

## CHAPTER -6 CONCLUSION

---

- *Calocybe indica* a new introduction in mushroom world, now is being successfully cultivated in North Bengal and standardized the technique for better production.
- Cultivation of *Agaricus bisporus* in foot hills of Darjeeling district (North Bengal) have been demonstrated successfully for the first time. Easy, low cost and less time consuming composting process was standardized and provide the technique to the rural farms
- Four species of another most popularly grown edible oyster mushroom such as *Pleurotus ostreatus*, *P. sajor-caju*, *P. djamor* and *P. florida* were selected for cultivation in this environmental condition throughout the year.
- Several lignocellulosic wastes and casing materials were evaluated for their suitability for cultivation of milky mushroom (*Calocybe indica*). Paddy straw, wheat straw, sugarcane bagasse, young coconut fiber, tea leaf, maize stalk as growing medium and vermicompost, coconