil	Nil	19	24
2. Motivating factors								
a. To earn money	32	64	16	64	2	40	50	62
b. Out of interest	13	26	4	16	2	40	19	24
c. As a hobby	5	10	5	20	1	20	11	14
3. Motivators								
a. Friends	34	68	7	28	1	20	42	52
b. Relatives	11	23	5	20	1	20	17	21
c. Family members	32	4	13	52	1	20	16	20
d. Neighbours	3	6	Nil	Nil	Nil	Nil	3	4
e. Agricultural University	Nil	Nil	Nil	Nil	2	40	2	3
4. Financial commitment								
a. < Rs.5000	27	54	10	40	Nil	Nil	37	46
b. Rs.5,001-10,000	15	30	11	44	Nil	Nil	26	33
c. Rs.10,001-50,000	8	16	4	16	5	100	17	21

Table 6 shows that 76 per cent of the cultivators were operating the mushroom unit on sole proprietorship basis and 24 per cent were on partnership basis. Partnership firms were few compared to individual ownership in all the three locations. The factors that motivated them to take up mushroom cultivation were to earn money (62 per cent), on one's own interest (24 per cent) and as a preferred hobby (14 per cent).

Fifty two per cent of the cultivators indicated that their friends motivated them to take up mushroom cultivation whereas 21 per cent expressed that their relatives had motivated them to take up the venture while 20 per cent were motivated by family members, four per cent by neighbours and three per cent by the Horticulture department, Tamil Nadu Agricultural University, Ooty.

The survey further revealed that 46 per cent were small cultivators, with a minimum investment of about Rs.5,000. Thirty three per cent of the cultivators had invested upto Rs.10,000 and 21 per cent had invested upto Rs.50,000.

Thirty two per cent of the cultivators from Coimbatore and 24 per cent from Erode, had obtained loans from banks, paying an interest between 12.5-15 per cent for establishing the mushroom cultivating units. They were repaying the loan amount on monthly basis. None of the cultivators from Ooty had availed any bank loan. However, they had obtained a few materials like polythene sheets on subsidy from the Horticulture department of Tamilnadu government.

Information on training received for mushroom cultivation and labourers employed is given in Table 7.

TABLE 7
DETAILS ON TRAINING AND EMPLOYMENT OF LABOURERS

S. Details No.		Location						Total	
		Coimbatore		Erode		Ooty			
		N-50	Percent	N-25	Percent	N-5	Percent	N-80	Per cent
1.	Training received	39	78	18	72	2	40	59	74
	Not received	11	22	7	28	3	60	21	26
2.	Labourers employed	35	70	19	76	5	100	59	74
	Not employed	15	30	6	24	Nil	Nil	21	26
3.	Among employed								
a.	Men	16	46	10	53	3	60	29	49
b.	Women	11	31	5	26	Nil	Nil	16	27
c.	Both	8	23	4	21	2	40	14	24

It was noted that 78 per cent and 72 per cent of the cultivators from Coimbatore and Erode and 40 per cent from Ooty (74 per cent on an average) had received formal training on mushroom cultivation before they got involved in the business. All of them had attended one day training programme organised by Tamil Nadu Agricultural University, at Coimbatore or Ooty. The others who had not received any training indicated that they had learnt techniques on mushroom cultivation from their friends or relatives who had motivated them to take up the venture. However, it is very important that the cultivators undergo a formal training before undertaking mushroom cultivation as even slight carelessness may result in loss.

Seventy per cent of the cultivators from Coimbatore, 76 per cent from Erode and 100 percent of the cultivators from Ooty had employed labourers to assist them. Men labourers were employed by 46 per cent, 53 per cent and 60 per cent of the cultivators from Coimbatore and Erode and Ooty whereas, 31 and 26 per cent of the cultivators from Coimbatore and Erode respectively had employed women. However, 23 per cent, 21 per cent and 40 per cent of the cultivators of Coimbatore, Erode and Ooty respectively who had engaged themselves in large scale mushroom cultivation had employed both men and women labourers.

Table 8 depicts details relating to the space utilized for the mushroom sheds

TABLE 8
SPACE UTILIZED FOR THE MUSHROOM SHEDS

Space utilized (Sq.ft)	Location						Total	
	Coimbatore		Erode		Ooty			
	N-50	Percent	N-25	Percent	N-5	Percent	N-80	Per cent
1. Less than 500	5	10	Nil	Nil	Nil	Nil	5	6
2. 501 -1000	15	30	16	64	Nil	Nil	31	39
3. 1001 -1500.	14	28	5	20	3	60	22	27
4. 1501 and above	16	32	4	16	2	40	22	28

It could be inferred from the above Table that 32 per cent, 16 per cent and 40 per cent of the cultivators from Coimbatore, Erode and Ooty respectively, utilized a large space of above 1500 sq.ft for cultivation. Thirty per cent and 64 per cent of the cultivators at Coimbatore and Erode used 501 sq. ft.-1000 sqft., while 10 per cent from Coimbatore had their sheds in less than 500 sq.ft only.

Table 9 gives details regarding the species of mushrooms selected for cultivation.

TABLE 9
MUSHROOM SPECIES SELECTED FOR CULTIVATION

Mushroom species	Location						Total	
	Coimbatore		Erode		Ooty			
	N-50	Percent	N-25	Percent	N-5	Percent	N-80	Percent
1. Oyster mushroom (Pleurotus)	50	100	18	72	Nil	Nil	68	85
2. Milky mushroom (Calocybe indica)	Nil	Nil	7	28	Nil	Nil	7	9
3. Button mushroom (Agaricus bisporus)	Nil	Nil	Nil	Nil	5	100	5	6

With regard to the species of mushroom cultivated all the mushroom growers in Coimbatore were cultivating oyster mushroom (Pleurotus) only. With regard to the strain of Pleurotus species, 74 per cent were cultivating Pleurotus florida for it's innate qualities like appearance, keeping-quality and better yield while the rest (26 per cent) were cultivating APK and CO1 of Pleurotus species.

In Erode, 72 per cent cultivated oyster mushroom, while the rest cultivated milky mushrooms. All those who cultivated oyster mushroom used only *Pleurotus florida* species due to its commercial value. All the cultivators from Ooty grew only button mushroom as it had greater demand and also fetched an appreciable profit. Besides, cool climate at Ooty was not very conducive for the growth of oyster and milky mushroom.

Water is an essential commodity for mushroom cultivation. Twenty eight per cent and 32 per cent of the cultivators in Coimbatore and Erode respectively and 100 percent of the cultivators at Ooty had abundant water supply while 56 per cent and 52 per cent from Coimbatore and Erode indicated that water was just enough. However, 16 per cent from each group expressed that water was a scarce commodity especially during summer.

Normally, the beds of oyster mushroom were arranged on racks or allowed to hang, whereas beds of milky mushrooms could be arranged only on plain ground. Due to the high cost involved and attack by rodents, 54 per cent and 16 per cent of the cultivators in Coimbatore and Erode respectively had hung the beds using plastic rope. However those who cultivated milky mushroom at Erode arranged the beds on the plain ground. All the cultivators in Ooty had arranged the beds on racks. For optimum growth of oyster mushrooms, the sheds had to be maintained at a temperature of 25°C-29°C. Milky mushroom could withstand temperature upto 35°C while button mushroom required 15-20°C. All the cultivators had spread sand on the floor while 56 per cent and 58 per cent of the cultivators in Coimbatore and Erode

Among the cultivators who prepared the spawn, 64 per cent and 75 per cent in Coimbatore and Erode respectively, expressed that the excess spawns were sold to small scale mushroom cultivators at the rate of Rs.10/ bottle for oyster mushroom and Rs.15/bottle for milky mushroom. In Coimbatore 33 per cent of the mushroom cultivators prepared less than 500 bottles per month, while 11 per cent prepared 500-750 bottles, 23 per cent prepared 751-1000 bottles and another 33 per cent between 1001 and 1250 bottles per month. All the mushroom cultivators in Erode produced only 250-500 bottles/month. Spawn production itself has become a source of income which fetches appreciable profit to the cultivators if prepared carefully.

The raw materials like polythene bags, insecticides and fungicides required for spawning were bought from shops in the town, while paddy straw was bought directly from the fields.

Button mushroom cultivators purchased horse dung from Madras Regimental Centre in Wellington at the cost of Rs.3000 per load (inclusive of labour cost). The other fertilizers, fungicides and straw were purchased from the local shops. The soil required for casing was taken from the forest at a cost of Rs.1000 approximately per load.

b. Mode of preparation of beds

Forty two per cent of the cultivators in Coimbatore used chemicals like formalin and bavistin for preparation of beds. The substrates were soaked in insecticides and fungicides overnight or boiled for one hour as per their convenience. Eighty four per cent of the cultivators in Erode soaked

the substrates in chemicals for about 16-18 hours, while 16 per cent sterilized the substrate by boiling it in hot water for 60-120 minutes. Insecticides like malathion or bavistin were sprayed in and around the shed to protect the beds from insects and germs. This was done once a week by 69 per cent and once a fortnight by 31 per cent of the cultivators in Coimbatore, whereas, 72 per cent in Erode sprayed the insecticide once a fortnight and 28 per cent once a month.

Generally three pickings or harvests were taken from each oyster mushroom bed. In case of any delay in the preparation of next set of beds, mushrooms from the fourth and fifth pickings even were collected. It was worth noting that the milky mushroom cultivators, went upto seven pickings without much decline in the yield per bed.

After cultivating mushrooms the beds were recycled by composting them and converting them into valuable manure by 30 and 76 per cent of the mushroom cultivators in Coimbatore and Erode. The cultivators who composted the used beds revealed that during rainy season mushrooms could be collected even from the waste beds. This was however possible only if adequate space is available. The used beds were sold as food for fish in pisci culture by 5 per cent of the mushroom cultivators in Erode.

The preparation for button mushroom cultivation is a laborious and time consuming process. Compost is prepared by mixing horse dung, fertilizers like ammonium sulphate, calcium, ammonium nitrate, urea and paddy straw along with insecticides and allowing the mixture to decompose

for a period of one month. Maintenance of pH at 7.0-7.5 is considered to be very important in this process. (The sample of compost was given to the agricultural research station Ooty for testing). The compost weighing approximately 10 kg was filled in each bag and spawning done. Once the spawning was done the bed was allowed for spawn-running for 18-20 days. Casing was done on each bed or bag and left for 15 days. Once the pin heads started appearing, water was sprinkled regularly. Harvesting was done from each bag for a period of 60-80 days. The spent compost was sold at the rate of Rs.2 per bag by 60 per cent while the remaining used it as manure in their own fields.

c. Mode of marketing the mushroom

Mushrooms were packed in lots of 200 g in polythene bags and sold to the shops by 42 and 44 per cent of mushroom cultivators in Coimbatore and Erode respectively. About 58 and 20 per cent of the cultivators in Coimbatore and Erode respectively, sold the produce directly to the customers. However, 36 per cent of the mushroom cultivators in Erode were selling their products through agents. The cost of mushroom fluctuated from time to time. Oyster mushrooms were sold to the shops at the rate of Rs.8/ packet at Coimbatore Rs.7 per packet at Erode and milky mushroom at the rate of Rs. 11 - 12 per packet.

Though all preferred to sell the mushrooms produced immediately after harvesting, 20 per cent and 30 per cent of the cultivators in Coimbatore and Erode said that they had to preserve them in the refrigerator

and sell them the following day. At times, when there is no demand, some of them even dried the mushrooms and sold them to the restaurants in powdered form for preparation of soups.

Cultivators from Ooty, sold the mushroom either to the local customers at the rate of Rs. 14/packet or to the local shops and agents at the rate of Rs. 12-Rs. 14/packet depending upon the quality of mushroom produced. As there is a great demand for button mushroom they are immediately sold out. The profit gained was directly proportional to the investment and care given during cultivation of mushroom. The profit realized by the mushroom cultivators is given in Table 10.

TABLE 10
PROFIT REALIZED BY THE MUSHROOM CULTIVATORS

S. No. Profit /month in Rs.		Location						Total	
		Coimbatore		Erode		Ooty			
		N-50	Percent	N-25	Percent	N-5	Percent	N-80	Percent
1.	<2500	15	30	5	20	Nil	Nil	20	25
2.	2501-5000	18	36	5	20	3	60	26	33
3.	5001-7500	6	12	4	16	Nil	Nil	10	12
4.	7501-10,000	8	16	3	12	2	40	13	16
5.	No profit or loss	3	6	8	32	Nil	Nil	11	14

It was surprising to note that six per cent of the mushroom cultivators in Coimbatore and 32 per cent of the cultivators in Erode, stated that they had neither profit nor loss. Thirty six per cent of cultivators in

Coimbatore earned a profit ranging between Rs.2501-5000 while 12 per cent had a profit of Rs.5001-7500 and 16 per cent had a profit of Rs.7501-10,000. Twenty per cent of the cultivators in Erode earned a profit of less than Rs.2500. Another 20 per cent earned Rs.2501-5000, 16 per cent earned Rs.5001 - 7500 and 12 per cent earned Rs.7501-10,000. In Ooty 40 per cent of the cultivators were earning a profit of Rs.7501-10,000/month as they owned big farms while the remaining 60 per cent were earning Rs.5001-7500/month. Thus, a majority of the cultivators of Erode had neither profit nor loss due to failure of the crop, especially during summer. Hence, they should switch over to cultivating mushroom species which can withstand even the hot climate.

4.1.1.3. Problems in mushroom cultivation

Table 11 and Figure 1 give information on the problems in mushroom cultivation.

TABLE 11
PROBLEMS FACED IN MUSHROOM CULTIVATION*

S. No.	Problems faced	Location						Total	
		Coimbatore		Erode		Ooty			
		N-50	Percent	N-25	Percent	N-5	Percent	N-80	Percent
1.	Infestation of bed	50	100	25	100	Nil	Nil	75	94
2.	Travelling for marketing	35	70	20	80	Nil	Nil	55	69
3.	Lack of adequate finance	33	66	9	36	3	60	45	56
4.	Sub standard quality of spawn	11	22	18	72	Nil	Nil	29	36
5.	Difficulty in collection of money	17	34	16	64	Nil	Nil	33	41
6.	Lack of water facilities	8	16	17	68	Nil	Nil	25	31
7.	Unsuitable location	19	38	6	24	Nil	Nil	25	31
8.	Storage of mushroom	6	12	10	40	Nil	Nil	16	20
9.	No problem	Nil	Nil	Nil	Nil	2	40	2	3

* Multiple response

PROBLEMS FACED BY MUSHROOM CULTIVATORS

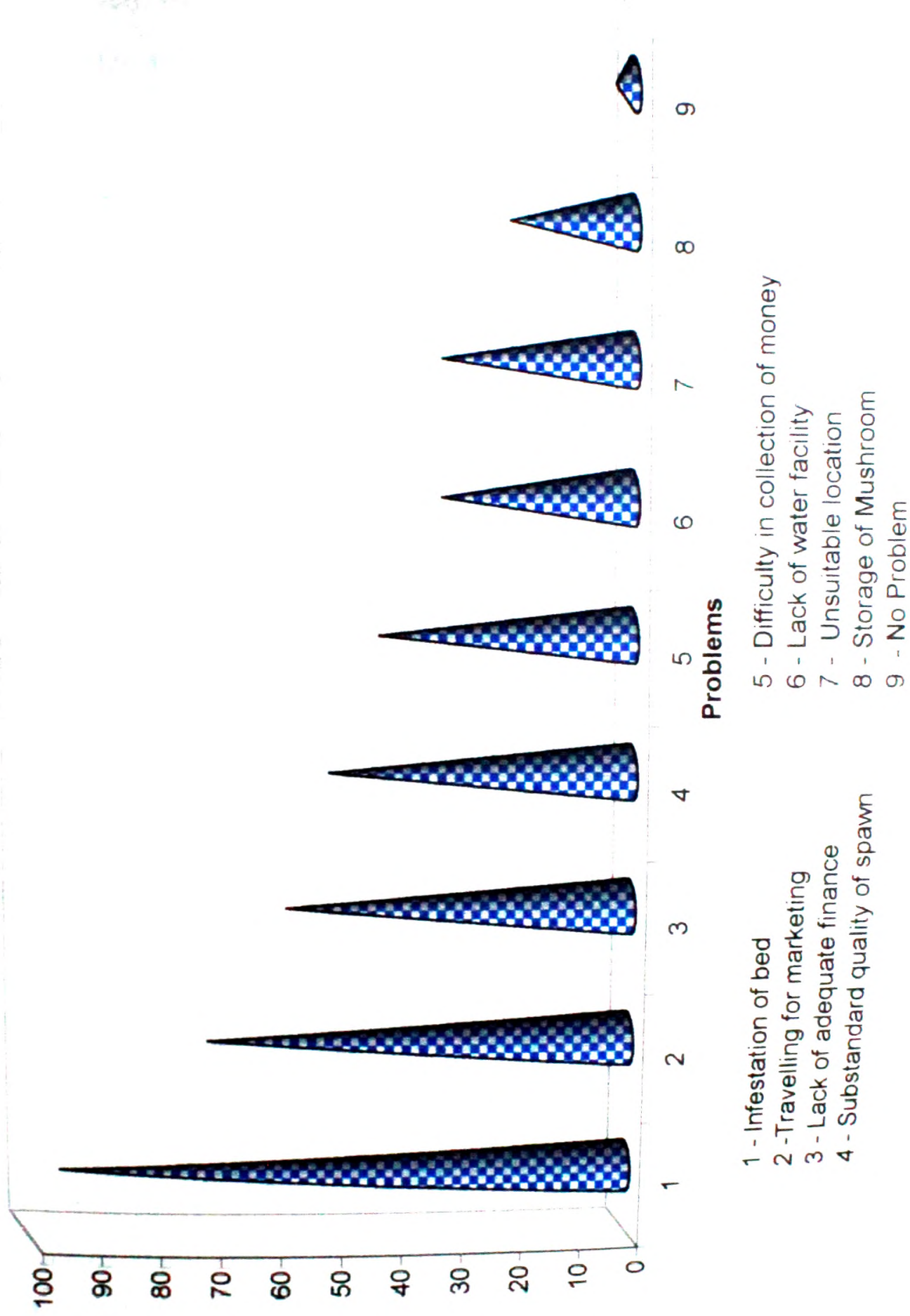


FIGURE - 1

About 38 and 24 per cent of the cultivators in Coimbatore and Erode respectively, were not satisfied with the location of the mushroom huts as they were far away from their residence, and hence had difficulty in supervising. Sixteen per cent of mushroom cultivators in Coimbatore and 68 per cent in Erode did not have adequate water supply, especially during summer and this was a major problem. All the mushroom cultivators in Coimbatore and 59 per cent in Erode had to purchase water, which brought down their profit in the enterprise. Financial difficulties were faced by 66, 36 per cent and 60 per cent in Coimbatore, Erode and Ooty respectively.

Among the cultivators of Coimbatore and Erode who procured spawns from outside 22 and 72 per cent respectively, experienced a loss due to substandard quality spawns given by the spawn producers. Infestation of the bed by flies, green mould and black mould, at one stage or the other, was experienced by all the cultivators. Spraying malathion in and around the shed whenever required was the only possible solution. There was also a reduction in the yield of mushroom during summer due to drying of mushroom in the pin head stage, which resulted in a loss during this season. Hence, the scientists should introduce hybrid strains, resistant to insects, fungus and higher temperature.

As mushroom gets deteriorated quickly, it should be marketed within 24 hours. Twelve per cent and 40 per cent of the cultivators in Coimbatore and Erode faced problems of storing the unsold mushrooms when they were not able to sell the product immediately due to lack of demand.

Travelling long distances for marketing the cultivated mushroom was stated as a problem by 70 per cent and 80 per cent of the cultivators in Coimbatore and Erode respectively. Hence, 40 and 60 per cent of the cultivators engaged assistants to market the mushroom. After selling the mushroom, especially to the shops and restaurants, there was great delay in the payment and this was expressed as a big problem by 34 and 64 per cent of the cultivators, in Coimbatore and Erode respectively. However, 40 per cent of the cultivators from Ooty who did the cultivation on a larger scale, revealed that they did not face any such problem. If the Horticulture department could extend their expertise to mushroom cultivators at least to solve the technical problems it will be possible for the cultivators to overcome the problems and realize reasonable profit. None of the mushroom cultivators surveyed, adopted any innovative methods in cultivation due to fear of infestation of the bed.

4.1.2. Marketing of mushrooms

4.1.2.1. Shops marketing mushrooms, species marketed and their demand

Information on types of shops that sell mushroom, species of mushrooms marketed and their demand is given in Table 12

TABLE 12

DETAILS ON SHOPS, SPECIES OF MUSHROOM AND THEIR DEMAND

Details	Location				Total	
	Coimbatore		Erode			
	N-50	Percent	N-20	Percent	N-70	Percent
1. Shops						
a. Fruit stalls	26	52	15	75	41	59
b. Vegetable shops	24	48	5	25	29	41
2. Species of mushroom sold*						
a. Oyster mushroom	39	78	8	40	47	67
b. Button mushroom	37	74	8	40	45	64
c. Milky mushroom	6	12	10	50	16	23
3. Demand for different species						
a. Oyster mushroom	13	26	4	20	17	24
b. Button mushroom	37	74	10	50	47	67
c. Milky mushroom	Nil	Nil	6	30	6	9

* Multiple response

The main outlets for mushroom in Coimbatore and Erode were fruit stalls (52 and 75 per cent) and vegetable stalls (48 and 25 per cent) respectively. The shops in Coimbatore sold oyster and button mushroom while milky mushroom is just making its appearance. All the three species were equally popular in Erode.

Button mushroom was most popular in both the places, while oyster mushroom was also purchased. Milky mushroom was acceptable at Erode due to better keeping-quality and possibilities of being cultivated even at higher temperatures. Since milky mushrooms have just caught the eyes of the cultivators, it may require some more time to assess their real acceptance and demand.

4.1.2.2. Sale of mushrooms by the shop keepers

A majority (54 per cent) of the shops in Coimbatore sold 5-10 packets of oyster mushroom while 59 per cent sold 21-40 packets of button mushroom every day. About 88 per cent, 63 per cent and 70 per cent of the shops at Erode sold 1-20 packets of oyster, button and milky mushroom respectively. The quantity of mushrooms sold in Coimbatore was more when compared to that in Erode, due to the fact that in Coimbatore an increasing number of people have accepted mushroom as a regular food item.

a. Profit realised by shopkeepers

All the shopkeepers stated that they purchased oyster mushroom at the rate of Rs.8/packet, button mushroom at the rate of Rs.15 and milky mushroom for Rs.12 and sold with a profit of Rs.2 on oyster and milky mushroom and Rs.3 on button mushroom. The entry of milky mushroom into the market may change the existing shortage during summer and may help the mushroom cultivators and the shopkeepers to realize better profits even during off-seasons.

b. Storage of mushrooms

When the shopkeepers were not able to sell all the mushrooms, they stored the same in the refrigerator (36 and 40 per cent of the shopkeepers in Coimbatore and Erode) for a day or two in the case of oyster and button mushroom and upto four days in the case of milky mushroom. Forty six per cent of the shopkeepers in Coimbatore informed that the cultivators or the agents took back the unsold mushrooms (especially oyster and milky mushroom). Thus, the keeping quality of milky mushroom is better, but its popularity among the public is yet to pick up. Hence, it is essential to popularize this variety among the consumers and create a demand in the market, which may motivate the cultivators to cultivate this variety and earn a better profit.

4.1.3. Use of mushrooms in the households

4.1.3.1. General background of the selected households

The details on family type, income, education and employment status of homemakers who used mushroom are given in Table 13.

TABLE 13
DETAILS ON GENERAL FAMILY BACKGROUND

S. No.	Details	Location				Total	
		Coimbatore		Erode			
		N-200	Percent	N-100	Percent	N-300	Percent
1. Family type							
	Nuclear family	147	74	64	64	211	70
	Joint family	53	26	36	36	89	30
2. Family income							
	Low income Rs.2001-4500	17	8	21	21	38	13
	Middle income Rs.4501-7500	141	71	63	63	204	68
	High income Rs.7500 and above	42	21	16	16	58	19
3. Educational status of homemakers							
	Illiterate	25	12	22	22	47	16
	School level	79	40	70	70	149	50
	College level	56	28	8	8	64	21
	Professional	40	20	Nil	Nil	40	13
4. Employment status of homemakers							
	Full time homemakers	109	55	72	72	181	60
	Partime employed	55	27	19	19	74	25
	Full time employed	36	18	9	9	45	15

Among the families surveyed 74 per cent and 64 per cent in Coimbatore and Erode were nuclear in nature.

It is clear from Table 13 that 71 and 63 per cent of the families surveyed in Coimbatore and Erode belonged to middle income group. While the rest were found distributed in the other two income groups. The table also reveals that 88 per cent of the homemakers of Coimbatore and 78 per cent of the homemakers of Erode were educated. Fifty five per cent of homemakers in Coimbatore and 72 per cent of homemakers in Erode were full-time homemakers while the rest were either full-time or part time employed. Thus the surveyed homemakers of Coimbatore had a better economic, educational and employment status when compared to the homemakers of Erode.

4.1.3.2. Availability of mushroom and purchasing habits

Though the production of mushroom is fast increasing, there is also a simultaneous increase in demand due to increasing consumption of mushroom inspite of increasing in cost price. Thirty per cent of the homemakers from Coimbatore and 10 per cent from Erode stated that mushrooms were not always available. Above 60 per cent of the homemakers in Coimbatore and Erode purchased only one packet of mushroom, weighing 200 g, at one time.

In spite of its higher price, button mushroom was preferred for its flavour, texture and taste by 72 per cent and 68 per cent of the homemakers of Coimbatore and Erode. Oyster mushroom was purchased by 57 per cent and 61 per cent of the homemakers of Coimbatore and Erode. Due to its easy availability at Erode, 32 per cent of the homemakers purchased milky mushroom when the other mushrooms were not available. Though milky

mushroom is cultivated at Erode and was found to have better keeping-quality, it is not yet popular among the people, because they were afraid to try new varieties of mushroom. Besides, when the milky mushroom was introduced in the market initially, the cultivators had allowed the mushroom to mature to the maximum which made the mushroom tough and fibery. In Coimbatore, only 5 per cent had consumed milky mushroom as it was not widely available here.

4.1.3.3. Consumption of mushrooms

Mushroom is considered as a delicacy since ancient times due to its exotic texture, flavour and taste. Recently, the use of mushroom has gained importance due to migration of people with different food habits and are widely used by the households. Details on the use of mushroom in the diet were collected and are presented below.

a. Information on food habits and mushroom consumption

Mushroom is popularly regarded as vegetarian meat. Table 14 gives details on food habits and mushroom consumption patterns of selected households.

TABLE 14

FOOD HABITS AND MUSHROOM CONSUMPTION PATTERNS

S. No.	Details	Location				Total	
		Coimbatore		Erode			
		N-200	Percent	N-100	Percent	N-300	Percent
1.	Food habits						
	Non-vegetarian	136	68	70	70	206	69
	Vegetarian	64	32	30	30	94	31
2.	Types of mushroom consumed						
	Natural mushroom alone	37	18	14	14	51	17
	Cultivated mushroom alone	95	48	14	14	109	36
	Consume both	42	21	62	62	104	35
	Do not consume mushroom	26	13	10	10	36	12

It is obvious that 69 per cent of the selected homemakers were non-vegetarians and 31 per cent were vegetarians.

Only 17 per cent of homemakers stated that they had consumed natural mushroom which was available during rainy season while 36 per cent had tasted cultivated mushroom alone and 35 per cent, both cultivated and natural mushroom. It was surprising to note that totally 12 per cent of the selected homemakers had neither consumed natural nor cultivated mushroom, as they were vegetarians and had refrained from using mushroom considering it as a non vegetarian food and had no idea of how to prepare and also considered the same poisonous. Hence, it is imperative to create an awareness among the public regarding the favourable aspects of mushroom consumption.

b. Reasons for consumption of cultivated mushroom

Mushroom recipes have gained popularity among the elite of the society because of their nourishing and appetizing qualities and have a definite place in the list of foods consumed by them. Mushrooms were preferred by 87 and 78 per cent of the selected homemakers in Coimbatore and Erode for their taste (43 per cent), popularity (34 per cent) and easy availability (13 per cent) and ease of preparation (10 per cent).

Mushrooms are now available in fresh, frozen, canned and dried forms. They are ideal for inclusion in both vegetarian and non vegetarian diets.

As cultivated mushrooms are scarce during summer months 41 and 51 per cent of the homemakers in Coimbatore and Erode revealed that they purchased and prepared the mushrooms whenever available in the market, the common preparations being fry, briyani, manchurian and chilly mushroom. The demand for mushroom could be increased if more and more recipes are popularized among the consumers through various mass media.

4.1.3.4. Attitude of homemakers towards mushrooms

Though mushroom is considered as the “Queen of vegetables” there is still a controversy among people as to whether it is a vegetarian or non vegetarian food. About 40 to 47 per cent of the homemakers in Coimbatore and Erode considered mushroom as a non vegetarian food as its flavour, texture and taste closely resemble that of non vegetarian food.

Though mushrooms have a host of medicinal properties, above 75 per cent of the homemakers were ignorant of them. About 53 per cent and 43 per cent of homemakers in Coimbatore and Erode avoided mushroom in their diet during illness as they thought that it may cause indigestion due to its fibrous nature.

When the selected homemakers were enquired about their interest in learning the art of mushroom cultivation, above 75 per cent revealed that they were not interested since they were already preoccupied with their household chores. Only 28 per cent and 25 per cent of the homemakers in Coimbatore and Erode showed an interest in learning mushroom cultivation.

4.1.4. Use of mushrooms in restaurants

4.1.4.1. Purchase of fresh mushrooms

Details on type, place and frequency of procuring mushroom by the selected restaurant owners are given in Table 15.

TABLE 15
DETAILS ON PROCUREMENT OF FRESH MUSHROOMS BY
THE SELECTED RESTAURANT OWNERS

S.No. Details of procurement	Location			
	Coimbatore		Erode	
	N-50	Percent	N-20	Percent
1. Type of mushroom*				
a. Oyster	34	68	4	20
b. Button	38	76	11	55
c. Milky	Nil	Nil	5	25
2. Place of purchase				
a. Provision shop	5	10	6	30
b. Fruit stall	22	44	10	50
c. Door delivery	23	46	4	20
3. Frequency of purchase				
a. Daily	29	58	12	60
b. Weekly	15	30	8	40
c. Occassionally	6	12	Nil	Nil

* Multiple response

Seventy six and 55 per cent of restaurants in Coimbatore and Erode preferred and purchased button mushroom, while milky mushroom was preferred next to button mushroom at Erode. Milky mushroom was not used in the restaurants of Coimbatore when the survey was conducted as it was just appearing in the market.

Among the restaurant owners 44 per cent and 50 per cent in Coimbatore and Erode stated that they purchased the mushrooms from fruit stalls. However, 46 per cent and 20 per cent of the restaurant owners of Coimbatore and Erode were supplied with the mushroom at their door step by the mushroom cultivators themselves. Fifty eight and 60 per cent of the restaurant owners in Coimbatore and Erode respectively, purchased mushroom and prepared the recipes every day, while 30 per cent and 40 per cent of them purchased once or twice a week depending upon their menu. Twelve per cent from Coimbatore expressed that they purchased mushrooms on special days while preparing special items in order to meet the demands of the consumers.

The data on quantity of different species of mushroom purchased by selected restaurants is represented in Table 16.

TABLE 16
QUANTITY AND SPECIES OF MUSHROOM PURCHASED BY THE
SELECTED RESTAURANTS

S. Quantity No. (kg)	Type of mushroom purchased									
	Coimbatore					Erode				
	Oyster		Button		Oyster		Button		Milky	
	N:34		N:38		N:4		N:11		N:5	
	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent
1. 0 - <2	13	38	7	18	1	25	3	27	1	20
2. >2 - <4	17	50	26	69	1	25	3	27	3	60
3. >4 - <6	4	12	5	13	2	50	5	46	1	20

4.2 Impact of supplements on cultivation of oyster mushroom

Three trials were done to find out the impact of supplements.

The average cost and yield of three trials are discussed below:

4.2.1 Cost of cultivating oyster mushroom

Cost is an important aspect in running any business successfully.

The cost incurred in preparing the beds, using selected supplements on selected substrates, is presented in Table 17.

TABLE 17
COST INCURRED IN PREPARING THE BEDS USING SELECTED
SUPPLEMENTS ON SELECTED SUBSTRATES

Sample No	Supplements	Cost incurred per bed (Rs)	
		Paddy straw	Banana leaf /Banana stem /Sugarcane bagasse
1	Rice flour	7.50	7.00
2	Rice bran	7.30	6.80
3	Soya flour	8.50	8.00
4	Groundnut cake	7.36	6.85
5	Cotton seed	7.35	6.85
6	Rice flour:Rice bran (3:1)	7.43	6.93
7	Rice flour:Rice bran (2:2)	7.35	6.85
8	Rice flour:Rice bran (1:3)	7.28	6.78
9	Rice flour:Soya flour (3:1)	7.75	7.25
10	Rice flour:Soya flour (2:2)	8.00	7.50
11	Rice flour:Soya flour (1:3)	8.25	7.75
12	Rice flour:Groundnut cake (3:1)	7.47	6.97
13	Rice flour:Groundnut cake (2:2)	7.43	6.93
14	Rice flour:Groundnut cake (1:3)	7.40	6.90
15	Rice flour:Cotton seed (3:1)	7.46	6.96
16	Rice flour:Cotton seed (2:2)	7.43	6.93
17	Rice flour:Cotton seed (1:3)	7.39	6.89
18	Unsupplemented	6.40	5.90

The cost of spawn is Rs.5 per bed , polythene bag costs 40 p, substrate costs 50 p, and chemical cost is Rs.1.00. All the expenses are

similar for all beds except a additional cost of 50 p for paddy straw bed, which is the cost of the straw itself. Banana leaves were obtained from the market and banana stem and sugarcane bagasse from farm as a wastes. The cost of the supplements varied due to the variation in their cost and differences in the proportions of supplements used. Table 18 presents the comparison of yields of mushroom and statistical differences between substrates and supplements cultivated by the investigator. Appendix 5 gives the statistical analysis. The differences in the yield of mushroom was statistically analysed only for the substrates paddy straw and sugarcane bagasse as the yields in the other two substrates were negligible.

TABLE 18
COMPARISON OF YIELDS OF MUSHROOM CULTIVATED BY THE
INVESTIGATOR DURING SUMMER

S. No	Supplements	Yield of mushroom (in g) from different substrates		
		Paddy straw	Sugarcane bagasse	Average
1.	Rice flour	426.67	466.67	446.67
2.	Rice bran	406.67	330	368.33
3.	Soya flour	0	0	0
4.	Groundnut cake	0	440	220
5.	Cotton seed	461.67	490	475.83
6.	Rice flour : Rice bran (3:1)	380	310	345
7.	Rice flour : Rice bran (2:2)	440	293.33	366.67
8.	Rice flour : Rice bran (1:3)	621.67	223.33	422.50
9.	Rice flour : Soya flour (3:1)	500	256.67	378.33
10.	Rice flour : Soya flour (2:2)	0	0	0
11.	Rice flour : Soya flour (1:3)	75	506.67	290.83
12.	Rice flour : Groundnut cake (3:1)	346.67	290	318.33
13.	Rice flour : Groundnut cake (2:2)	0	220	110
14.	Rice flour : Groundnut cake (1:3)	0	0	0
15.	Rice flour : Cotton seed (3:1)	450	500	450
16.	Rice flour : Cotton seed (2:2)	526.67	330	428.33
17.	Rice flour : Cotton seed (1:3)	446.67	416.67	431.67
18.	Unsupplemented	313.33	346.67	330

ANOVA

Source of variance	SS	df	MS	F	F crit
Sample	2777744	17	163396.7	42.52507	1.766576
Columns	52/08333	1	52.08333	0.013555	3.973895
Interaction	1090910	17	64171.2	16.70098	1.766576
Within	276650	72	3842.361		
Total	4145356	107			

Statistical analysis of the data revealed that while significant differences between the supplements were observed (F value 42.53 $P < 0.01$) the difference between the substrates was not found to be significant (F value 0.01) when compared against the respective critical values. Among the supplements, on an average, cotton seed flour alone and rice flour : cotton seed (3:1) ranked first and second, followed by rice flour alone, rice flour: cotton seed (1:3), rice flour : cotton seed (2:2) and rice flour: rice bran (1:3). Rice flour : groundnut cake (2:2) ranked the least. However, the beds supplemented with soya flour alone, rice flour:soya flour (2:2), rice flour: groundnut cake (1:3) did not show any yield. The investigator noticed growth of *corpinus* species (ink cap mushroom) on all the beds which showed no yield. Hence, she had to dispose of the beds. This may be due to the formation of ammonia produced by the supplements, rich in nitrogen, which encouraged the growth of *corpinus* species as pointed out by Upadhyay (1998).

The yield of oyster mushroom cultivated during winter as recorded by the investigator is given in Table 19.

TABLE 19
YIELD OF OYSTER MUSHROOM DURING WINTER

S. No.	Supplements	Yield of mushroom (g)			
		Paddy straw	Banana leaf	Banana stem	Sugarcane bagasse
1.	Rice flour	663	750	793	655
2.	Cotton seed	503	555	580	513
3.	Rice flour: groundnut cake (1:3)	462	570	570	476
4.	Rice flour: cotton seed (1:3)	608	768	760	650
5.	Un supplemented	447	555	560	472

Results revealed that all the samples, irrespective of the supplement and substrate used, showed greater yield during winter when compared to cultivated during summer. While banana leaf and banana stem produced very little or no mushroom during summer, the same had produced maximum yield in winter, as seen in the case of the bed supplemented with rice flour alone and that of rice flour and cotton seed in the proportion of 1:3. Thus, cool climate (20-25° C) seems to have enhanced the production of mushroom.

Statistical analysis (F test) of the yield of oyster mushroom during winter is given in Table 20.

TABLE 20
COMPARISON OF YIELD OF MUSHROOM CULTIVATED BY
INVESTIGATOR IN WINTER USING SELECTED SUBSTRATES AND
SUPPLEMENTS

Supplements	Substrates				Total
	Paddy staw	Banana leaf	Banana stem	Sugarcane bagasse	
Rice flour					
Count	3	3	3	3	12
Sum	1990	1575	2378	1971	7914
Average	663.33	525	792.67	657	659.5
Variance	133.33	151875	756.33	147	37577.91
Cotton Seed Powder					
Count	3	3	3	3	12
Sum	1510	1695	1740	1538	6483
Average	503.33	565	580	512.67	540.25
Variance	33.33	175	0	6.33	1216.20
Rice Flour:Groundnut Cake 1:3					
Count	3	3	3	3	12
Sum	1385	1710	1710	1428	6233
Average	461.67	570	570	476	519.42
Variance	408.33	100	300	163	2995.90
Rice Flour:Cotton Seed1:3					
Count	3	3	3	3	12
Sum	1825	2303	2280	1950	8358
Average	608.33	767.67	760	650	696.5
Variance	303.33	506.33	625	400	5525.18
Unsupplemented					
Count	3	3	3	3	12
Sum	1340	1665	1680	1517	6202
Average	446.67	555	560	595.67	516.83
Variance	758.33	25	100	2564.33	2909.06
Total					
Count	15	15	15	15	
Sum	8050	8948	9788	8404	
Average	536.67	596.53	652.53	560.27	
Variance	7952.38	29917.41	11359.12	6845.21	
ANOVA					
Source of Variation	SS	df	MS	F	F crit
Sample	347070.17	4	86765.04	10.89	2.61
Columns	114489.27	3	38163.09	4.792	84
Interaction	119207.57	12	9933.96	1.25	2.00
Within	318770	40	7969.25		
Total	899527	59			

Statistical analysis indicated a significant difference among the supplements as well as among substrates ($F_{10.89, 4.79, P<0.01}$) when compared against the respective critical values. Among the substrates banana stem ranked first, followed by banana leaf, sugarcane bagasse and paddy straw. Among the supplements, rice flour: cotton seed (1:3) ranked first and unsupplemented, the least. It could be inferred from the Table that environmental factors play an important role in enhancing the yield of mushroom.

Differences in the yield of mushroom in summer and winter were analysed by 't' test. Yield from banana stem and banana leaf were not subjected to the test, as the yield from these two substrates were either negligible or there was no yield, as noticed in summer. Rice flour : ground nut cake (1:3) supplemented samples did not yield mushroom in summer, irrespective of the substrate. Hence 't' test could not be applied for this supplement either. The results of the 't' test are given in Table 21.

TABLE 21
MUSHROOM OBTAINED DURING WINTER AND SUMMER

Supplements	Yield of mushroom/bed (g)					
	Paddy straw			Sugarcane bagasse		
	W	S	't'	W	S	't'
Rice flour	663.3± 11.54	426.7± 20.82	19.89**	657± 12.1	466.7± 65.1	4.75**
Cotton seed	503.3 ± 5.77	461.7± 50.8	1.64 ^{NS}	512.7± 2.52	490± 20.0	2.18*
Rice flour : cottonseed (1:3)	608.3± 17.6	446.7± 30.5	9.18**	650± 20.0	416.7± 15.3	18.53**
Un supplemented	446.7± 27.54	313.3± 68.05	3.63*	472.7± 7.5	346.7± 5.8	26.58**

* $P>0.01$; ** $P>0.05$; N.S. Not significant W. Winter S. Summer

Among the beds prepared using paddy straw, the difference between the bed supplemented with rice flour alone and rice flour: cotton seed (1:3) showed a statistically significant difference ($P < 0.01$) in the yield produced during summer and winter. Among the beds prepared using sugarcane bagasse, the difference between the bed supplemented with rice flour and rice flour: cotton seed (1:3) and unsupplemented sample showed a statistically significant difference at ($P < 0.01$) level. The difference between the unsupplemented sample in paddy straw bed and the bed supplemented with cotton seed showed a statistically significant difference at ($P < 0.05$) level. No statistically significant result was noticed between the beds prepared with paddy straw and supplemented with cotton seed powder during summer and winter. The yield of mushroom in winter and summer is given in Figure 2.

4.2.2 Profit/loss realized by the investigator in cultivating oyster mushroom

As the investigator herself sold the mushroom harvested directly to the consumers at the rate of Rs.9/200g., she could get one rupee more profit, at the same time, the consumers could get the mushroom at one rupee less cost, as generally the mushroom is sold at a cost of Rs.10/200g in the shops. Figure 3 gives the profit margin realised in cultivating oyster mushroom during summer by the investigator.

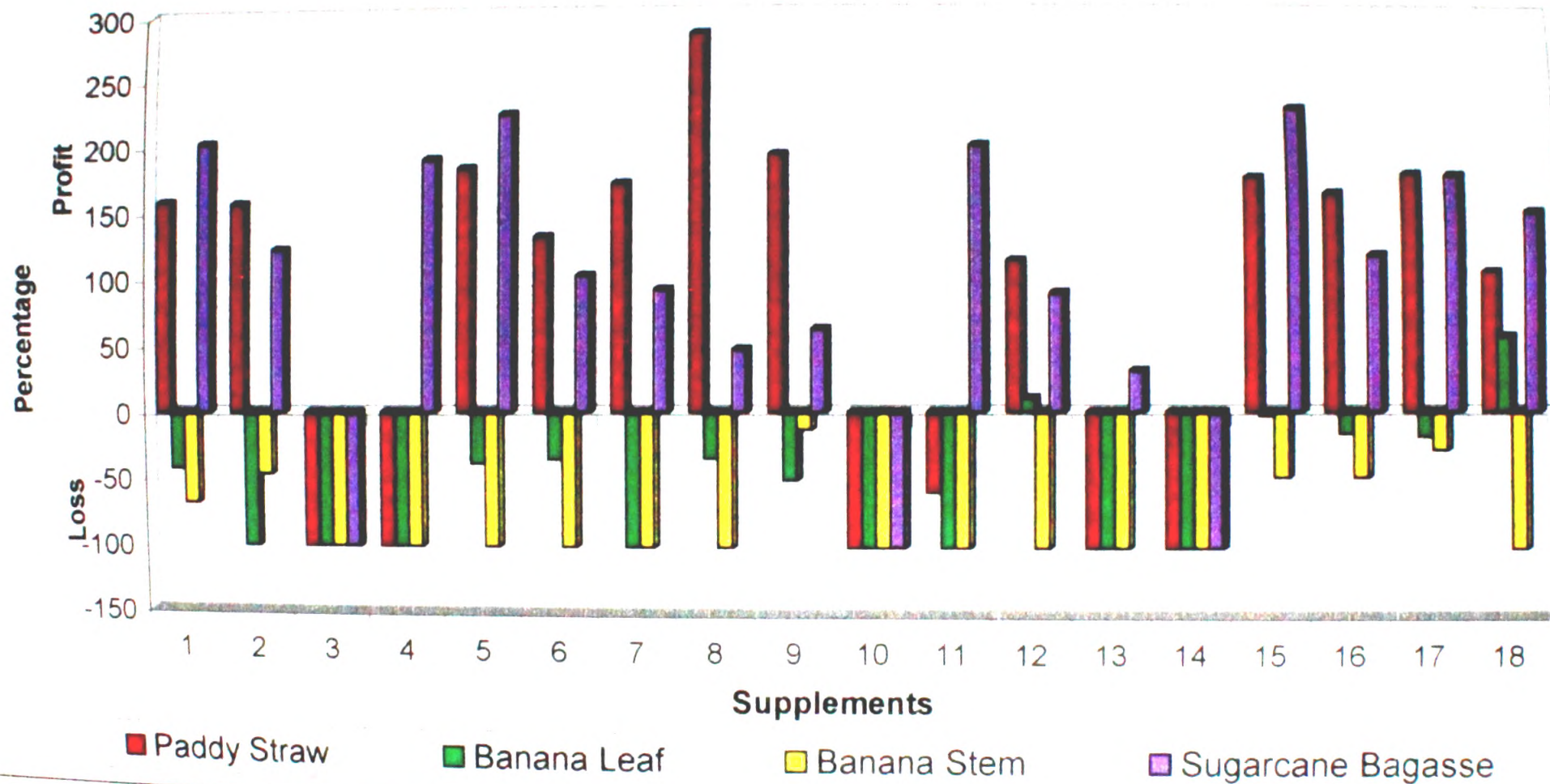
The profit margin, while cultivating 20 beds on various substrates incorporated with supplements, is given in Tables 22, 23, 24 and 25.

YIELD OF MUSHROOM IN WINTER AND SUMMER



FIGURE - 2

PROFIT/LOSS REALIZED BY CULTIVATING OYSTER MUSHROOM DURING SUMMER



1 Rice Flour
2 Rice Bran
3 Soya Flour
4 Groundnut Cake
5 Cotton Seed

6 Rice Flour Rice Bran (3 1)
7 Rice Flour Rice Bran (2 2)
8 Rice Flour Rice Bran (1 3)
9 Rice Flour Soya Flour (3 1)
10 Rice Flour Soya Flour (2 2)

11 Rice Flour Soya Flour (1 3)
12 Rice Flour Groundnut Cake (3 1)
13 Rice Flour Groundnut Cake (2 2)
14 Rice Flour Groundnut Cake (1 3)
15 Rice Flour Cotton Seed (3 1)

16 Rice Flour Cotton Seed (2 2)
17 Rice Flour Cotton Seed (1 3)
18 Unsupplemented

FIGURE - 3

TABLE 22

**PROFIT/LOSS REALIZED BY CULTIVATING OYSTER MUSHROOM ON
PADDY STRAW WITH AND WITH OUT THE SUPPLEMENT**

Sample No	Supplements	Yield from 20 beds and profit/loss realised				
		Yield (kg)	Income (Rs.)	Expenditure (Rs.)	Profit/loss (Rs.)	Profit/loss margin (%)
1	Rice flour	8.5	382.5	150.0	232.5	155.0
2	Rice bran	8.1	364.5	146.0	218.5	149
3	Soya flour	NY	NY	170.0	-170	-100
4	Groundnut cake	NY	NY	147.2	-147.2	-100
5	Cotton seed	9.2	414	147.0	267	181.6
6	Rice flour : Rice bran (3:1)	7.6	342	148.6	193.4	130.1
7	Rice flour : Rice bran (2:2)	8.8	396	147.0	249	169.4
8	Rice flour : Rice bran (1:3)	12.4	558	145.6	412.4	283.2
9	Rice flour : Soya flour (3:1)	10.0	450	155.0	295	190.3
10	Rice flour : Soya flour (2:2)	NY	NY	164.0	-164	-100
11	Rice flour : Soya flour (1:3)	1.5	67.5	165.0	-97.5	- 59.1
12	Rice flour : Groundnut cake (3:1)	6.9	310.5	149.4	161.1	107.8
13	Rice flour : Groundnut cake (2:2)	NY	NY	148.6	-148.6	-100
14	Rice flour : Groundnut cake (1:3)	NY	NY	148.0	148	-100
15	Rice flour : Cotton seed (3:1)	9.0	405	149.2	255.8	171.4
16	Rice flour : Cotton seed (2:2)	10.5	472.5	148.6	323.9	218
17	Rice flour : Cotton seed (1:3)	8.9	400.5	147.8	252.7	171
18	Unsupplemented	6.3	283.5	128.0	155.5	121.5

The - sign in front of figures indicate loss

Sample 8 supplemented with rice flour and rice bran in the proportion of 1:3 resulted in a maximum yield and maximum income (Rs.558) and a profit margin of 283.2 percent could be obtained. Sample 16 supplemented with rice flour and cotton seed in the proportion of 2:2 resulted in 218 percent profit. However, the unsupplemented sample could give only 121.5 percent profit. Profit margin for most of the other supplements was between the amount realized for the rice flour:rice bran (1:3) and unsupplemented sample. However, there was a loss to the extent of 59 to 100 percent in the case of beds

supplemented with soya flour, groundnut cake, rice flour : soya flour (2:2 and 1:3) and rice flour : groundnut cake (2:2 and 1:3). Thus, if the mushroom cultivators could carefully select the supplement which is capable of producing maximum yield, they could enhance their production as well as their income.

TABLE 23
PROFIT/LOSS REALIZED BY CULTIVATING OYSTER MUSHROOM
ON BANANA LEAF WITH AND WITHOUT THE SUPPLEMENTS

Sample No	Supplements	Yield (kg)	Income (Rs.)	Expenditure (Rs.)	Profit/loss (Rs.)	Profit/loss margin (%)
1	Rice flour	1.8	81	140.0	-59.0	-42
2	Rice bran	NY	NY	136.0	-136.0	-100
3	Soya flour	NY	NY	160.0	-160.0	-100
4	Groundnut cake	NY	NY	137.0	-137.0	-100
5	Cotton seed	1.9	85.5	137.0	-51.5	-37.5
6	Rice flour:Rice bran (3:1)	2	90	138.6	-48.6	-35.1
7	Rice flour:Rice bran (2:2)	NY	NY	137.0	-137.0	-100
8	Rice flour:Rice bran (1:3)	2	90	135.6	-45.6	-33.6
9	Rice flour:Soya flour (3:1)	1.6	72	145.0	-73.0	-50.3
10	Rice flour:Soya flour (2:2)	NY	NY	150.0	-150.0	-100
11	Rice flour:Soya flour (1:3)	NY	NY	155.0	-155.0	-100
12	Rice flour:Groundnut cake (3:1)	2.8	126	139.4	13.4	9.6
13	Rice flour:Groundnut cake (2:2)	NY	NY	138.6	-138.6	-100
14	Rice flour:Groundnut cake (1:3)	NY	NY	138.0	-138.0	-100
15	Rice flour:Cotton seed (3:1)	3	135	139.2	-4.20	-3
16	Rice flour:Cotton seed (2:2)	2.6	117	138.6	-21.6	-15.6
17	Rice flour:Cotton seed (1:3)	2.5	112.5	137.8	-25.3	-18.4
18	Unsupplemented	4.4	198	118.0	80	67.8

The - sign in front of figures indicate loss.

From Table 23 it is inferred that the maximum profit of 67.8 per cent could be obtained only from the bed that was not supplemented and 9.6 per cent from the bed supplemented with rice flour: ground nut cake (3:1).

Hence, it could be concluded that banana leaf is not suitable for mushroom cultivation, during summer.

TABLE 24
PROFIT/LOSS REALIZED BY CULTIVATING OYSTER MUSHROOM ON BANANA STEM WITH AND WITHOUT SUPPLEMENTS

Sample No	Supplements	Yield (kg)	Income (Rs.)	Expenditure (Rs.)	Profit/loss (Rs.)	Profit/loss margin (%)
1	Rice flour	1	45	140.0	- 95.0	- 67.8
2	Rice bran	1.6	72	136.0	- 64.0	- 47
3	Soya flour	NY	NY	160.0	-160.0	-100
4	Groundnut cake	NY	NY	137.2	-137.2	-100
5	Cotton seed	NY	NY	137.0	-137.0	-100
6	Rice flour:Rice bran (3:1)	NY	NY	138.6	-138.6	-100
7	Rice flour:Rice bran (2:2)	NY	NY	137.0	-137.0	-100
8	Rice flour:Rice bran (1:3)	NY	NY	135.6	-135.6	-100
9	Rice flour:Soya flour (3:1)	2.8	126	145.0	- 19.0	- 13.1
10	Rice flour:Soya flour (2:2)	NY	NY	150.0	-150.0	-100
11	Rice flour:Soya flour (1:3)	NY	NY	155.0	-155.0	-100
12	Rice flour:Groundnut cake (3:1)	NY	NY	139.4	-139.4	-100
13	Rice flour:Groundnut cake (2:2)	NY	NY	138.6	-138.6	-100
14	Rice flour:Groundnut cake (3:1)	NY	NY	138.0	-138.0	-100
15	Rice flour:Cotton seed (3:1)	1.6	72	139.2	- 67.2	- 48.2
16	Rice flour:Cotton seed (2:2)	1.6	72	138.6	- 66.6	- 48.1
17	Rice flour:Cotton seed (1:3)	2.2	99	137.8	- 38.8	- 28.2
18	Unsupplemented	NY	NY	118.0	-118.0	-100

* The - sign in front of figures indicate loss.

Table 24 reveals that none of the supplements enhanced the production of mushroom. There was a loss which ranged between 13.1-100 percent. Hence, using banana stem as substrate is not advisable during summer, as the bed gets infected very quickly due to the high moisture content and humidity and does not yield desirable results.

TABLE 25

**PROFIT/LOSS REALISED BY CULTIVATING OYSTER MUSHROOM ON
SUGARCANE BAGASSE WITH AND WITHOUT SUPPLEMENTS**

Sample No	Supplements	Yield (kg)	Income (Rs.)	Expenditure (Rs.)	Profit/loss (Rs.)	Profit/loss margin (%)
1	Rice flour	9.3	418.5	140.0	278.5	198.9
2	Rice bran	6.6	297	136.0	161.0	118.4
3	Soya flour	NY	NY	160.0	-160.0	-100.0
4	Groundnut cake	8.8	396	137.0	258.5	188.6
5	Cotton seed	9.8	441	137.0	304.0	221.9
6	Rice flour:Rice bran (3:1)	6.2	279	138.6	140.4	101.3
7	Rice flour:Rice bran (2:2)	5.9	265	137.0	128.5	93.8
8	Rice flour:Rice bran (1:3)	4.5	202.5	135.6	66.8	49.3
9	Rice flour:Soya flour (3:1)	5.1	229	145.0	84.5	58.3
10	Rice flour:Soya flour (2:2)	NY	NY	150.0	-150.0	-100.0
11	Rice flour:Soya flour (1:3)	10.1	454.5	155.0	299.5	193.2
12	Rice flour:Groundnut cake (3:1)	5.8	261	139.4	121.6	87.2
13	Rice flour:Groundnut cake (2:2)	4.4	198	138.6	59.4	42.9
14	Rice flour:Groundnut cake (1:3)	NY	NY	138.0	-138.0	-100.0
15	Rice flour:Cotton seed (3:1)	10	450	139.2	311.0	223.7
16	Rice flour:Cotton seed (2:2)	6.6	297	138.6	158.4	114.3
17	Rice flour:Cotton seed (1:3)	8.3	373.5	137.8	235.7	171.0
18	Unsupplemented	6.9	310.5	118.0	192.5	163.1

* The - sign in front of figures indicate loss.

With regard to the yield of mushroom on sugarcane bagasse, the profits realized were not as high as was noted with paddy straw. A profit margin of 223.7 percent was realized in the beds supplemented with rice flour and cotton seed in the proportion of 3:1, followed by cotton seed alone (221.9 percent), rice flour alone (198.9 percent) and rice flour and soya flour in the proportion of 1:3 (193.2 percent). A minimum of 42.9 per cent profit was noticed in the beds supplemented with rice flour and groundnut cake (2:2). However, 100 percent loss was also noticed in beds supplemented

with soya flour alone , rice flour: soya flour (2:2) and rice flour: groundnut cake (1:3). It may be concluded that sugarcane bagasse may also be used as a substrate, as an alternative to paddy straw, safely during both summer and winter.

Profit realized by cultivating 20 beds of oyster mushroom during winter on selected substrates using the supplements is given in Table 26 and Figure 4.

TABLE 26
PROFIT GAINED BY CULTIVATING OYSTER MUSHROOM
DURING WINTER

Sample No	Supplements	Yield (kg)	Income (Rs.)	Expenditure (Rs.)	Profit (Rs.)	Profit margin (%)
1.	Paddy straw					
	Rice flour (RF)	13.3	596.7	150	446.7	297.3
	Cotton seed (CS)	10.1	452.7	147	305.7	207.9
	Groundnut cake (GNC)	9.3	415.8	147.2	267.8	181.9
	RF:GNC (1:3)	12.2	547.2	148	399.2	269.7
	RF:CS (1:3)	8.9	402.3	147.8	254.5	172.1
2.	Banana leaf					
	Rice flour (RF)	15.0	675	140	535	382.1
	Cotton seed (CS)	11.1	499.5	137	362.5	264.6
	Groundnut cake (GNC)	11.4	513	137.2	375.8	273.9
	RF:GNC (1:3)	15.4	691.2	130	561.2	431.6
	RF:CS (1:3)	11.1	499.5	137.8	361.7	262.5
3.	Banana stem					
	Rice flour (RF)	15.9	713.7	140	573.7	409.8
	Cotton seed (CS)	11.6	522	137	385	281.0
	Groundnut cake (GNC)	11.4	513	137.2	375.8	273.9
	RF:GNC (1:3)	15.2	684	130	554	426.1
	RF:CS (1:3)	11.2	504	137.8	366.2	265.7
4.	Sugarcane bagasse					
	Rice flour (RF)	13.1	589.5	140	449.5	321.0
	Cotton seed (CS)	10.3	461.7	137	324.7	237
	Groundnut cake (GNC)	9.5	428.4	137.2	291.2	212.2
	RF:GNC (1:3)	13.0	585	130	455	350
	RF:CS(1:3)	9.4	423	137.8	285.2	207

PROFIT GAINED BY CULTIVATING OYSTER MUSHROOM DURING WINTER

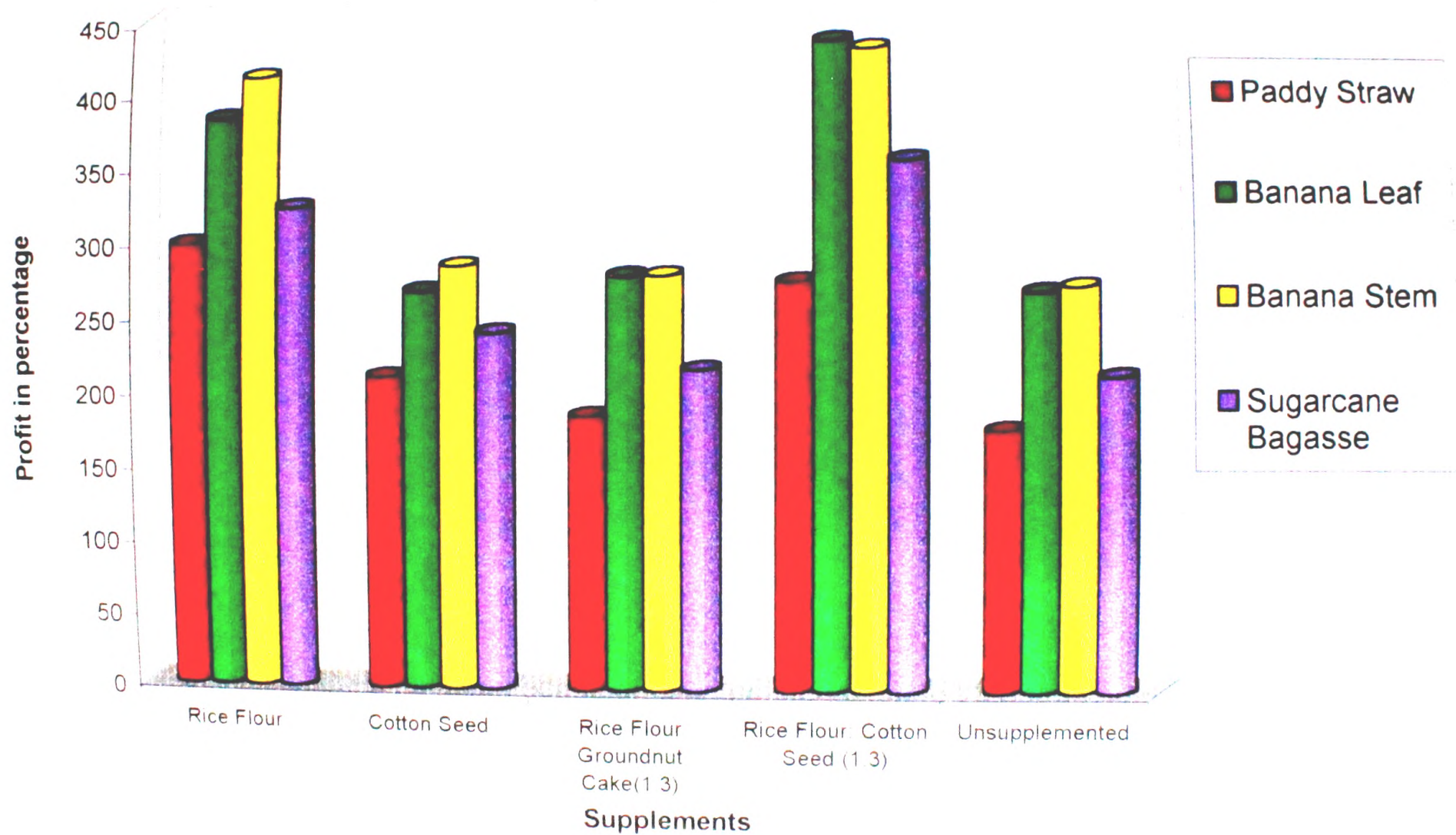


FIGURE - 4

The yield of mushroom was greater during winter than in summer. The bed prepared using banana leaf and supplemented with rice flour and groundnut cake (1:3), which did not produce any yield during summer, showed maximum yield during winter, fetching a profit margin of 431.6 percent followed by banana stem supplemented with rice flour and groundnut cake in the proportion of 1:3 (426.1 percent) and rice flour alone (409.8 percent). It may be concluded that banana leaf and banana stem could also be used for cultivation of mushroom during winter successfully, while the other two substrates may be used during both the seasons.

4.2.3 Time required for completion of different stages in mushroom growth

The time required in days for completion of each stage in oyster mushroom growth is shown in Table 27 and 28. The recording was done during both summer and winter.

TABLE 27
TIME REQUIRED FOR COMPLETING DIFFERENT STAGES IN
MUSHROOM GROWTH IN SUMMER

S.No.	Supplements	Time required in days									
		Paddy straw					Sugarcane bagasse				
		SR	PHA	I	II	III	SR	PHA	I	II	III
1	Rice flour (R.F)	14	17	21	32	41	15	18	23	30	38
2	Rice bran (R.B)	15	20	24	31	40	16	21	26	32	36
3	Soya flour (S.F)	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY
4	Groundnut cake(GNC)	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY
5	Cotton seed (C.S)	13	18	22	28	38	10	14	22	26	31
6	Rice flour:Rice bran 3:1	10	16	28	30	42	12	17	21	26	32
7	Rice flour: Rice bran 2:2	10	16	19	29	40	12	18	22	26	33
8	Rice flour: Rice bran 1:3	13	18	20	28	37	14	18	23	30	36
9	Rice flour: Soya flour 3:1	12	16	19	26	32	10	14	22	28	34
10	Rice flour: Soya flour 2:2	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY
11	Rice flour: Soya flour 1:3	28	38	44	NY	NY	15	19	27	32	40
12	Rice flour:Groundnut cake 3:1	13	25	36	40	47	12	17	22	39	44
13	Rice flour:Groundnut cake 2:2	NY	NY	NY	NY	NY	11	15	22	40	48
14	Rice flour:Groundnut cake 1:3	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY
15	Rice flour:Cotton seed 3:1	11	13	19	24	37	10	16	25	32	39
16	Riceflour:Cotton seed 2:2	13	15	18	28	34	13	19	24	32	41
17	Riceflour:Cotton seed 1:3	14	18	22	31	42	12	19	24	29	35
18	Unsupplemented	14	19	22	31	38	12	19	24	32	40

* TABLE 27 does not include information relating to the mushroom growth using banana leaf and banana stem as their yields were negligible.

SR = Spawn running PHA = Pin head appearance NY = No Yield
 I-First harvest II-Second harvest III-Third harvest

It is evident that in the mushroom cultivated on paddy straw, there was a quick white mycelial growth of the fungus (spawn running) in sample 6 and 7 (RF:RB 3:1 and RF:RB 2:2), while delayed growth of the mycelium was noticed in sample 11 (RF:SF 1:3). Pin head appearance was seen around 13th day in sample 15 (RF:CS 3:1), while a maximum of 38 days were required for sample 11 (RF:SF 1:3) for the pin heads to develop. First harvest could be done within 18 days in sample 16 (RF:CS 2:2), while second and third harvests were done on 28th and 34th day in the same bed. The bed supplemented with rice flour: soya flour in the proportion of 1:3 (sample 11)

took a maximum of 44 days to produce the first flush of mushroom. Further the bed did not produce any mushroom for the next picking. A maximum of 40 days and 47 days were required by the bed supplemented with rice flour: groundnut cake (3:1) for the second and third harvests respectively.

Fast growth of the mycelium was noticed in the beds prepared with sugarcane bagasse and supplemented with cotton seed, rice flour and soya flour (3:1) and rice flour and cotton seed (3:1). The pin head started appearing within 14 days in samples five (cotton seed alone) and nine (rice flour: soya flour 3:1).

It was observed that within a short period of 31 days all the three harvests could be done on the bed prepared, using sugarcane bagasse supplemented with cotton seed. In general, the time required was short in the beds prepared using sugarcane bagasse. Thus, sample 8 in paddy straw showed a greater yield in a lesser period than unsupplemented sample, while the beds prepared using sugarcane bagasse with cotton seed supplementation showed the higher yield within a short time.

The beds prepared using banana leaf and banana stem showed a comparatively delayed growth and, in most cases, no yield was noticed. In unsupplemented sample, though the bed prepared using sugarcane bagasse showed spawn-running within 12 days, it took 40 days to complete three harvests. In the case of beds prepared using paddy straw it took 14 days for spawn-running, 19 days for pin head appearance, 22, 31 and 38 days for I, II and III harvests respectively.

TABLE 28

TIME REQUIRED FOR COMPLETION OF DIFFERENT STAGES, IN MUSHROOM GROWTH IN WINTER

Sample No.	Supplements	Substrates used (Stages)																			
		Paddy straw					Banana leaf					Banana stem					Sugarcane bagasse				
		SR	PHA	I	II	III	SR	PHA	I	II	III	SR	PHA	I	II	III	SR	PHA	I	II	III
1.	Rice flour	24	27	30	34	39	19	23	25	31	36	18	21	24	30	35	21	23	26	1	36
2.	Cotton seed	23	28	31	35	41	21	23	27	32	37	20	22	25	31	37	22	25	28	33	38
3.	Rice flour : Ground nut cake (1:3)	24	27	32	36	42	22	24	27	32	38	21	24	26	32	38	23	26	29	35	39
4.	Rice flour : Cotton seed (1:3)	26	29	31	35	50	20	23	26	31	37	19	22	25	30	36	22	25	27	32	37
5.	Unsupplemented	26	29	32	37	43	22	25	28	33	39	20	23	26	31	38	23	27	30	34	39

SR - Spawn-running

PHA- Pin head appearance

I, II, III - First, second and third harvests respectively

A minimum of 18 and 19 days were required for spawn-running in beds prepared from banana stem and banana leaf supplemented with rice flour. Beds prepared with banana stem supplemented with rice flour took a minimum of 21 days for pin head appearance.

In general it is obvious from the table that the harvesting started only from the 24th day and ended on 43rd day. However, by way of yield and period required for maturation of sporocarp cultivated on banana stem and banana leaf, supplemented with rice flour proved to be satisfactory. Though it may be concluded that the number of days required for completing three pickings were not constant and varied with substrate and supplement used, unsupplemented samples appeared to take more time for maturation of sporocarp when compared to supplemented samples both in summer and winter.

4.2.4 Size of the harvested mushroom

The results relating to the size of the harvested mushroom in summer and winter are given in Table 29 and 30.

TABLE 29
SIZE OF THE HARVESTED MUSHROOM IN SUMMER

Sample No.	Supplements	Size (in sq.cm)			
		Substrates			
		Paddy straw	Banana leaf	Banana stem	Sugarcane bagasse
1	Rice flour	141	60	18	48
2	Rice bran	59	NY	16	56
3	Soya flour	NY	NY	NY	NY
4	Groundnut cake	NY	NY	96	17
5	Cotton seed	143	35	NY	91
6	Rice flour: Rice bran (3:1)	42	23	NY	60
7	Rice flour: Rice bran (2:2)	60	NY	NY	131
8	Rice flour: Rice bran (1:3)	119	38	NY	63
9	Rice flour: Soya flour (3:1)	85	29	57	96
10	Rice flour: Soya flour (2:2)	NY	NY	NY	NY
11	Rice flour: Soya flour (1:3)	85	NY	NY	62
12	Rice flour: Groundnut cake (3:1)	80	37	NY	62
13	Rice flour: Groundnut cake (2:2)	NY	NY	NY	42
14	Rice flour: Groundnut cake (1:3)	NY	NY	NY	NY
15	Rice flour: Cotton seed (3:1)	69	34	37	50
16	Rice flour: Cotton seed (2:2)	101	34	63	61
17	Rice flour: Cotton seed (1:3)	120	43	36	64
18	Unsupplemented	162	48	NY	50

The size and thickness of the sporocarp are indicators of the healthy growth of the mushroom. It is clear that mushroom grown on paddy straw beds, produced the biggest sporocarp in the supplemented as well as unsupplemented samples. The mushroom grown on sugarcane bagasse ranked next, followed by banana stem and leaf.

Mushroom produced by the paddy straw beds supplemented with rice flour : rice bran (1:3) and rice flour : soya flour (3:1) had a thick sporocarp (2cm) when compared to the mushroom produced on other beds.

Beds prepared with sugarcane bagasse and supplemented with rice flour produced a sporocarp with a minimum thickness (0.6 cm)

TABLE 30
SIZE OF THE HARVESTED MUSHROOM IN WINTER

Sample No.	Supplements	Size in (sq.cm)			
		Substrates			
		Paddy straw	Banana leaf	Banana stem	Sugarcane bagasse
1.	Rice flour	67	100	110	97
2.	Cotton seed	51	83	88	45
3.	Rice flour: Groundnut cake (1:3)	44	78	74	52
4.	Rice flour: Cotton seed (1:3)	49	75	89	46
5.	Unsupplemented	36	65	70	46

The size of the mushroom cultivated on banana stem (110 sq. cm), banana leaf (100 sq. cm), sugarcane bagasse (97 sq. cm) and paddy straw (67 sq. cm) supplemented with rice flour respectively was big. The size of mushroom was big when cultivated on banana leaf, banana stem and sugarcane bagasse. The thickness of the sporocarp increased in supplemented samples though it was not as thick as the mushroom produced in summer. The difference in the size and thickness of the mushroom may be due to environmental factors and agronomic variations adopted during the process of cultivation.

4.3. Analysis of the substrates for their cellulose, lignin and hemicellulose content, its bioefficiency and NPK

A comparison of cellulose, lignin and hemicellulose content of fresh and spent substrates is given in Table 31 and Figure 5.

CELLULOSE, LIGNIN AND HEMI CELLULOSE CONTENT OF FRESH AND SPENT SUBSTRATES

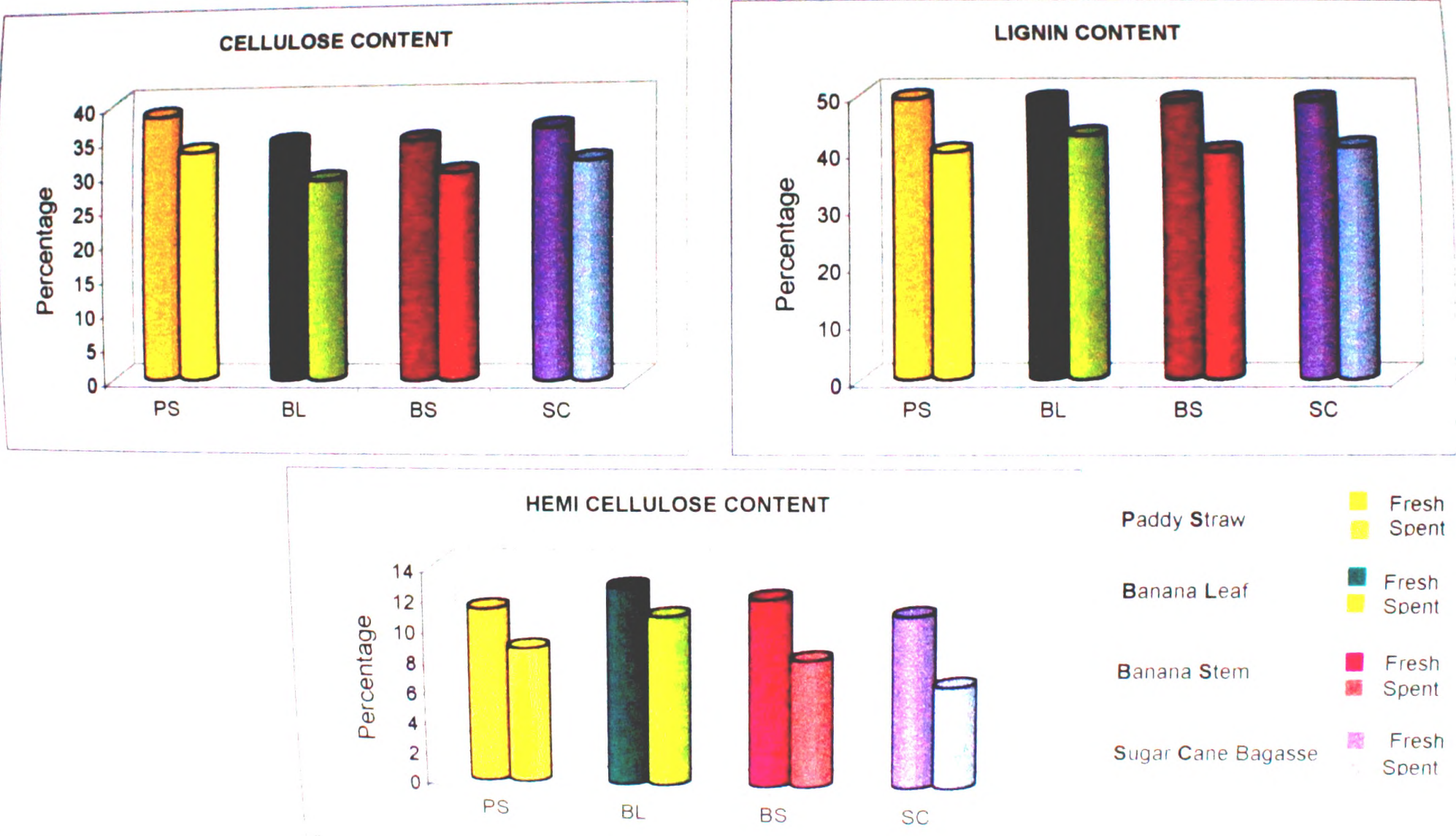


FIGURE - 5

TABLE 31

CELLULOSE, LIGNIN AND HEMICELLULOSE CONTENT OF FRESH AND SPENT SUBSTRATES (IN PERCENTAGE)

Content	Substrates							
	Paddy straw		Banana leaf		Banana stem		Sugarcane bagasse	
	Fresh	Spent	Fresh	Spent	Fresh	Spent	Fresh	Spent
Cellulose	38.23	32.97	34.21	28.75	34.32	29.61	35.99	31.28
Difference	5.26		5.46		4.71		4.71	
Lignin	49.26	39.71	48.91	42.62	48.70	39.68	48.82	40.66
Difference	9.55		6.29		9.02		8.16	
Hemicellulose	11.26	8.72	12.71	10.86	11.98	8.11	10.96	6.49
Difference	2.54		1.85		3.87		4.47	

The cellulose content was higher in the spent substrate of paddy straw than the other substrates. The lignin content was high in the spent banana leaf and sugarcane bagasse, while hemicellulose content was high in the spent substrates of banana stem and banana leaf. Thus, while some percentage of cellulose, lignin and hemicellulose were lost during the cultivation of mushroom, the substrates still retained a good percentage of carbohydrate and thus could be recycled as manure for plants. It can also be used as animal feed as the spent substrate will be easily digested by animals when compared to fresh ones.

The bioefficiency of the selected four substrates was calculated based on the yield of mushroom produced from the initial 500g of dry weight of the selected substrates. Five hundred grams of paddy straw increased to 1,730g, banana leaf to 2,150g, banana stem to 1,395g and sugarcane bagasse

to 1,895g by weight when soaked in water and all the excess water removed before preparing the bed.

The bioefficiency of the substrates are given in Table 32 and

Figure 6.

TABLE 32
BIOEFFICIENCY OF THE SUBSTRATES

Sample No.	Supplements	Bioefficiency of the substrates (per cent)							
		Paddy straw		Banana leaf		Banana stem		Sugarcane bagasse	
		D.W	W.W	D.W	W.W	D.W	W.W	D.W	W.W
1	Rice flour	9.21	26.6	1.37	4.9	0.59	2.3	8.42	22.7
2	Rice bran	8.52	24.4	NY	NY	0.98	3.3	5.98	16.0
3	Soya flour	NY	NY	NY	NY	NY	NY	NY	NY
4	Groundnut cake	NY	NY	NY	NY	NY	NY	9.11	23.2
5	Cotton seed	9.31	27.2	2.35	5.6	NY	NY	10.09	25.8
6	Rice flour : Rice bran (3:1)	7.45	20	2.11	5	NY	NY	7.06	19.0
7	Rice flour : Rice bran (2:2)	7.55	22	NY	NY	NY	NY	5.39	14.6
8	Rice flour : Rice bran (1:3)	10.68	31.1	2.45	5.7	NY	NY	4.60	12.7
9	Rice flour : Soya flour (3:1)	9.02	26.3	1.86	4.5	1.76	6.4	5.49	17.1
10	Rice flour : Soya flour (2:2)	NY	NY	NY	NY	NY	NY	NY	NY
11	Rice flour : Soya flour (1:3)	1.37	4.1	NY	NY	NY	NY	8.33	22.4
12	Rice flour : Groundnut cake (3:1)	6.57	17.3	2.84	6.7	NY	NY	5.39	23.6
13	Rice flour : Groundnut cake (2:2)	NY	NY	NY	NY	NY	NY	3.82	10.3
14	Rice flour : Groundnut cake (1:3)	NY	NY	NY	NY	NY	NY	NY	NY
15	Rice flour : Cotton seed (3:1)	9.8	28.1	3.32	7.9	0.98	3.6	8.43	22.4
16	Rice flour : Cotton seed (2:2)	9.6	27.7	2.74	6.5	0.98	3.6	6.17	16.3
17	Rice flour : Cotton seed (1:3)	9.6	24.8	2.94	6.9	1.27	4.7	7.84	21.2
18	Unsupplemented	5.98	20.9	4.61	11	NY	NY	6.47	17.1

DW: Dry weight of substrate

WW: Wet weight of substrate

BIOEFFICIENCY OF THE SUBSTRATES

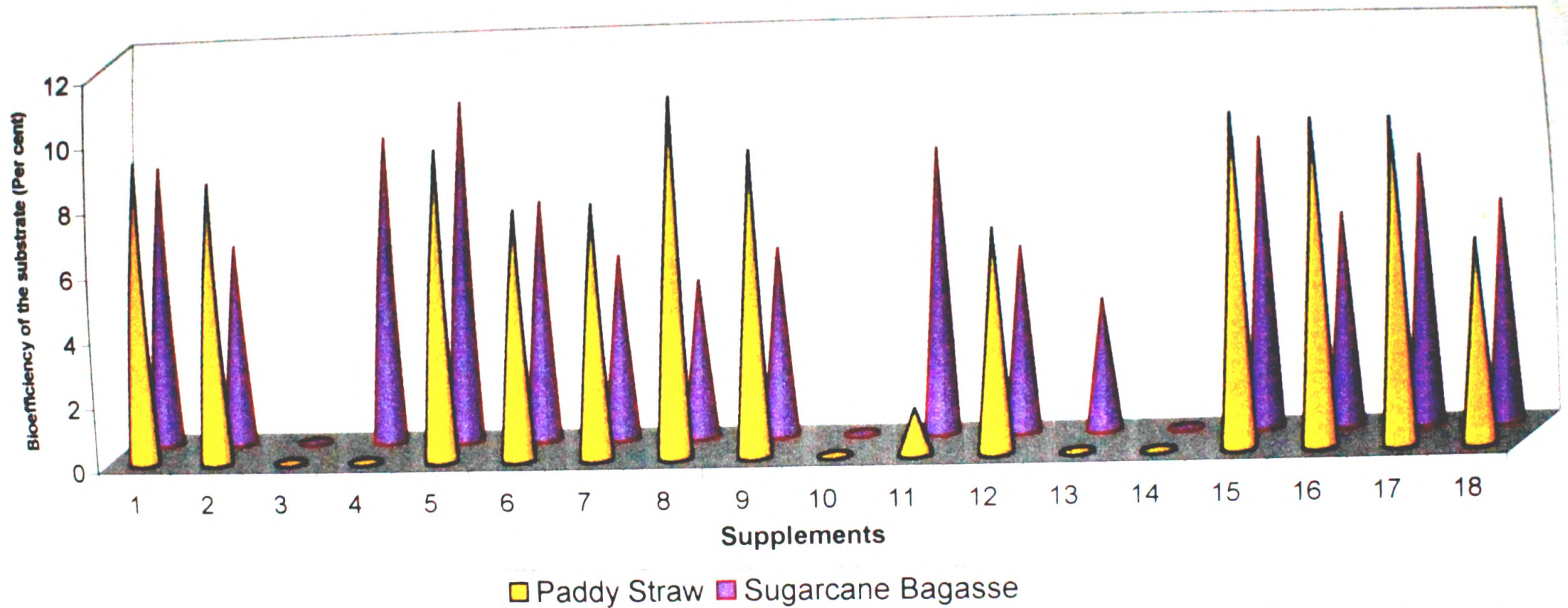


FIGURE - 6

The bioefficiency was maximum in sample 8 in which paddy straw was used as substrate and the same supplemented with rice flour and rice bran in the proportion 1 : 3. Sample 1 (rice flour alone), sample 5 (cotton seed alone), sample 9 (rice flour : soya flour 3:1), sample 15,16 and 17 (rice flour: cotton seed 3:1, 2:2 and 1:3) also recorded bioefficiency values above 9 per cent with paddy straw as substrate. This data is slightly lower than that given by Pimpalskar et al (1994). According to them the biological efficiency was found to be 15 per cent by dry weight basis.

Based on wet weight calculation the bioefficiency was much higher, ranging from 24.4 - 31.3 per cent, for the sample mentioned above. The bioefficiency values using banana leaf and banana stem as substrate were very low when calculated both on dry weight and wet weight basis.

Sugarcane bagasse as a substrate appeared to perform well, recording bioefficiency values as high as 10.09 per cent on dry weight basis and 25.8 per cent on wet weight basis. The bioefficiency of unsupplemented sample on the substrate paddy straw was only 5.98 per cent and 20.9 per cent on dry weight and wet weight basis respectively. The same on sugarcane bagasse as substrate was only 6.47 per cent and 17.1 per cent when calculated on dry weight and wet weight basis.

The over all picture that emerges indicate preference for use of paddy straw and sugarcane bagasse as substrate. It may be further inferred from the table that supplementation has improved the bioefficiency of the substrates.

The NPK content of the spent substrates is given in Table 33.

TABLE 33
NPK CONTENT OF THE SPENT SUBSTRATES

S.No.	Spent substrates	NPK content (per cent)		
		Nitrogen (N)	Phosphorus (P)	Potassium (K)
1.	Paddy straw	1.74	0.9	0.21
2.	Banana leaf	1.79	0.03	0.91
3.	Banana stem	0.11	0.26	0.51
4.	Sugarcane bagasse	1.46	0.05	0.13

Table 33 shows that banana leaf, paddy straw and sugarcane bagasse contained 1.79, 1.74 and 1.46 per cent of nitrogen, while it was much less (0.11 per cent) in banana stem. Phosphorus content was high in paddy straw (0.9 per cent), while banana stem recorded 0.26 per cent and the other two substrates recorded negligible amounts. With regard to potassium, 0.91 per cent was found in spent substrate of banana leaf, while paddy straw contained 0.21 per cent, banana stem 0.51 percent and sugarcane bagasse 0.13 per cent. Thus, the spent substrate which is still rich in NPK when disposed into the soil will be a good soil conditioner and will also serve as soil fertilizer.

4.4 Impact of supplements on cultivation of milky mushroom

4.4.1. Yield of milky mushroom, cost of cultivation and profit margin realized

Table 34 presents details of cost of production, profit margin and profit percentage in cultivating mushroom during seasons other than winter

TABLE 34
PROFIT IN CULTIVATING MILKY MUSHROOM

Details	Samples	
	Unsupplemented (20 beds)	Supplemented (20 beds)
Yield of mushroom (Kg)	13.5	13.03
Expenditure incurred (Rs)	249	258
Net profit (Rs)	561	523.80
Profit percentage	225.3	202.7

* Cost of mushroom calculated at the rate of Rs. 12/200g

** The expenditure incurred does not include labour and other permanent investment

The cost incurred for supplemented groups was more due to supplementation with rice flour when compared to unsupplemented samples. Calculating the cost of mushroom cultivated at the rate of Rs.12/200g, a maximum net profit of Rs.31 was obtained from one bed of unsupplemented sample, while supplemented sample fetched a profit of Rs.29.20 only.

When the number of beds prepared for experimental purpose was extrapolated to 20 beds it was observed that the profit margin gained was Rs.561 in unsupplemented sample and Rs.523.80 for supplemented sample. The profit percentage was calculated as 225.3 percent for unsupplemented sample and 202.7 percent for supplemented sample. In future various supplements could be tried in cultivating milky mushroom as an attempt to increase the yield.

4.5. Cultivation of button mushroom

4.5.1. Yield from button mushroom and profit margin realized by mushroom cultivators.

As button mushroom could not be cultivated in plains, based on the information collected from the cultivators the profit realized in cultivating button mushroom was worked out and is presented in Table 35.

TABLE 35
PROFIT IN CULTIVATING BUTTON MUSHROOM

S.No	Details	Profit realized 20 beds
1.	Cost of spawn and compost	Rs. 400
2.	Cost of labour and maintenance	Rs. 200
3.	Quantity of mushroom produced	30 kg
4.	Amount realized at the rate of Rs 13/200g	Rs. 1950
5.	Value of spent compost (20 bags)	Rs. 40
6.	Amount realized/bag	Rs. 69.50
7.	Expenditure incurred	Rs. 600
8.	Net profit	Rs. 1,390
9.	Profit (in percent)	232

It is evident that an investment of Rs. 30 could fetch a profit of Rs. 69.50 which amounts to 232 percent. As preparing compost is a laborious and also highly technical process, all the entrepreneurs had employed labourers for the activity. Only the spent compost of button mushroom is sold at the cost

of Rs. 2 per bag, hence it has been included under profit realized. Though the profit seems to be very attractive, the number of days taken to realize the profit is almost twice that of milky and oyster mushroom. Hence, in order to obtain a standard income one should plan and cultivate the mushroom so that there is regular yield.

4.6. Comparing the keeping quality, acceptability and nutritive value of oyster, button and milky mushrooms

4.6.1. Keeping quality of three species of mushrooms in fresh forms

When mushrooms were stored, their quality deteriorated by way of change in colour, texture and odour, because they respire fast, lack protective covering, rich in oxidizing enzymes and due to the presence of high water content. The changes that took place when fresh mushrooms were stored in different conditions, and the time taken for these changes to occur until it became unfit for consumption are discussed below.

The keeping quality of oyster and button mushroom was good only for 24 hours, when kept at room temperature in a polythene cover, as well as in closed stainless steel vessel, after which the mushroom developed an unacceptable odour and change of colour. However, the quality of milky mushroom appeared to be good for 48 hours. These findings are in line with those of Kaushal and Sharma (1995) who opined that like all fleshy fruits and vegetables, mushrooms are highly perishable because of their high moisture content and delicate nature and cannot be stored for more than 24 hours at ambient temperature. When stored in the refrigerator, irrespective of the variety of mushroom and the method adopted, they could be stored safely for three days. On the fourth day the quality of oyster mushroom started deteriorating,

especially in the samples left in the stainless steel vessel. However button and milky mushrooms could be stored for one more day, after which it started deteriorating. Thus, the quality of milky mushroom was better when compared to button and oyster mushrooms. The keeping-quality of the samples kept in refrigerator in a perforated polythene cover was better than the mushroom kept in a closed vessel. Fresh and stale samples are shown in Plate 5. The mushroom samples left in the refrigerator for four days in perforated polythene bag are shown as stale mushroom in Plate 4 along with fresh samples.

4.6.2. Time taken for drying the three species of mushroom

The time required for drying button and oyster mushrooms was six hours, irrespective of the method of drying. However, the milky mushroom could be dried in five hours. One hundred grams of the button, oyster and milky mushrooms were reduced to 14g, 9.8g and 13.2g respectively. The dried mushroom could be stored upto three months without any change in colour, texture and flavour. The fresh and dried mushrooms are shown in Plate 5. The quantity of dried mushroom is not the same quantity obtained from the fresh mushroom by weight as shown in Plate 5.

4.6.3. Acceptability of the mushroom recipes using the three species of mushroom in fresh and dried forms

The results of the organoleptic qualities, as assessed by the selected adults, revealed that button mushroom recipes were most acceptable with reference to the taste, texture, flavour and appearance, while milky mushroom was preferred next, followed by oyster mushroom for all the recipes tried. In general, all the three varieties of dried mushroom recipes received

Fresh and stale mushrooms

PLATE 4



Oyster



Button



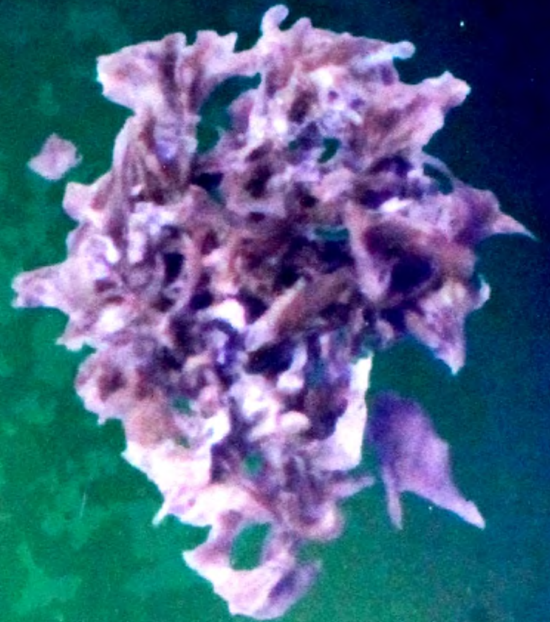
Milky

Fresh and dried forms of mushrooms

PLATE.5



Oyster



Button



Milky



low scores when compared to fresh samples. The percentage of scores obtained for the recipes prepared and the cost incurred for the recipes are given in Appendix VI and VII. Dried mushrooms could be used in preparing soups and curries.

4.6.4. Nutrient content of fresh and dried mushrooms

Table 36 gives information on nutrients energy, protein, fat, fibre, ascorbic acid and calcium content of the selected species of mushroom in fresh and dried forms.

TABLE 36
NUTRIENT CONTENT OF FRESH AND DRIED MUSHROOMS/100g

Nutrients	Fresh			Dried		
	Oyster	Milky	Button	Oyster	Milky	Button
Energy (kilo calories)	43	38	43	481	371	560
Protein (g)	2.0	2.2	3.0	16.0	17.7	26.2
Fat (g)	0	0	0	0	0	0
Fibre (g)	1.0	2.0	1.0	5.0	7.0	6.0
Ascorbic acid (mg)	3.9	5.2	3.9	0.26	0.52	0.26
Calcium (mg)	6.0	4.0	4.0	20	15	10

Due to high moisture content, fresh mushrooms contained lower quantities of nutrients than dried form of mushrooms in general. When analysed for energy, oyster and button mushrooms recorded 43 kilo calories while milky mushroom recorded 39 kilo calories. This was almost in on par

with the statement given by Chadha and Sharma (1995), as 36 and 35 kilo calories was noticed in button and oyster mushroom respectively. The protein content ranged between 20 and 30g in fresh form and 16.0 and 26.2g in dried form. Fat was not present in any species of mushroom analysed, while 0.4 per cent of the presence of fat was indicated by Madan (1994). The presence of ascorbic acid content was more in fresh form of mushroom when compared to the dry form. Among the three species, fibre and ascorbic acid was found to be maximum in milky mushroom in both fresh (2g and 5.2 mg) and dried form (7.0 g and 0.52 mg). Oyster mushroom contained a maximum of six mg of calcium in fresh form and 20 mg in the dried form. This is closely related to the results given by Rai (1995). According to him the presence of calcium may range between 20 and 40 mg. The low energy content, fat free nature, presence of fibre, calcium and some amount of good quality protein with the meaty flavour, make mushrooms most desirable for obese, diabetic and heart patients.

4.7. Suitability of mushroom cultivation as a self employment avenue

4.7.1. Yield from oyster mushroom cultivated and profit margin

realized by the women entrepreneurs

Table 37 highlights the yield of oyster mushroom in 20 beds cultivated by women entrepreneurs following standard procedures and profit margin gained.

TABLE 37

**YIELD FROM THE OYSTER MUSHROOM AND PROFIT REALIZED BY
THE ENTREPRENEURS**

Entrepreneurs	Yield in kg (20 beds)	Sale price (Rs.)	Expenditure incurred (Rs.)	Profit (Rs.)	Profit (%)
1	6.92	276	138	138	100
2	6.4	256		118	85.5
3	7.0	280		142	102.9
4	6.9	276		138	100
5	7.0	280		142	102.9
6	7.4	296		158	114.5
7	7.0	284		146	105.6
8	7.6	304		166	120.3
9	6.3	252		114	82.6
10	7.4	296		158	114.5
Average	7.0	280		142	102.9

* The expenditure incurred does not include labour and other permanent investments.

The highest yield realized was 7.6 kg, followed by 7.4 kg and the lowest yield was 6.3 kg. The differences in the yield may be due to the quality of spawn, climatic conditions, environmental changes and the difference in care given by the entrepreneurs.

A maximum of Rs. 166 and a minimum of Rs. 114 were realized as profit by the entrepreneurs and the profit percentage worked out to 120.3 percent and 82.6 percent respectively. Hence, it could be concluded that if

a mushroom cultivator could prepare 20 beds a day, after the scheduled period, a profit in the range of Rs. 114-166 could be obtained.

As the entrepreneurs themselves cultivated the mushroom in the available space within their homes, labour and rent for space utilized have not been included in the expenditure. As all expenditures were common for all the entrepreneurs cost was calculated as Rs.138 for 20 beds.

Cultivation of oyster mushroom as a self employment activity brought out mixed reactions among the women entrepreneurs. Those who got higher margin of profit were happy to continue with the enterprise, while those who got lower profit margin were not very convinced about the outcome.

If the selected entrepreneurs could take the trouble to prepare mushroom dishes, namely, mushroom noodles and chilly mushroom, they could sell them at the rate of Rs. 30 and Rs. 24 per plate and if all the 7 kg of mushroom is used for these dishes they could get a profit of Rs. 910 for mushroom noodles and Rs.787.5 for chilli mushroom. This would boost their income remarkably.

4.7.2. Yield from milky mushroom cultivated and profit margin realized by the women entrepreneurs

Table 38 reveals the yield of milky mushroom in 20 beds as cultivated by women entrepreneurs following standard procedures and profit margin gained.

TABLE 38
YIELD FROM THE MILKY MUSHROOM AND PROFIT REALIZED
BY THE ENTREPRENEURS

Entrepreneurs	Yield in kg (20 beds)	Sale price (Rs.)	Expenditure incurred (Rs.)	Profit (Rs.)	Profit (%)
1	23.1	1386	249	1137	456
2	23.5	1410		1161	466
3	20.5	1230		981	394
4	22.7	1365		1116	448
5	23.1	1387		1138	457
6	21.2	1275		1026	412
7	23.1	1387		1138	457
8	26.7	1600		1351	542
9	24.4	1462		1213	487
10	21.8	1312		1063	426
11	22.5	1350		1101	442
12	21.8	1312		1063	427
13	24.4	1462		1213	487
14	22.5	1350		1101	442
15	28.0	1680		1431	574
16	25.0	1500		1251	502
17	21.3	1275		1026	412
18	23.1	1387		1138	457
19	23.5	1410		1161	466
20	25.0	1500		1251	502
Average	23.27	1396		1147	460

* The expenditure incurred does not include labour and other permanent investments.

Cultivation of milky mushroom seems to be more profitable when compared to oyster mushroom. The profit (percentage) gained by the entrepreneurs ranged between Rs. 1,431 (574 percent) and Rs. 981 (394 percent) by spending Rs. 249 for 20 beds. Though the returns from milky

mushroom are very attractive, one should bear in mind the ground space occupied by them, as these mushroom beds could not be stacked one above the other like oyster mushroom. In cultivating oyster mushroom four to five beds could be stacked one above the other on a rope within a space of one sq. ft approximately, while milky mushroom occupied approximately two sq. ft for each bed. Hence, the number of beds that could be prepared in the available space are limited to a great extent. Besides, the percentage of profit was very high when the entrepreneurs harvested upto seven times from the beds prepared. Thus, the introduction of milky mushroom as a self employment avenue was successful and became very popular among the entrepreneurs.

SUMMARY AND CONCLUSION

V. SUMMARY AND CONCLUSION

India is enviably rich in its cultural heritage and natural resources. Being an agricultural country it has tremendous potential for the agro-based industries. Mushroom cultivation is one of the enterprises capable of recycling accumulated agricultural waste, generate new self employment opportunities and augment income without competing for additional land space. Mushrooms have desirable nutritional qualities and medicinal properties, besides being a fashion food.

Among twenty species of commercially cultivated mushrooms, three species namely button mushroom (*Agaricus bisporus*), oyster mushroom (*Pleurotus*) and paddy straw mushroom (*Volvariella*) are widely cultivated. A new species of mushroom known as milky mushroom (*Calocybe indica*) has been released by the Tamil Nadu Agricultural University Research Station during the year 1998 and is becoming popular. Among the species stated above, cultivation of oyster mushroom is considered most appropriate due to low cost technology, direct use of different agro-wastes and simple procedures involved in cultivation in plains. Milky mushroom seems to have an added advantage of reasonable keeping quality and possibilities of cultivating even during hot summer. Keeping the above aspects in mind the present investigation entitled, "Exploring the Possibilities of Enhancing the Yield

of Mushroom and Introducing it as a Self Employment Avenue” was taken up with the following objectives:

1. Collecting information regarding methods of cultivation, expenditure involved, preference for variety, extent of sale and utilization by selected cultivators, shopkeepers, restaurants and households located in the cities of Coimbatore and Erode.
2. Finding out the possibilities of increasing the yield of mushroom using agro-wastes like paddy straw, banana leaf, banana stem and sugarcane bagasse and selected supplements.
3. Analysing the bioefficiency, nitrogen, phosphorus and potassium (NPK) content of the spent substrates and cellulose, lignin and hemi cellulose content of fresh and spent substrates.
4. Evaluating the keeping quality, nutrient content and acceptability of mushrooms and
5. Introducing mushroom cultivation as an income generating activity among selected women and assessing their profit margin.

The study consisted of surveys and experiments. Surveys were carried out using individual questionnaires among 80 mushroom cultivators from Coimbatore, Erode and Ooty, 70 sale outlets, 70 restaurants and 300 households located at Coimbatore and Erode, in order to find out the technical details on mushroom cultivation from cultivators, sale patterns from sale outlets, and utilization of mushrooms by restaurants and households.

Four different agro-wastes namely paddy straw, banana leaf, banana stem and sugarcane bagasse all rich in cellulose were selected as substrates for cultivating mushrooms on experimental basis. To enhance the quantity of mushroom produced, supplements like rice flour, soya flour, groundnut cake, cotton seed flour and rice bran were selected, as these are good sources of carbohydrates, nitrogen and fat. Forty grams each of rice flour, soya flour, ground nut cake, cotton seed flour and rice bran were added separately as supplements and at the same time different proportions of these flours were also added having rice flour as the base. Thus, 17 different combinations of supplements were identified to be used along with unsupplemented standard sample making a total of 18 samples.

Oyster mushroom was cultivated following standard procedures on all the four substrates with and without supplements. The yield realized from each bed was recorded and the mushrooms evaluated for their physical appearance and time taken for its maturation. The cost effectiveness of the whole process was studied. Bioefficiency of the substrates were found out, and the NPK of the spent substrate and the cellulose, lignin and hemicellulose contents of the fresh and spent substrates were also analysed. Milky mushroom was cultivated following standard procedure on paddy straw with and without rice flour supplementation and the yield assessed. Secondary data relating to button mushroom cultivated was collected based on the details obtained from the cultivators in the hill station of Ooty as this could not be cultivated in plains by the investigator.

The keeping quality of fresh mushrooms kept at room temperature and in refrigerator in a perforated polythene cover and in a closed vessel was observed for five consecutive days. Mushrooms were dried in of hot air oven, solar drier and traditional sundrying and the time taken for drying the oyster, milky and button mushrooms recorded.

The fresh and dried mushrooms were analysed for their nutrient content with reference to energy, fat, protein, ascorbic acid and fibre. Using the fresh and dry mushrooms eight recipes were prepared and subjected to sensory analysis, and cost effectiveness.

Cultivation of oyster mushroom was introduced among ten prospective women entrepreneurs at Coimbatore and Milky mushroom was introduced among twenty women at Erode. Training on all aspects related to mushroom cultivation was given to these women entrepreneurs. The investigator helped them in procuring the spawn, preparing and maintaining the beds, harvesting and marketing the cultivated mushroom. The economic inputs and benefits realized by the entrepreneurs were recorded.

The highlights of the findings are given in the following pages.

1. Twenty two percent of the cultivators were women. All the cultivators received help from their family members. Seventy six per cent of the cultivators were doing the business on sole proprietorship basis and the rest on partnership basis. The motivators behind these cultivators were

friends (52 per cent), relatives (21 per cent), family members (20 per cent), neighbours (4 per cent), and Horticulture department (3 per cent). The money initially invested in the endeavour ranged between Rs. 5,000 - Rs. 50,000.

Seventy per cent of the cultivators had received one day training before taking up the business. Seventy, 76 and 100 per cent of the cultivators in Coimbatore, Erode and Ooty respectively had employed labourers to help them in cultivation of mushrooms. Space utilized for cultivation ranged between 500-1500 sq. ft. Oyster mushroom was cultivated by all the cultivators in Coimbatore and 72 per cent in Erode and button mushroom by the cultivators at Ooty only.

Majority of 84 per cent of the cultivators had adequate water facility. Fifty four per cent and 16 per cent of the oyster mushroom cultivators had hung the beds on plastic ropes. However, those who cultivated milky and button mushroom had arranged the beds on the floor or on the racks. The cultivators had spread sand on the floor, hung wet gunny bags on the sides and even spread leaves on the roof to maintain the necessary temperature inside the shed especially during hot summer. Only 28 and 32 per cent of the cultivators from Coimbatore and Erode produced spawns. Those who produced spawns, sold the excess to other mushroom cultivators. While 84 per cent sterilized the substrates using chemicals, like bavistin and formalin the rest boiled it for 60-120 minutes. Insecticides and fungicides were sprayed in and around the shed to prevent infection.

Oyster mushrooms were harvested three to four times and milky and button mushrooms upto seven times from a single bed. The spent substrates were recycled by 30 per cent, 76 per cent and 100 percent of the cultivators in Coimbatore, Erode and Ooty. Mushrooms were sold to shops, consumers or agents at the rate of Rs. 7-8/200g of oyster mushroom, Rs. 11-12/200 g of milky mushroom and Rs. 12-14/200 g of button mushroom. A profit ranging from Rs. 2500 - Rs. 10,000/month was realized by the mushroom cultivators surveyed.

Infestation of the bed (94 per cent), travelling for marketing (69 per cent), lack of adequate finance (56 per cent), substandard quality of spawn (49 per cent) and difficulty in collection of money (41 per cent) were the major problems faced by the cultivators. Due to fear of infestation they did not adopt any innovative methods in cultivation.

2. The main sale outlets for mushrooms were fruit and vegetable shops in Coimbatore and Erode. The quantity of mushroom sold at Coimbatore was more when compared to Erode probably due to its wide acceptance in Coimbatore. The shop keepers purchased and sold the mushroom at a profit of Rs. 2/200 g on oyster and milky mushroom and Rs. 3/200 g on button mushroom.

3. Homemakers of Coimbatore had a better economic, educational and employment status when compared to the homemakers of Erode. Due to increased consumption, demand for mushroom was experienced

by the homemakers. Button mushroom was preferred most, for its exclusive flavour, texture and taste followed by oyster and milky mushrooms respectively. Except 12 per cent, all the other homemakers consumed mushrooms for their taste (43 per cent), popularity (34 per cent), easy availability (13 per cent) and ease of preparation (10 per cent). Except 12 per cent the rest of the homemakers had consumed either natural, cultivated or both the mushrooms.

Mushroom was considered as a non vegetarian food by 40 and 47 per cent of the homemakers in Coimbatore and Erode. Fifty three per cent and 43 per cent of the homemakers in Coimbatore and Erode avoided its consumption during illness. Only 28 per cent and 25 per cent of the homemakers in Coimbatore and Erode expressed their interest to learn mushroom cultivation.

4. Seventy six and 55 per cent of restaurants in Coimbatore and Erode respectively purchased button mushroom. Milky mushroom was not used in restaurants of Coimbatore. Fifty eight and 60 per cent of restaurant owners in Coimbatore and Erode respectively purchased mushroom every day. The quantity of mushrooms purchased ranged between 1-6 kg per day. Fried rice, mushroom soup, manchurian and chilly mushroom were the common items prepared due to great demand by more than 60 per cent of the restaurants and fetched great profits.

5. The cost of preparing one bed ranged between Rs. 5.90 and Rs.8.50. The cost varied with substrates and supplements used. The mushroom yield on banana leaf and stem as substrates was negligible during summer. When the yield of mushroom on paddy straw and sugarcane bagasse

using selected supplements were analysed, sample 8 (rice flour: rice bran 1:3) produced maximum yield on paddy straw and sample 11 (rice flour: soya flour 1:3) produced maximum yield on sugarcane bagasse. However, when analysed statistically no significant difference in the yield was noticed between the two substrates - paddy straw and sugar cane bagasse. Significant differences were noticed between the supplemented samples. Among the paddy straw substrate beds, the bed supplemented with rice flour: rice bran (1:3) resulted in a maximum profit of 283.2 per cent, the sugarcane bagasse bed supplemented with rice flour: cotton seed (3:1) resulted in a profit of 223.7 per cent and the unsupplemented bed on banana leaf recorded 67.8 per cent profit. However, no profit could be realized when banana stem was used as substrate.

6. When the yield of mushroom was assessed during winter banana stem supplemented with rice flour and banana leaf supplemented with rice flour: cotton seed (1:3) recorded a maximum yield of 793 g and 768 g per bed respectively. Statistical analysis also revealed a significant difference between substrates and supplements at ($P < 0.01$) level.

7. The statistical analysis on the yield of mushroom during summer and winter revealed that paddy straw beds supplemented with rice flour alone and rice flour: cotton seed (1:3) with a significant difference at ($P < 0.01$) level while sugar cane bagasse, rice flour alone, rice flour and cotton seed 1:3 and unsupplemented sample with a significant difference at ($P < 0.01$) level in the yield.

8. Paddy straw bed supplemented with rice flour: rice bran in the proportion of 1:3 showed maximum yield within 37 days while among the sugarcane bagasse beds, cotton seed supplementation showed the highest yield at a shortest time of 31 days. The banana leaf and banana stem beds which showed a delayed growth, also produced minimum yield when cultivated in summer.

Though the substrates, paddy straw and sugarcane bagasse were ideal for summer, banana stem and banana leaf appeared to produce better results during winter. Hence, the cultivators may choose the substrates accordingly, if available from their own farm.

9. The beds prepared with paddy straw supplemented with cotton seed and rice flour alone produced sporocarps with a maximum size of 141 sq. cm and 143 q.cm while banana leaf produced a maximum of 60 sq. cm when supplemented with rice flour. Banana stem supplemented with groundnut cake and sugarcane bagasse supplemented with rice flour: rice bran in the proportion of 2:2 produced sporocarps of size 96 sq. cm and 131 sq. cm respectively. However, in winter irrespective of the substrates used the beds supplemented with rice flour produced larger sporocarps.

10. Mushrooms cultivated on supplemented samples during summer and winter were comparatively thicker than the mushrooms produced in unsupplemented beds irrespective of the substrates used. Thus, in general the quantity and quality of mushrooms produced on supplemented beds were better than the unsupplemented beds.

11. Though the cellulose, lignin and hemicellulose contents of the spent substrates were lower than those of fresh substrates, the contents could still to be used as a manure and soil conditioner.

12. Maximum bioefficiency of 10.68 per cent was noticed on paddy straw supplemented with rice flour and rice bran (1:3), followed by 9.8 per cent and 9.6 per cent for the beds supplemented with rice flour: cotton seed ((3:1), (2:2) and (1:3)) and 9.21 per cent when supplemented with rice flour alone. The bio efficiency of sugar cane bagasse when supplemented with cotton seed and groundnut cake alone was above nine per cent. However the bioefficiency of the other two substrates namely - banana leaf and banana stem was negligible. The bioefficiency by fresh weight basis was almost two to three times more when compared to dry weight. The bioefficiency of supplemented samples was more than the unsupplemented samples by two to three per cent by dry weight basis and five to six per cent by wet weight basis.

13. The nitrogen content of the spent substrate was the highest in banana leaf (1.79 per cent) followed by paddy straw (1.74 per cent) and sugar cane bagasse (1.46 per cent). Maximum quantity of phosphorous was noticed in paddy straw (0.9 per cent) and potassium in banana leaf in spent form. Thus when these substrates are disposed into the soil they could serve as good soil conditioners.

14. With regard to the cultivation of milky mushroom by investing Rs.249 a profit of 225.3 per cent and 202.7 per cent was realized from 20 unsupplemented and supplemented beds respectively.

15. With regard to button mushroom cultivation, by investing Rs. 30 one could realize a profit of Rs. 69.50 which amounts to 232 percent profit margin.

16. Storage of mushrooms in the refrigerator in perforated polythene bag had a better keeping quality than the the samples left in the closed vessel for two to four days, while the mushroom samples left outside could be kept only for one to two days. Thus, the keeping quality could be increased by storing the mushroom in a perforated polythene bag and leaving it in refrigerator.

17. Irrespective of the method of drying, the three species of mushroom samples took five to six hours for drying. In general, fresh mushrooms contained less of nutrients than dried forms of mushrooms except ascorbic acid. Calcium (6 mg) and energy (43.32 kilo calories) were more in oyster mushroom, ascorbic acid (5.2 mg) and fibre (2 g) in milky mushroom and protein (3.0 g) in button mushroom in fresh forms. The same trend could be noticed in dried forms also, with an exception of ascorbic acid.

18. Acceptability was good for fresh mushrooms. Recipes prepared using dried mushrooms scored low. Probably the dried mushrooms can be included into recipes like soups where it can be made more acceptable.

19. While introducing mushroom cultivation as an entrepreneurial activity, the ten entrepreneurs who cultivated oyster mushroom realized an yield of 7.6 kg with profit of Rs. 166 when they had laid 20 beds.

20. The twenty entrepreneurs who cultivated milky mushroom realized highest yield of 28 kg with profit of 574 percent. Thus the profit was very high for milky mushroom when compared to oyster mushroom.

To conclude mushroom production which does not demand large land space helps in bio conversion of agro-waste into useful and nutritive food for human consumption. Though the production technology of only few more species of mushroom is available, yet these have not been grown on commercial scale. Availability of raw materials, congenial climate, increasing awareness among the masses about mushroom, easily available facilities for training, spawn production and other knowhow, wide gap between global supply and demand for mushrooms and easily available man power, are the factors favourable for encouraging mushroom production. If the technological gaps are filled and the markets are simultaneously be developed, mushroom will become another “wonder crop” of the country, and can help in uplifting women and rural cultivators.

Recommendations:

1. A hybrid strain of mushroom with high yielding capacity, resistant to insects and fungus and capable of being grown in summer also should be developed urgently
2. A competitive, economic as well as commercially viable method of cultivation like adoption of a semi mechanised system on a large scale measure may be contemplated so that labour, time and energy could be saved thereby reducing the cost of production.

3. Production and distribution of quality spawns as well as collection and sale of mushrooms through cooperatives may be considered
4. Demonstration of mushroom recipes and distribution of free samples and free recipe booklets will help in creating awareness and will break down the reservation of people in using mushroom in their daily menu
5. The nutritive and medicinal value of mushroom should be popularized through mass media, advertisements and posters
6. Training on mushroom cultivation should be extended to prospective women entrepreneurs at their locations, by giving them adequate economic assistance and motivating them to start mushroom units and
7. Research needs to be done to investigate and improve post harvest handling to ensure that quality is maintained and that the appearance is retained at least until the product reaches the consumer.

Let us resolve all our efforts to bring India on the mushroom map of the world.

REFERENCES

REFERENCES

- Abate,D. (1998). "Cultivation of the oyster mushroom in traditional brick pots", *Food Chain Intermediate Technology*, No.23, Pp.19&20.
- Afyon,A. Konuk, M. Balevi,T. (1996). "A study on nutritional values of some edible mushrooms from Beysehir (Konyo) district in Turkey", *The Indian Journal of Nutrition and Dietitics*, Vol.6, Pp.33-37
- Ahlawat, O.P. and Rai, R.D. (1997). "Effect of azotobacter and phosphotika biofertilizers on the spawn-run, pinning and yield of white button mushroom (*Agaricus bisporus*)", *Mushroom Research*, Vol.6, No.2, P. 74.
- Ajlouni, S.O., Beelman, R.B., Thompson, D.B. and Mau,J.L. (1993). "Stipe trimming at harvest increases shelf-life of fresh mushrooms (*Agaricus bisporus*)", *Food Technology, Abstracts and Reviews*, Vol.64, No.2, P.146.
- Anitha, P. (1993). "Mushroom gaining popularity in Tamil Nadu", *The Economic Times, Capart Press Clippings*, Vol.9, No.11, P. 81.
- Annamalai,S. (1994). "A vegetarian substitute for meat", *The Hindu*, Dec.24, Pp.5-7.
- Asanovic, S. (1996). "Maitake mushroom as an anticancer agent", *A supplement to the journal of the American Dietetic Association*, Vol.96, No.9, P.44.

- Babu, K.M and Nair, R.K. (1991). "Mushroom cultivation on oil palm factory wastes", Indian Mushroom proceedings of National Symposium on mushrooms, Thiruvananthapuram Pp. 104-108.
- Bahram, H. (1989). "Edible oyster mushroom on the straw", Mushroom Journal Vol.9, Pp. 97-108.
- Bahl, N. (1995). "Export potential of mushrooms" Advances in Horticulture, Vol.13, P.583.
- Bahukhandi, D. (1990). "Effect of various treatments on paddy straw on yield of some cultivated species of *Pleurotus*", Indian phytopath, Vol.43, Pp.471-472.
- Balakrishnan, B. (1992). "Mushroom as medicines", Kisan world, Vol.19, P.47.
- Balakrishnan, B. and Nair, M.C (1995). "Production technology of oyster mushroom (*Pleurotus* spp.) Mushroom Research, Vol.13, Pp.109-114.
- Banik, P. (1996). "Mushroom - the cheapest source of protein", Indian Farming, Vol.45, No.11, P.29.
- Bano, Z. Rajarathinam, S and Nagarajan, N. (1978). "Some aspects on the cultivation of *Pleurotus flabellatus* in India", Mushroom science, Vol.10, No.2, Pp.597-607.
- Bano, Z., Rajarathinam, S and Sasirekha, M.N. (1992). "Mushroom-unconventional single cell protein for a conventional consumption", Indian Food Packer, Vol.XLVI, No.5, Pp.21-25.
- Bano,Z., Rajarathinam,S and Sashirekha M.N. (1993). "Production and processing a mushroom", Food Digest, Vol. 16, No.1, Pp.61-66.

- Bano, Z. and Rajarathinam, S. (1994). "Mushroom processing - Future perspective", National Symposium on Mushrooms, Pp. 63-75, 102, 103, 125.
- Basu, M.S. (1997). "Mitigating challenges of food and nutritional security in India not merely a peanut approach", Indian farming. Vol. 47, No. 9, P. 24.
- Bhandari, B. (1996). "Food and medicinal values of edible mushroom", Published by Vigyan Samiti, Udaipur, P. 21.
- Bharathi, V.V., Jacintha, M. (1994). "Family Resource Management (New concepts and Theory)", Discovery Publishing House, New Delhi, Pp. 40-52.
- Binani, M. (1993). "How to grow button mushrooms", Capart press clippings, Vol. 9, No. 6, P. 13.
- Bisaria, R., Madan, M. and Bisaria, V.S. (1987). "Mineral content of mushroom, *Pleurotus sajor - caju*, cultivated on different agro-residues". Mushroom Journal for tropics. Vol. 17, Pp. 53-60.
- Bobek, P., Kuniak, L., Ozdin, C. (1994). "Hypolipemic effect of extracts of dried and fresh oyster mushroom (*Pleurotus ostreatus*) in the Syrian hamster", Nutrition Abstracts and Reviews, Vol. 64, No. 2, P. 146.
- Bobek, P., Kuniak, L., Ozdin, C. (1994). "The mushroom *Pleurotus ostreatus* reduces secretion and accelerates the fractional turnover rate of very low density lipoprotein in the rats", Nutritional Abstracts and Reviews, Vol. 64, No. 2, P. 148.

- Bullman, D. (1993). "The Mushroom industry around the world what will the future bring", *Mushroom News*, Vol 41, No.10, Pp. 4-12.
- Chanda, S., Chakrabarti, S., Das, S. and Dey, R.K. (1993) "Cultivation of *Pleurotus sajor-caju* on leaf fibre residues of *Sesbania grandiflora*", *Mushroom Research*, Vol.2, No.2 Pp.90-96.
- Carrera, M.D. and Saavendra, L.A. (1989). "Prospects of edible mushroom cultivation in developing countries", *Food Laboratory News*, Vol.8, No.2, Pp.21-32.
- Chadha, K.L. (1992). "Mushroom research and development in India", *Mushroom Research*, Vol.1, No1, Pp.1-10.
- Chadha, K.L. (1994). "Infrastructure for mushroom research in India", *Souvenir National Symposium on Mushroom*, Mushroom Society of India, Pp.22-34.
- Chadha, K.L. (1994). "Mushroom scenario in India", *Mushroom Research*, Vol.3, Pp.1-4.
- Chadha, K.L. and Sharma, S.R. (1995). "Mushroom research in India, History infrasturcture and achievements", *Advances in Horticulture*, Vol.73, Malhotra Publishing House, New Delhi, India, P.1.
- Chakravarthy, K. (1993). "Mushroom an item of commerce", *Indian Food Packer*, Vol.XLVII, No.6, P.12
- Chandra, A. (1992). "Fugus fable" *Kisan World*, Vol19, No.6, P.49.
- Chandrasekhar, R. (1996). "Fungi as a delicacy", *The Hindu*, Sunday, August 11, P.11.

- Chang, S.T. and Miles, P.G. (1991). "Recent trends in world production of cultivated edible mushrooms", Mushroom, Vol.504, Pp.15-17.
- Chang, S.T and Miles, P.G. (1993). "Cited in Singh. S, Ganesh kumar.C, and Singh, S. (1995). "Production processing and consumption pattern of mushroom", Indian food industry. Vol.14, No.6, P.44.
- Chang, S.T. (1994). "Mushroom biology and mushroom production", Mushroom Journal for the Tropics, Vol.11, No.3, Pp.45-51.
- Chaudary, C.V. (1993). cited in Singh, S. Ganesh kumar, C and Singh, S. (1995). "Production processing and consumption pattern of mushroom", Indian food industry, Vol.14, No.6, Pp.38-44.
- Chinnadurai, R. (1994). "Possibilities of high income", Kurukshetra, Vol.XLII, No.12, P.11.
- Chitale, K. and Singh, R.D. (1995). "Yield responses of Agaricus bisporus and Pleurotus sajor-caju to the chemical treatments of the substrates", Mushroom Research, Vol.4, P.31.
- Curvetto, N.R., Pelmastro, S.E and Devatis, P.J. (1997) "A low cost method for decontaminating sunflower seed hull-based substrate in the cultivation of Pleurotus edible mushrooms", Mushroom Research, Vol.6, No.1, P. 25.
- Das, T.K., Sharma, R and Singh, B (1988). "Utilization of weeds and other waste products for spawn and production of oyster mushrooms", Weed abstract Vol. 37, P. 504.

- Das, M. (1997). "Mushroom cultivation for rural women", Social welfare, Vol.6, No.10, P.13.
- Deacon, R.E and Fire baugh, F.M., (1988). "Family Resource Management Allyan Bacon; London Pp.55-76.
- Dhanda,S. and Kakkar, V.K, (1996). "Mushroom harvested rice straw as a feed for buffaloes", Indian Farming, Vol.45, No.12, Pp. 25-27.
- Dhar, B.L. (1991). "The mushroom industry in India - an overview", The Mushroom Journal, No.503, P.23.
- Dhar, B.L. (1992). "Post harvest storage of white button mushroom - *Agaricus bitorquis*", Mushroom Research, Vol.1, No.2, Pp.127-128.
- Dhar, B.L. (1998). "Composite mushroom farm design suiting Indian condition", Compendium of Lectures, National training course on mushroom production technology and post harvest management, National Research Centre for Mushroom, Solan, P. 49.
- Dhar, B.L. (1998). Cultivation of *Agaricus bitorquis* summer white button, Compendium of Lectures, National training course on mushroom production technology and post harvest management, National Research Centre for Mushroom, Solan, P.73.
- "Doshi, A. Monot, J.F. and Chakravarti, B.D. (1988). "Nutritional status of an edible mushroom *Calocybe indica*", Indian Journal of Mycology, Plant Pathology, Vol.18, No.3, Pp.301 & 302.
- Doshi, A. and Sharma, S.S (1995). "Production technology of speciality mushroom", Mushroom Research, Vol.1, No.1, Pp. 135,149,150 &152.

- Easwaramoorthy, S., Ramaraj, B and Shanmugam, N. (1983). cited in Balakrishnan, B. and Nair M.C (1995). Production Technology of oyster mushroom (*Pleurotus* spp.) *Advances in Horticulture* Vol.13, P.112.
- Editor (1993) "Mushrooming importance at home and abroad", *Food Digest* Vol.19, No.1, P.26.
- Editor (1993) "New scheme to boost mushroom cultivation", *Financial Express*, 4th April, 1993. P.19.
- Editor (1993). "New scheme to promote mushroom cultivation", *Financial Express*, Vol.9, No.4, Capart Press Clippings.
- Editor (1994). "Challenges facing the mushroom industry", *Indian Food packer*, Vol. 58, No.2, P. 90.
- Flegg, P.B. (1993). "An excellent event", *The Mushroom Journal*, P.11.
- Flegg, P.B. (1994). "Mushroom cultivation - Future perspective", *Souvenir for National Symposium on Mushroom*, Mushroom Society of India. Pp. 50-55.
- Ganeshkumar, C., Singh, S. and Singh, S. (1997). "Mushroom production agro industry in India", *Indian farming*, Vol. 47, No.9, Pp.19-23.
- Gangulli, N.K. and Chanakya, H.N. (1994) "Mushroom cultivation on spent biomass from biogas plants", *Current Science*, Vol.66, No.1, Pp.70-73.
- Garcha H.S., Khanna, P.K. Sodhi, H.S., Dhanda, S. Sidhu, A and Phutela, R.D. (1987). "Nutrient supplementation of *Agaricus bisporus*", Elsevier Science Publishers, The Netherlands, Pp.101-108.

- Geetha, D., Sivaprakasam, K. and Seetharaman, K. (1995). "Edible oyster mushroom", The Hindu Aug. 24, P.28.
- Gnanambar (1995). "Mushroom cultivation", The International Journal of Environment Education and Information", Vol.15, No.2, P.215.
- Gokulapalan, T.R. (1994). "Other edible mushrooms", Kisan World, Vol.21, No.9, P.37.
- Gunasegeran, K and Graham, M. (1987). "Effect of organic additives on yield of the phoenix mushroom grown on cellulose waste", Mushroom journal for tropics, Vol. 8, Pp. 23-28.
- Gupta, V.K. and Langar, P.N., (1988). "Pleurotus florida for upgrading the nutritive value of wheat straw", Biological wastes, Vol.23, Pp. 57-64.
- Gupta, Yand Vijay, B (1992). "Post - composting supplementation in Agaricus bisporus under seasonal growing conditions", Mushroom Research Vol.1, Pp.115-117.
- Gupta, Y. (1996). "Statistical Methods", Himalayan Publication, New Delhi, Pp. 20-30.
- Gupta, Y. (1998). "Crop management in white button mushroom", Compendium of Lectures, National training course on mushroom production technology and post harvest management, National Research Centre for Mushroom, Solan, P. 44.
- Gurumoorthy, T.R (1994). "Mushroom cultivation", Kisan World, Vol.21, No.10, P.5.

- Harendarraaj (1988). "Mushroom industry set for higher growth", Indian Farmer Times, Vol.16, No.1, Pp.17 & 18.
- Horio, H. and Ohtsuru, M. (1995) "Effects of administration of *Grifolia frondosa* in glucose tolerance and glucosuria in rats with experimental diabetes", Nutrition Abstracts and Reviews, Vol.65, No.12, P.1245.
- India Year Book (1999). A reference annual, Research reference and training division, Ministry of information and borad casting, Govt. of India, New Delhi, P. 305.
- Jagadishkumar, Tripathi, R.S., Sharma, M.L. and Chandra Dav (1995). "Economics of mushroom production in the hills of Uttra Pradesh", Agricultural Situation in India, Vol.LII, No. 9, P. 599 & 600.
- Jandaik, C.L. (1974). "Artificial cultivation of *Pleurotus sajor caju* mushroom", Mushroom Journal, Vol.22, P.405.
- Jandaik, C.L. (1989). "Response of *Pleurotus sajor-caju*, to supplementation prior to and after pasteurisation of straw". Indian phytopath Vol.42. Pp.284-285.
- Jandaik, C.L., Sharma, V.P. and Raina, R. (1993). "Yellow blotch of *Pleurotus sajor caju* (Fr) singer - a bacterial disease new to India", Mushroom Research, Vol.2, P.45.
- Jandaik, C.L. (1995). "Economics of mushroom cultivation", Advances in Horticulture Mushroom, Malhotra Publishing House, New Delhi, P.572.
- Jandaik, C.L. and Goyal, S.P. (1995). "Farm and farming of oyster mushroom (*Pleurotus species*)", Indian Farmers Digest, Vol.28, No.1, Pp.72 & 73.

- Jandaik, C.L. and Sharma, S.R. (1995). "Present studies of morchella in India", *Advances in Horticulture*, Vol.13, Pp. 171 & 185.
- Jayaprakash, C.R. (1998). "Kalathai Vellum Kalangal", *January Dhinamani*, Pp.6-9.
- Joshi, V.K., Seth, P.K., Sharma, R.C and Sharma, R. (1991). "Standardization of a method for the preparation of sweet chutney from edible mushrooms *Agaricus bisporus* (L.)", *Indian Food Packer*, VXXXXV, No.2, Pp.39-43.
- Kalai selvi, M.M and Vijayalakshmi, G.S. (1997). "Reutilization of paddy chaff" *Kisan World*. Vol.24, No.3, P.13.
- Kannan, R. Pillayarsamy, K., Chokalingam, P. (1998). "Mushroom-Delicious food", *Kisan World*, Vol.24, No.1, P.39.
- Kapoor, J.N (1989). cited in Singh, S. Ganesh Kumar, C. and Singh, S. (1995). "Production processing and consumption pattern of mushroom", *Indian food industry* Vol.14, No.6, P.44.
- Karthikeyani, P.T., Senthilkumari, M. and Saratha, T. (1996). "Growing oyster mushroom using vermicompost", *Dhinamalar*, Nov.25.
- Karunanithi, K. and Santha, K. (1996). "Medicinal values of mushroom", *Kisan World*, Vol.23, No.8, P.31 & 32.
- Kaul, T.N. (1993). "Conservation of mushroom resources in India", *Mushroom Research*, Vol.2, No.1, Pp.11-18.
- Kaul, T.N. (1994). "Management of mushroom disorders", *Mushroom Research*, National Symposium on Mushroom, Vol.3, P.104.

- Kaviarasan (1993). cited in Anitha, D. (1993). "Mushrooms gaining popularization in Tamil Nadu". The Economic Times, Capart press clippings. Vol.9, No.11, P.81.
- Khandar, R.R, Vaishnav, M.V., Akbari, L.F., and Andhania, J.H. (1991). "Effect of various plant substrates on sporophore production of *P. sajor caju*", Indian mushrooms, Proceedings of National Symposium on Mushroom, Thiruvananthapuram, Pp.112-113
- Khader, V. (1997). "Mushroom cultivation for rural women entrepreneurship", Indian Farming, Vol.47, No.1, Pp.21-23.
- Khader, V. (1996). "Button mushroom for high proteineous diet", Indian Farming, Vol.46, No.7, Pp. 45-51.
- Khader, V. and Pandya, N. (1997). "Mushroom based infant foods", Food and Nutrition News, Vol.2, No.2, P.4.
- Khalar, S. and Doss, S.K. (1987). "Biological conversion of paddy straw into food", Biological Waste, Vol.22.
- Khanna, P.K. (1995). "Production technology of paddy straw mushroom (*Volvariella* spp.)", Advances in Horticulture, Vol.13, P.53.
- Khanna, P.K, Bhandari, R., Soni, G.L. Singh, C.R. and Garcha, H.S. (1993). "Role of mushroom (*Plerotus florida*) as hyper cholesterolemic/hypo lipidemic agent", Food Technology Abstracts, Vol.28, No.10, P. 556.
- King, T.A. (1993). "Mushrooms, the ultimate health food but little research in US to prove it", Mushroom news, Vol. 41, No.2, Pp.26-29.
- Kobe (1995). "A mushroom a day", Indian Food packer, Vol.49, No.6, P.67.

- Kohlii, M.S. (1990). "Mushroom cultivation world wide", Kisan World, Pp.33 & 34.
- Kohlii, M.S. (1991). "Problems and prospects of development of mushroom cultivation in India", Kisan World, October, P. 13-18.
- Kompany, E. and Rene, F. (1995). "Effect of freezing condition on aroma retention in frozen and freezing - dried mushrooms (*Agaricus bisporus*)", Journal of Food Sciences and Technolocy, Vol.32, No.4, Pp.278-282.
- Krishnakumar, P. (1997). "Vegetarian Mushroom", (Mangayar Malar), April, (Women's Magazine) Pp.127 & 128.
- Krishnamoorthy, A.S. and Muthusamy, M. (1996). "A new variety mushroom - *Calocybe indica*", Mushroom News letter. (Kalan Seithi Madal), Vol.2, No.2, P.42.
- Krishnamoorthy, A.S. and Muthusamy, M. (1997). "Milky mushroom", Kisan World, Vol.24, No.1, P.39.
- Krishnamoorthy, A.S., Muthuswamy, M., Marimuthu, P., Narashiman, V., Muthusankaranarayanan, A. (1998). "Milky mushroom", Tamil Nadu Agricultural University, Regional Research Centre, Aruppukottai, P.15.
- Krishnamoorthy, A.S., Theradimani, M. and Muthusankaranarayanan, (1998). "Milky musrhoom - APK -2", Indian Farmers Digest, Vol.31, No.7, P.43.
- Krishnamoorthy, S., Theradimani, M. and Muthusankaranarayanan, A. (1998). "Cultivation of milky mushroom", April 16th, The Hindu, P.24.
- Kumar, D.S.M., Biswas, M.K. and Raipur, I.G.K.V.V. (1992). "Oyster mushroom", Kisan World, Vol.19, No.3, P. 45.

- Kumar, S. and Bindraban, V. (1994). "Mushroom cultivation of small scale farmers - a farming system approach", Mushroom Research, National symposium on Mushroom, Vol.3, P.103.
- Kumuthakavalli, R. and Paliwal, K. (1997). "Castor stalk, an alternative substrate for oyster mushroom production", Invention Intelligence, Vol.32, Pp.80-81.
- Lakhanpal, T.N. (1994). "Collection and utilization of mushrooms", Kisan World, Vol.21, No.8, P.39.
- Lakhanpal, T.N. (1995). "Mushroom flora of north west Himalayas", Advances in Horticulture, Vol.13, P.351.
- Lakhsmanan, P. (1995). "Reasons for failures in mushroom cultivation" (Naveena Velanmai), Modern Agriculture Mushroom, P.27.
- Lakhsmanan, P. and Dharmalingam, V. (1995). "A revolution in cultivating oyster mushroom:", Thinamani Agricultural Edition, P.8 (12.9.95).
- Lakhsmanan, P. (1997). "Excellent food cultivated in a room" (Arrayil Payirkum Arpuda Unavu); (Thinanamani) Daily News, Monday, October 6th P.10
- Lakshmanan, P. and Dharmalingam, V. (1996). "Oyster mushroom cultivation", The Hindu, Nov.21, P.10.
- Lakshminarasiah, H. (1993). "Characteristics of rural poverty in India, Capart press clipping, Vol. 9, No.1, P.26.
- Lal kaushal, B.B and Sharma, K.D. (1995) "Post-harvest technology of mushroom", Advances in Horticulture, V.13, P.553.

- Lescano, G. (1994). "Extension of mushroom (*Agaricus biosporus*) shelf-life by gamma radiation", *Journal of post harvest biology and technology*, Vol.14, Pp.255-260.
- Madan, M. (1994). "Mushroom cultivation for rural development", *National symposium on mushroom, Mushroom society of India*, Solan, P.83.
- Madhusudhanan, K. and Chandramohan, R. (1997). "Cultivation of *Pleurotus sajor caju* (Fr) Singer on areca wates - standardization of substrate preparation during summer and rainy seasons", *Mushroom Research*, Vol.6, No.2, Pp.75-78.
- Mahalingam, N. (1991). "Mushroom 'polybag spawn' a novel technique to produce spawn", *Kisan World*, June, P.24.
- Mahalingam, N. (1994). "Assistance for mushroom cultivation and processing", *Kisan World*, Vol.21, No.2, P.42.
- Marimuthu, T., Krishnamoorthy A.S., Sivaprakasam, K. and Jeyarajan, R. (1989). "Oyster mushroom production", *Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore*, P.50.
- Manorama Year Book (1999). Kottayam, Kerala, P.355.
- Mascarenhas, M. (1994). "Structure-activity characterisation, a quick method to screen mushrooms for the presence of antitumour glucans", *Mushroom Research*, Vol.3, P.77.
- Mathai, G. (1996). "Substrates to grow oyster mushroom", *The Hindu*, Nov.7, P.28.

- Mathew, J.R. Kothandaraman and Thresiamma, K. J. (1991). "Cultivation of oyster mushrooms on rubber processing factory waste - A possible solid waste utilization method", Indian Mushrooms. Proceedings of National Symposium on Mushrooms, Thiruvanthapuram, Pp.97-99.
- Mehetre, S.S., Dhumal, P.M. Shinde, R.B., Kale, K.D and Magdum, S.G. (1996). "Soybean straw-an agrowaste best for mushroom cultivation", Indian Farming, Vol. 46, No.4, P.20 & 21.
- Mehta, K.B.(1994). "Black ear mushroom", Kisan World, Vol.21, No.6, P.55.
- Metha, K.S. (1993). "Button mushrooms", Kisan world, Vol. 20, Pp. 41 & 42.
- Miller, F.C (1994). "Mushroom composting as a managed ecosystem", Mushroom Research, Vol.3, P.5
- Miller, F.C. (1994). "World trade in mushroom", Souvenir National Symposium on Mushroom, Pp.56-62.
- Mitra, A.K. and Purkayastha, R.P. (1995). "Improvement in productivity of edible mushroom its commercial cultivation in the plains of India", Indian Farming, Vol.45, No.8, P.28.
- Mohan, S. (1998). "Agricultural waste can boost mushroom output", The Hindu, Tuesday, April 21, 1998. Vol.121, No.94, P.3.
- Mostafa, H. El-kattan, Zakia, A. Helmy, Baharam, H. Mahmoud and Khalia, A. Abderkawi (1991). Effect of additives on oyster mushroom production, Mushroom Journal, Vol.II, Pp.67-74.

- Moore et al (1985). cited in Singh, S. Ganesh kumar, C. and Singh. S. (1995).
"Production processing and consumption patttern of mushroom". Indian
food industry, Vol.14, No.6, P.44.
- Murugesan, A.G., Sukumaran, N. and Sankar, V. (1996). "Mushroom
cultivation utilizing biological wastes", Proceedings of the Academy of
Environmental Biology, Vol.5, No.2, Pp.229-232.
- Murugesan,A.G., Vijayalakshmi, G.S., Sukumaran, N. and Mariappan,C.
(1995). "Utilization of water hyacinth for oyster mushroom cultivation",
Bioresource Technology, Vol.51, Pp.97-98.
- Nagarajan,N.R. (1997). "Mushroom industries", Kisan World, Vol.24, No.2,
Pp.52-53.
- Nair,M.C. (1991). "Report on the recently held National Symposium on
mushrooms", Kisan World, Vol, P.28.
- Nallathambi, F. and Marimuthu, T. (1992). "Development of carbendazim
resistance in *Pleurotus citrinopileatus*", Mushroom Research, Vol.1,
Pp.123-125.
- Nallathambi, P. and Marimuthu,T. (1993). "Pleurotus platypus a patent oyster
mushroom for organic recycling of agriculture wastes", Mushroom
Research, Vol.2, No.2, P.75.
- Nehru,C., Kumar, V.J.F., Uma Maheshwary,C. and Gothandapani, L. (1995).
"Solar drying characteristics of oyster mushroom, Mushroom Research,
Vol.4, No.1, Pp.27-30.

- NIN (1983). "A Manual of Laboratory Techniques, National Institute of Nutrition", Indian Council of Medical Research Hyderabad. India, Pp.31-134.
- Padmanabhan, N.R. (1994). (Unavu Kalaan Virpanai Oru Kannottam), sale of edible mushroom-an analysis, (Air Uzavan), Agriculturist, Vol. 20, No.4, Pp.23-24.
- Pakela, Y. and Eicker (1997). "An alternative spawn for use in rural cultivation of oyster mushrooms (*Pleurotus* spp)", Mushroom Research, Vol.5, No.1, P.7
- Pandey, M. and Tewari, R.P. (1993). "Mushroom - A protein rich vegetable", Indian Farmers Digest, Vol.23, No.5, Pp.13 & 14.
- Pandian, S., Sheela, J. and Sivasankar, (1996). "Constraints in mushroom cultivation", Agricultural college and Research Institute, Madurai, P.55.
- Peter Oei (1991). "Manual on mushroom cultivation", Tool Publication, Netherlands, Pp.13-14 and 50-55.
- Phutela, R.P. and Gupta, U. (1995). "Farm and farming of straw mushroom (*Volvariella* spp.)", Indian Farmer's Digest, Vol.28, No.1, Pp.79-84.
- Pimpalskar, M.S. Boxi, P.V. Sidhaye, V. (1994). "Oyster mushroom cultivation in rural development - A case study from Nagothane, West Maharashtra", Abstracts of national symposium on mushroom society of India, Solan, P.119.

- Poongodi, G.I. and Sakthisekaran, I. (1995). "Nutrient content of mushrooms *Pleurotus ostreatus* and *Agaricus bisporus*", Madras Agricultural Journal, Vol.82, No.9/10, Pp.555 & 556.
- Prakasam, V., Nakiran, S., Palanisamy, A., Narasimman, V. and Sundarababu, P.C. (1998). "Economic Improvement through Mushroom Cultivation", A.E. Publication, Coimbatore, P.1.
- Prakash, T.N. and Tejeswini (1991). "Prospects of mushroom cultivation in India", Indian Mushroom, Proceedings of National Symposium on Mushroom, Thiruvananthapuram, Pp.97-99.
- Prasad, P. (1997). "Nature's White Umbrella", Scienc Express, Indian Express, 18th March, P.8.
- Prasad, P. (1998). "Let the mushrooms mushroom", Nutrition, National Insitute of Nutritions", Indian Council of Medical Research, Hyderabad, Vol.31, No.1, Pp. 3-10.
- Quimio, T.H. (1985). "Mycophagy : The art of eating mushroom", Mushroom Newsletter for the Tropics, Vol.5, No.4, P.2.
- Rai, U. (1993). "New mushrooms delight gourment", Indian Express, Capart Press Clippings, Vol.9, No.1, Jan. 1993, P.11.
- Rai, R.D. (1995). "Nutritional and medicinal values of mushrooms", Advances in Horticulture", Vol.13, P.537.
- Rai, R.D. (1998). "Post harvest handling and processing including receipes of mushrooms", Compenduim of Lecturers, National training course on mushroom production technology and Post-harvest managment, Solan. India, P.138.

- Raj, S. (1988). "Growing mushroom easy way", Indian Farmer Times, Vol.6, No.9, P.14.
- Rajan, M. (1996). "Nutritional composition of edible mushrooms", Indian Farming, Vol.45, No.11, P.29.
- Rao, C.S. (1991). "Evaluation of substrates and supplements for the oyster mushroom cultivation in the state of Goa", Indian Mushrooms proceedings, National Symposium on mushroom, Thiruvananthapuram, Pp.93-95.
- Rao. M.V. (1998). "Population- Food and Nutrition. Challenge and options before India", Proceedings of nutrition society of India, Vol.45, P.16.
- Ravishanakar, K., Kamalutheen, M. and Vena, R. Reddy, (1997). "The use of immaturred Paddy", Nilavalam, Vol.29, No.12, Pp.27-28.
- Reddy, V., Prahlad Rao, N., Sastry, G.J and Kashinath, K. (1993). "Nutrition trends in India", National Institute of Nutrition, Hyderabad, P.5.
- Reddy, G.L. and Venkataraman, P. (1995). "A hand to mouth existence", Social welfare, Vol.42, No.2, Pp.18-19.
- Rice, A.N., and Tucker, S.M. (1986). "Family life management : Macmillan publishing company, New York, Pp. 109-126.
- Rodwell, J. (1987). "Into the market but out of the kitchen", The Mushroom Journal, No.18, P.397.
- Rodwell, J. (1990). "Technical topics", The Mushroom Journal, No.208, Pp. 128 & 129.
- Sadhu and Singh, A. (1992). "Mathematical Statistics", Himalaya Publishing House, Bombay, Pp.127 & 130.

- Saini, L.C. (1994). "Mushrooms production", Journal of Research, Vol.24, No.2 & 3, P.107.
- Samanta, A.K. and Patro, N. (1996). "Recycling of farm wastes for organic farming", Indian farmer's digest, Vol.XXIX, No.10, P.25.
- Sandhu, G.S. (1994). "Pest management in mushroom cultivation", Kisan World, Vol.21, No.2, P.28.
- Sandhu, G.S. (1995). "Insect pests of mushrooms crop and their management", Indian farmer Digest", Vol. XXVIII, No.1, P.57.
- Sangwan, M.S. and Saini, L.C (1995). "Cultivation of Pleurotus sajor caju on agro-industrial waste, Mushroom Research, Vol.3, Pp.33-34.
- Sarala, B.S., (1997). "Identification of poisonous wild mushroom", Kisan World, Vol. 24, No.6, P.61.
- Sarkar, A.N. (1992). "Mushroom cultivation for poverty alleviation", Yojana, Vol.36, No.21, Pp.32-36.
- Sathyasundaram, I. (1995). "Appropriate technology is the answer", Facts for you, Vol.17, No.3, Pp.27-29.
- Savithri, A., Soundarajan, S. and Shantakumar, R.S. Hopper (1993). "Mushroom production an income generating activity for landless women", Mushroom Research, Vol.2, Pp.91-94.
- Saxena, S. (1993). "Post harvest processing in mushroom cultivation", Kisan World, Vol.20, No.9, Pp.14 & 15.
- Saxena, R. (1998). "Functional foods", Nutrition, National Institute of Nutrition, Vol.32, No.2, P.7.

- Sekar, C., Maheshwari and Parvathy, S. (1995). "Dry land farming - an over view", Kisan world, Vol.22, No.1, P.34.
- Seetharman, K. Muthuswamy, M. Ebanazar, E.G. (1997). Medicinal uses of Mushrooms, Thinamani (Daily Newspaper), 3rd Nov.P.11.
- Seetharaman, K., Mohammad Usman, K. and Muthusamay, M. (1998). "Natures fungi, growers pride", Science Express, Indian Express, Tuesday 21, April, P.4.
- Seth, P.K. (1976). "Supplementation of organic substrates to synthetic composts for increased mushroom yield", Indian journal of mushrooms Vol.2, P.11
- Seth, P.K. (1987). "Cultivation of white button mushroom", Indian Horticulture, Vol, 39, No.1, Pp. 31-35.
- Sethi, V., Bhagwan, J., Behal, N and Lal, S. (1991). "Low cost technology for preserving mushrooms", Indian Food Packer, Vol.XLV. No.16, P.22.
- Shandilya, T.R. (1988). "Polythene sacks or wooden trays for growing white button mushrooms" Indian Horticulture, Vol.33, No.2, Pp.4& 5.
- Sharma, B.R. and Chand, R. (1992). "Diversification of agriculture : An aid to employment generation in rural India", Agriculture Situation in India, Vol.XLVII, No.7, Pp.567-571.
- Sharma, S.S., Doshi, A., Trivedi, A. and Kothari, K.L. (1994), "Factors affecting sporophore production of *Calocybe indica*, Abstracts of National Symposium on Mushrooms, P.73.
- Sharma, S.R. (1995). "Management of mushroom diseases", Advances in Horticulture", Vol.13, P.195.

Sharma, S.R. (1998). "Cultivation of speciality mushrooms", Compendium of Lectures, National training course on mushroom production technology and post harvest management, National Research Centre for Mushroom, Solan, P.111.

Sharma, S.R. (1998). "Moulds and diseases of mushroom and their management", Advances in Horticulture", Compendium of Lectures, National training course on mushroom production technology and post harvest management, National Research Centre for Mushroom, Solan, P. 95.

Singh, R.D. Tewari A.K. and Rakwal, R. (1992). "Employment generation through mushroom cultivation", Indian Farmers digest, Vol.XXV, No.5-6, Pp.21-23.

Singh, A.K. Awasthi, S.K. and Rai, B. (1995). "Utilization of sugar cane trash (dried leaves) for production of oyster mushroom, *Pleurotus florida*", Mushroom Research Journal, Vol.4, P.35.

Singh, R.P and Chaube, H.S. (1995). "Economic of button mushroom cultivation", Indian Farmers digest", Vol.XXVIII, No.1, Pp.65-71.

Singh, S., Ganeshkumar, C., and Singh, S. (1995). "Production processing and consumption pattern of mushrooms", Indian Food Industry, Vol.14, No.6, Pp.38-47.

Singh, A., Kesharvani, G.P. and Gupta, O.P. (1996). "Preservation technology for mushroom, *Volvariella volvacea*", Mushroom Research, Vol.5, No.1, Pp.97-100.

- Singh, M. and Sarhadi, N. (1997). "Money from mushroom", *Intensive Agriculture*, Vol.35, No.5&6, P.12.
- Singh, R.P. and Bhatt, N. (1997). "Mushroom cultivation a self-employment opportunity for rural women", *Indian Farmers Digest*, Vol.30, No.8, Pp.13-15.
- Sivaprakasam, K. Bhaskaran, T.L. and Kandaswamy, T.K. (1979). "Mushroom industry and its potential in Tamil Nadu", *The Farm Science*, Vol.4, Pp.21-27.
- Sivaprakasam, K. and Ramaraj, B. (1991). "Studies on some factors influencing the yield of oyster mushroom", *Proceedings of national symposium, Kerala Agricultural University*, Pp.127-132.
- Sivaprakasam, K. and Seetharaman, K. (1995). "Mushroom cultivation in Tamil Nadu", *Advances in Horticulture*, Vol.13, P.497.
- Sivaprakasam, K. and Seetharaman, K. (1997). "A new mushroom MTU.1. Mushroom News letter, Vol.3, No.1, P.1.
- Sohi, H.S. (1996). "Food value of mushroom", *A booklet on nutritive and medicinal values of edible mushroom*, Published by Vigyan samit, Udaipur, P.15.
- Soni, G., Kanna, P.K. Kapoor, S. and Garcha, H.S. (1994). "A comparative study on the hypocholesterolemic and hypo lipidemic action of edible mushroom", *Mushroom Research, National Symposium on Mushroom*, P.106.
- Subbaraja, K.T. and Subramanian, K.S. (1994). "Dried oyster mushrooms", *Kisan World*, Vol.21, No.1, Pp.43 and 44.

- Subramanian, C.V. (1995). "Mushrooms: Beauty, diversity, relevance",
Current Science, Vol. 69, No.12, Pp. 986-997.
- Suguna, S., Sreenarayanan, V.V., Gothandapani, L. and Marimuthu (1993).
"Mechanical drier for mushroom", Kisan World, P.19.
- Suguna, S., Usha, M., Sree Narayanan, V. V., Raghupathy, R. and
Gothandapani, L. (1995). "Dehydration of mushroom by sundrying, thin
layer drying, fluidized bed drying and solar cabinet drying", Journal of
Food Science Technology, Vol.32, No.4, Pp.284-288.
- Swaminathan, M.S. (1996). "Sustainable agriculture and a hunger - free. India,
Agricultural situation in India, Vol.LII, No.5, P.279.
- Tewari, R.P. and Pandey, M. (1994). "Substrate supplementation for higher
yield in mushroom cultivation", Kisan World, Vol.21, No.4, P.14.
- Tewari, S. and Kapoor, P. (1998). "Mushroom cultivation - an economic
analyzers", Mitra Publications, New Delhi, P.2.
- Tiwari, .B. (1993). "Mushroom : A food for all, Capart Press clippings, Vol.9,
No.10, Pp. 7-11.
- Thakur, K. (1995). "Improvement of edible mushroom", Advances in
Horticulture, Vol.13, P.35, Malhotra Publishing House, New Delhi.
- Thapa, C.D. (1994). "Nematode problems in mushroom cultivation", Kisan
World, Vol.21, No.1, P.60.
- The Hindu (1997). "The secret world of fungal evolution", Science and
Technology, Nov.13, P.25.
- The Hindu (1998). High yielding oyster mushroom for hills, Nov.17.

- The Hindu (1999). "Hot line - Fresh mushroom" Science and Technology, Jan 7, P.25.
- Thilagavathy, D., Kumuthakavally, R. and Shanmugam, S. (1991). "Study of oyster mushroom cultivation in various substrates", Indian mushrooms Proceedings of National symposium on mushroom. Thiruvananthapuram Pp.86-88.
- Tom, M.A. (1977). "Mathematical analysis", (Second edition) Addison Wesley Publishing Company, London, Pp.396 & 397.
- Upadhyay, R.C and Sohi, H.S. (1988). "Apple pomace, a good substrate for the cultivation of edible mushrooms", *Current science*, Vol. 57, Pp.189-190.
- Upadhyay, R.C. and Vijay, B. (1988). "Optimum compost depth in polythene bags for *Agaricus bisporus* cultivation", *Indian journal of agricultural science*, Vol.38, Pp.778-779.
- Upadhyay, R.C. (1998). "Cultivation of oyster mushroom complete technology package". Compendium of Lectures, National training course on mushroom production technology and post harvest management, National Research Centre for Mushroom, Solan, Pp.76,78.
- Upadhaya, R.C. (1998). "Economic of oyster mushroom", Compendium of Lectures, National training course on mushroom production technology and post harvest management, National Research Centre for Mushroom, Solan, Pp. 92 & 102.

- Vandana (1993). "Mushrooms, a money-spinner", Financial Express, Capart Press Clippings, Vol.9, No.1, P.1.
- Varghese, M.A., Ogale, N.N. Srinivasan, K. (1994). Home Management, Willey Eastern Limited, New Delhi, Pp. 40-97.
- Verma,R.N. (1996). "The nutritive values of mushroom", A booklet on nutritive and medicinal value of edible mushrooms", Published by Vigynan Samiti, Udaipur, Pp.3-7.
- Verma, R.N. (1998). "Semi mechanised cultivation of oyster mushroom", Compendium of Lectures, National training course on mushroom production technology and post harvest management, National Research Centre for Mushroom, Solan, Pp. 19 & 20.
- Verma, R.N. (1998). "The Science and Scope of mushroom cultivation in the world", Compendium of Lectures, National training course on mushroom production technology and post harvest management, National Research centre for mushroom, Solan, P.1.
- Vijay, B and Upadhyay, R.C. (1989). "Chicken manure as a new nitrogen supplements in oyster mushroom cultivation", Indian Journal of mycology Plant pathology, Vol.19, Pp.297-298.
- Vijay, B and Gupta, Y, (1994). "Cultivation of white button mushroom (*Agaricus bisporus*)", Published by National centre for Mushroom Research Training, Solan, India, P.3.

- Vijay, B. and Gupta, Y. (1995). "Production technology of *Agaricus bisporus*", *Advances in Horticulture*, Vol.13, P.63, Malhotra Publishing House, New Delhi, Pp. 63-95.
- Vijay, B. (1998). "Composting radiants and different methods of composting of white button mushroom", *Compedium of Lecturers*, National training course on mushroom production technology and post harvest management, National Research Centre for mushroom, Solan, Pp.19 & 20.
- Vyas,S.C., Vyas, U. and Vyas, S. (1994). "Management of mushroom diseases", *Mushroom Research*, National Symposium on Mushroom, Vol.3, P.87.
- Vays, N.L., (1999). "Mushroom as a cheaper source of nutrition", *The Hindu*, August -19, P.24
- Wood, D. (1985). "Useful biodegradation of lignocellulose", *Annual Proceedings of the Phytochemical Society, Europe*, Vol.26, Pp.295-309.
- Yakin,S. and Terkinsen, O.C. (1993). "Studies on nutritional values of some culture mushroom (*Agaricus bisporus*, *A.campestres* & *A.bitorquis*)", *Nutrition Abstracts and Review*, Vol.63, No.3, P.No.207.
- Yapar, s. Helvari, S.S. and Peker, S. (1990). "Drying behaviour of mushrooms slices", *Drying Technology International Journal*, Vol.8, No.1, Pp.77-99.
- Zandrazil, F. and Dube, H.C. (1992). "The oyster mushroom importance and prospects", *Mushroom Research*, Vol.1, No.1, Pp. 25-31.
- Zandrazil, F. (1997). "The conversion of straw into feed by basecto mycetes", *European Journal of Applied Micorbiology*, Vol.4, P.273.

APPENDICES

APPENDIX -I

QUESTIONNAIRE TO FIND OUT PROBLEMS AND PROSPECTS OF MUSHROOM CULTIVATION AMONG MUSHROOM GROWERS

I Family Background details

1. Name and address of the unit
2. Name of the interviewee
3. Name of the interviewer

Name of the family members	Age	Sex	Education	Employment	Type of the family

4. Total family income

II Information on mushroom cultivation

1. Type of sector government/private
2. If private, type of ownership: Sole proprietor/partner ship
3. Reason for starting the mushroom cultivation
 - a. Hobby
 - b. For entrepreneurship
 - c. Interest
 - d. Any other specify
4. Person who motivated mushroom cultivation
 - a. Parents
 - b. Friends
 - c. Relatives
 - d. Neighbours
 - e. Anyother
5. Total money invested initially
6. Money received as loan if any
7. Agency from which loan received
8. Rate of interest
9. Mode of payment

III. Information on training of mushroom cultivation

1. Did you receive any training on mushroom cultivation?
Yes No
2. If yes, from where did you receive the training? How long?

3. If no, how did you learn to cultivate mushroom?
 - a. Through friends
 - b. Through relatives
 - c. Through magazines
 - d. Other specify
4. Do you have any intention to undergo training now?
5. Number of assistant helping you in mushroom cultivation

Male	Female	Working performance	Technically trained

IV Information on mushroom cultivation

1. Area of your mushroom hut?
2. Species of mushroom cultivated?
3. Availability of water facilities
 - a. Abundance
 - b. Just enough
 - c. Scarce
4. If scarce how do you manage?
5. Mention the method of arranging the beds
 - a. Hanging
 - b. Arranging on racks
 - c. Arranging on ground/floor
6. Method adopted to maintain the optimum temperature, humidity and moisture
 - a. By sprinkling water on the bed
 - b. By spreading sand on the floor
 - c. By arranging the beds on the floor
 - d. Hanging gunny bags on the sides
7. Mention the season you consider ideal for mushroom cultivation
8. If the season is not ideal how do you manage the condition?

IV Technical details

1. Do you procure (or) prepare spawns?
2. If procuring, from where do you procure spawns?
3. If produced how do you produce spawns?
4. Mention where do you get mother spawns?

5. Do you sell spawns?

Yes No

If yes

Cost per bottle of spawn produced	Number of bottles Prepared/month	Number of bottles sold/month

6. From where do you purchase raw materials for preparing the bed?

V. Preparation of bed

1. Method of sterilising the materials Mention the infestation commonly seen in the beds Mention the method to avoid infestation of beds

2. Chemicals used to overcome infestation of bed Frequency of application of chemical used Period of soaking of substrate

3. Total number of days approximately required for the mushroom cultivation

a. Budding stage b. 1st picking c. 2nd picking d. 3rd picking

4. Number of pickings taken from the bed

5. How do you dispose the used bed?

VI. Storage and distribution

1. Did you pack the picked mushroom before distribution?

Yes No

If yes, quantity/packed

2. Method of distribution

- a. Distribute to the shops b. Shopkeepers collect from us
c. Give it to the agents d. Sell it to consumer directly

3. Selling price of cultivated mushroom

Method of distribution Cost per packet

Shops
Shopkeeper's collect
Agents
Consumers
Others

4. Do you have customers from places other than Coimbatore, Erode and Ooty for purchase of spawns/buying mushrooms?

Yes No If yes, please specify the places

5. Is the demand for mushrooms increasing in the domestic market?

Yes No

6. Do you sell immediately all the mushroom cultivated?

7. If not, how do you preserve the cultivated mushroom?

- a. Always b. Sometimes

8. Mention the last 2 months profit/loss of cultivating unit

VII. Problems

1. Tick the problems faced in mushroom cultivation How did you rectify it?

Problems	Faced	Rectified
a. Location of the area		
b. Water facilities		
c. Finance		
d. Preparation of spawn		
e. Preparation of bed		
f. Infestation of bed		
g. Harvesting of mushroom		
h. Storage Distribution		
j. Collection of the money		
i. Any other specify		

VIII. Innovative measure adopted

1. Have you tried any methods to increase the yield of mushroom?

Yes

No

2. If yes, in what way?

a. Addition of supplementation?

b. Use of various substratum

c. Any other, specify

3. Have you tried any other material for preparing mother spawns?

4. If yes, how do you prepare?

APPENDIX -II

QUESTIONNAIRE TO COLLECT DETAILS ON SELLING PATTERN OF MUSHROOMS IN THE SELECTED SHOPS

1. Name of the invetigator
2. Name of the interviewee
3. Name of the shop
4. Address

I. Details of selling mushrooms

1. Types of mushroom available
 - a. Oyster mushroom
 - b. Button mushroom
 - c. Milky mushroom
2. Quantity per packet
3. What type of mushroom have more demand?
 - a. Oyster mushroom
 - b. Button mushroom
 - c. Milky mushroom
4. Who supply mushroom to your shop?
 - a. Shopkeepers
 - b. Cultivators
 - c. If others, specify
5. Frequency of buying mushroom
 - a. Daily
 - b. Alternate days
 - c. Weekly
6. Amount of mushroom received per day
7. When do you have great demand for mushroom?
 - a. Every day
 - b. Week ends
 - c. Holidays
 - d. Wedding season
 - e. Particular months
8. Number of packets sold per day
9. Cost price of mushroom per packet
10. Do you sell all mushrooms supplied to you every day?
 - Yes
 - No

If yes,

 - a. Regularly
 - b. Occasionally
 - c. Rarely

11. If all packets are not sold how do you dispose the remaining mushroom?

b. How long

12. Give the following details

Types of mushroom	Cost price	Selling price	Frequency of supply	Demand	Quantity/ packet	Brand name if any

APPENDIX III

QUESTIONNAIRE TO COLLECT DETAILS ON THE PREPARATION OF MUSHROOM RECIPES IN SELECTED RESTAURANTS

1. Name of the investigator

2. Name of the interviewee

Age :

Sex :

3. Location of the restaurant

4. Name of the restaurant

5. Type of restaurant

a. Vegetarian

b. Non-vegetarian

6. Do you include mushroom recipes in your menu?

7. Details on purchase of mushroom

Type of mushroom purchased	Quantity purchased	Place			Frequency		Cost/ Monthly
		Provision shop	Fruit stall	Door delivery	Daily	Weekly	
Button							
Oyster							
Milky							

8. Details on preparation of mushroom recipes

Kind of mushroom delicacies	Quantity of items Purchased	Frequency of items prepared			Cost/ plate	Give the order of preference
		Daily	Weekly	Monthly		

9. If you purchase yourself do you have any problem in transportation?

Yes

No

If yes, how will you manage?

10. Are mushrooms available freely whenever you require them?

If not available, how will you manage?

11. Do you sell all the mushroom recipes prepared?

If no, how will you preserve them?

12. Do you buy mushroom and store before use?

If, so how?

How long?

13. Do you feel that the demands for mushroom recipes are increasing among consumers?

Yes

No

14. Do you have any idea of adding few more mushroom recipes in your menu?

Yes

No

15. Are mushroom preparation profitable?

Yes

No

APPENDIX IV
QUESTIONNAIRE TO FIND THE USE OF MUSHROOM IN SELECTED
HOUSEHOLDS

I. General information

1. Name of the investigator
2. Name of the interviewee
3. Type of family in which you are?
 - a. Joint family
 - b. Nuclear family
4. Employment status of the homemakers
 - a. Full time homemaker
 - b. Employed - Full time/Part-time
5. Family background details

S. No.	Name of the family members	Relation to the head of the family	Age	Sex	Educational status	Occupation	Income per month

II. Details on the use of mushroom in the diet

1. Are you a

a. Vegetarian	b. Non-vegetarian	c. Ova-vegetarian
---------------	-------------------	-------------------
2. Have you tasted mushroom preparation before?

Natural mushroom Only	cultivated mushroom Only	Tasted both Tasted none
--------------------------	-----------------------------	----------------------------
3. Mention the preparations tasted

Fry Manchurian	Soup	Briyani	Kurama	Others (Mention)
----------------	------	---------	--------	------------------
4. Are the items generally prepared at home (or) purchased

5. How often do you include mushroom in your diet?

Alternate days Weekly Once in a month Occasionally Whenever available

6. Reason for using mushroom

Tasty Nutritious Easy to prepare Easy Availability Other reasons (Mention)

7. Do your family members like mushroom preparation?

i. Like ii. Dislike

8. Source of information gained regarding mushroom as food

a. Magazine b. Mass media (T.V. Radio) c. Friends
d. News paper e. Ladies club f. Others (Specify)

III. Particulars on purchasing habit of cultivated mushroom

1. From where do you purchase mushroom?

a. Provision shop b. Fruit stall c. Door delivery d. Any other means (mention)

2. Quantity purchased per consumption

3. Type of mushroom purchased

Type	Reason
------	--------

a. Oyster mushroom	
b. Button mushroom	
c. Milky mushroom	

4. Do you purchase any processed mushroom products given below?

a. Dried
b. Mushroom pickle
c. Any other (Specify)

5. Do you use mushroom immediately after purchase?

Yes No

6. If no, how do you preserve it?

7. Are mushrooms available whenever you want to purchase them?

Yes No

IV. Account on attitude towards mushroom

1. Do you consider mushroom as
 - a. Vegetarian
 - b. Non-vegetarian food? Give reason
2. Do you prepare mushroom on any auspicious day?
3. Can mushrooms be used as a substitute for meat?
4. Have you any idea about the medicinal value of mushroom?
5. If yes, what do you know about the medicinal value of mushroom?
6. Under what conditions do you restrict mushroom in the diet?
7. Are you interested in mushroom cultivation?
8. Have you any idea about mushroom cultivation?

APPENDIX V
COMPARISON OF YIELDS OF MUSHROOM CULTIVATED BY THE
INVESTIGATOR DURING SUMMER

Anova: Two-Factor With Replication

Summary	Paddy Straw	Sugar Cane	Total
Rice Flour			
Count	3	3	6
Sum	1280	1400	2680
Average	426.6667	466.6667	446.6667
Variance	433.3333	4233.333	2346.667
Rice Bran			
Count	3	3	6
Sum	1220	990	2210
Average	406.6667	330	368.3333
Variance	533.3333	1900	2736.667
Soya Flour			
Count	3	3	6
Sum	0	0	0
Average	0	0	0
Variance	0	0	0
GNC			
Count	3	3	6
Sum	0	1320	1320
Average	0	440	220
Variance	0	400	58240
C.S.			
Count	3	3	6
Sum	1385	1470	2855
Average	461.6667	490	475.8333
Variance	2508.333	400	1404.167
RF:RB 3:1			
Count	3	3	6
Sum	1140	930	2070
Average	380	310	345
Variance	4900	1300	3950

Summary	Paddy Straw	Sugar Cane	Total
RF:RB 2:2			
Count	3	3	6
Sum	1320	880	2200
Average	440	293.3333	366.6667
Variance	16900	233.3333	13306.67
RF:RB 1:3			
Count	3	3	6
Sum	1865	670	2535
Average	621.6667	223.3333	422.5
Variance	3058.333	2033.333	49637.5
RF:Sf 3:1			
Count	3	3	6
Sum	1500	770	2270
Average	500	256.6667	378.3333
Variance	6300	1633.333	20936.67
RF:Sf 2:2			
Count	3	3	6
Sum	0	0	0
Average	0	0	0
Variance	0	0	0
RF:Sf 1:3			
Count	3	3	6
Sum	225	1520	1745
Average	75	506.6667	290.8333
Variance	625	17733.33	63244.17
RF:GNC 3:1			
Count	3	3	6
Sum	0	660	660
Average	0	220	110
Variance	0	12100	19360
RF:GNC 2:2			
Count	3	3	6
Sum	0	660	660
Average	0	220	110
Variance	0	12100	19360

Summary	Paddy Straw	Sugar Cane	Total		
RF:GNC 1:3					
Count	3	3	6		
Sum	0	0	0		
Average	0	0	0		
Variance	0	0	0		
RF:GC 3:1					
Count	3	3	6		
Sum	1350	1500	2850		
Average	450	500	475		
Variance	11100	9300	8910		
RF:CS 2:2					
Count	3	3	6		
Sum	1580	990	2570		
Average	526.6667	330	428.3333		
Variance	3333.333	22500	21936.67		
RF:CS 1:3					
Count	3	3	6		
Sum	1340	1250	2590		
Average	446.6667	416.6667	431.6667		
Variance	933.3333	233.3333	736.6667		
Control					
Count	3	3	6		
Sum	940	1040	1980		
Average	313.3333	346.6667	330		
Variance	4633.333	33.3333	2200		
Total					
Count	54	54			
Sum	16185	16260			
Average	299.7222	301.1111			
Variance	48916.43	29296.86			
ANOVA					
Rice of variation	SS	df	MS	F	F crit
Sample	2777744	17	163396.7	42.52507	1.766576
Columns	52.08333	1	52.08333	0.013555	3.973895
Interaction	1090910	17	64171.2	16.70098	1.766576
Within	276650	72	3842.361		
Total	4145356	107			

APPENDIX - VI

THE COST INCURRED FOR PREPARING VARIOUS RECIPES USING SELECTED VARIETY OF FRESH MUSHROOMS

S.No	Meal	Delicacies	Mushroom variety	Cost per plate (Rs.)
1.	Break Fast	Mushroom Fantasy	Button	19.00
			Oyster	17.25
			Milky	18.50
2.		Mushroom Omelette	Button	12.00
			Oyster	11.00
			Milky	10.25
3.	Lunch	Mushroom Pulao	Button	14.00
			Oyster	11.75
			Milky	13.50
4.		Mushroom Poogath	Button	6.00
			Oyster	4.75
			Milky	5.56
5.	Tea	Mushroom sandwich	Button	7.75
			Oyster	5.50
			Milky	6.00
6.		Mushroom Bonda	Button	6.00
			Oyster	4.75
			Milky	5.50
7.	Dinner	Mushroom Soup	Button	9.50
			Oyster	7.25
			Milky	9.00
8.		Mushroom Delight	Button	10.50
			Oyster	8.25
			Milky	10.00

APPENDIX -VII

PERCENTAGE OF SCORES OBTAINED BY MUSHROOM RECIPES OF FRESH AND DRIED FORM OF SELECTED VARIETIES

S.No.	Mushroom Delicacies	Button mushroom		Oyster mushroom		Milky mushroom	
		Fresh	Dried	Fresh	Dried	Fresh	Dried
1.	Mushroom Fantasy	83	67	75	50	83	92
2.	Mushroom omlette	100	59	92	58	100	67
3.	Mushroom pulao	75	83	67	67	75	83
4.	Mushroom poogath	92	67	83	50	92	58
5.	Mushroom Saandwich	100	50	92	42	92	50
6.	Mushroom Bonda	100	75	100	75	100	75
7.	Mushroom Soup	100	67	83	75	100	67
8.	Mushroom Delight	100	67	75	50	83	58
	Average Score	94	67	83	58	91	69

APPENDIX VIII

PROCEDURES FOR ANALYSIS OF SELECTED NUTRIENTS

Estimation of Vitamin-C by Dye Method

Principle

Vitamin - C is a good reducing agent and it reduces the dye 2,6 dichlorophenol indophenol. In this reaction, vitamin-c itself is oxidised to dehydro ascorbic acid. In the absence of interfering substances the capacity of an extract of the sample. To reduce a standard solution of the dye, as determined by titration, is directly proportional to Vitamin - C content. Oxalic acid is the medium thereby not only stabilising Vitamin - C but also to form complexes with metallic ion, thereby preventing the catalytic oxidation of Vitamin - C.

Reagents needed

- 1 2,6 Dichlorophenol indophenol.
- 2 4% Oxalic acid
- 3 Standard ascorbic acid
- 4 Sodium bicarbonate

Calculation for dye factor

Pipetted out ten ml of the standard ascorbic acid solution into a conical flask and then added twenty five ml of four per cent oxalic acid. From that five ml was placed in a container and the contents were titrated against

dye in the burette. The end point was the appearance of pink colour which persisted for five seconds. The content of dye consumed is equivalent to the ascorbic acid present.

Procedure

Five gm of the sample was weighed and soaked in four per cent oxalic acid for ten minutes. This was ground in a mortar and pestle and transferred into centrifuge tubes and centrifuged. More oxalic acid was added to the centrifuge tube and centrifuged and the supernatant clear liquid was transferred to standard flask (100 ml). This was made upto the mark with four per cent oxalic acid. The dye was taken in a burette and titrated against five ml of extract in a conical flask. The titration was repeated till concordant values was obtained.

Estimation of Calcium

Principle

Calcium present is precipitated as calcium oxalate by the addition of ammonium oxalate. The precipitate is washed and dissolved in sufficient amount of dilute sulphuric acid and titrated against standard 0.01 N potassium permanganate.

Reagents needed

- 1 Methyl red.
- 2 Strong ammonia
- 3 Glacial acetic acid
- 4 2 N H_2SO_4
- 5 0.1 N KMNO_4 (Stock)
- 6 4% Ammonium oxalate

Procedure

Five gm of sample was ashed by ignition. Ash from ignited sample was dissolved in Hcl and made upto hundred ml. Ten ml of prepared ash solution was pipetted out in a clean conical flask, and added 90 ml of distilled water. One or more drops of methyl indicator is added which changes the colour to pink. The mixture was neutralized with NH_3 till pink colour changes to yellow. The solution was heated to boil and 10ml of saturated 4% ammonium oxalate was added. The mixture was allowed to boil for few minutes and glacial acetic acid was added till the colour of solution was detintely pink.

The mixture was kept aside in a warm place and when the ppt. settled down, the supernatant was tested with a drop of calcium chloride solution to ensure the completion of precipitation. This ppt. was then filtered through whatman filter paper number forty two and washed with ammoniacal water till free of oxalate. The ppt was transferred to a beaker by making hole in the filter paper and pouring over it dilute H_2SO_4 (2N) about 15 ml. The solution was then heated about 70°C and titrated against N/100 KMnO_4 (0.01N) solution. The appearance of pale pink colour was the end point (one ml of 0.01 KMnO_4 contains 0.2 mg of Calcium).

Estimation of Fat

Procedure

Washed and dried the soxhlet apparatus. The weight of the round bottom flask was taken. Five gm of the sample was taken in a thimble. Ether was taken in the round bottom flask and extraction of lipid was carried out. Repeated the extraction of lipid, three times, evaporated off the ether from the flask and dried the lipid in the flask at 60°C overnight weighed the flask again and from the difference in weight the percentage of fat content was calculated.

Estimation of Nitrogen

Principle

The standard method for the determination of nitrogen is the conversion of nitrogen present in the sample into Ammonium sulphate. By boiling with concentrated sulphuric acid and subsequently decomposing the Ammonium sulphate by means of an alkali such as sodium hydroxide - Ammonia is liberated. The liberated ammonia is absorbed by two percent boric acid solution and is titrated against N/70 sulphuric acid using mixed indicator. The protein content is then determined by multiplying the volume by 6.25.

Reagents required

1. Two per cent boric acid
2. Forty per cent NaOH
3. Mixed indicator

Procedure

0.5g of the given food stuff was weighed accurately and transferred into a microkjeldal flask. Five ml of concentrated H_2SO_4 was added and a pinch of CuSO_4 and K_2SO_4 mixture (digesting mixture) were also added as a catalyst. This was digested until a colourless solution was obtained. In another microkjeldal flask only H_2SO_4 was taken and digested as before. This was taken as the blank solution.

Distillation

The digested samples were made upto hundred ml in a standard flask and used for distillation. Five ml of two per cent boric acid was pipetted out in a clean conical flask and added about two drops of mixed indicator. The colour will turn into pink. The kjeldal apparatus was washed with distilled water by back suction with distilled water. The conical flask containing the boric acid was kept at the end of condenser. Five ml of the blank solution was pipetted out into a distillation chamber through the funnel. Then added ten to fifteen ml of forty per cent NaOH into the same. Washed the funnel with little amount of distilled water and closed the pinch cock. The steam generator was heated and steam was generated and heated the mixture in the distillation flask and ammonia was liberated. The liberated ammonia was condensed and collected by the boric acid solution. The solution turned to blue. After that the distillation was continued after the colour change. The blue coloured solution was titrated against N/70 H_2SO_4 taken in the burette. The end point is the appearance of pink colour. Same distillation procedure was repeated for the sample also. The titrations were repeated till the concordant values were obtained for the blank and the sample.

Determination of Energy Value of Foods Using Bomb Oxygen Calorimeter

Principle

The principle behind the working of bomb calorimeter is based on the fact that a known weight of the sample if completely burnt in the apparatus permits the heat developed by the combustion to be absorbed by a definite weight of water. By determining the rise in temperature it is possible to calculate within close limit the number of heat units liberated.

Procedure

The food was weighed and taken in a capsule. Ends of the fuse wire was attached and the capsule was placed in loop electrode, the bomb was assembled and oxygen was filled with fifteen ampheres. Two litres of distilled water which was cooled to 2° F below the room temperature was taken in the calorimeter bucket. The thermometer was inserted and the stirring mechanism was started while the terminals were attached to the bomb, it was allowed to run two minutes before taking the temperature. The temperature readings were recorded at one minute intervals for an initial period of five minutes. Exactly at the fifth minutes, the wire was ignited and button was held for fifteen seconds. The temperature readings exactly the minute after ingestion were recorded. After the maximum was reached, the temperature was noted

every one minute for five minutes. The calorimeters was opened, the bucket and the bomb removed. Residual pressure was released. Then the bomb calorimeter cover was taken out. The combusted pieces of the fuse wire were removed from the electrodes. They were straightened and the length of all the pieces combined to make pure wire connection and energy value was be calculated.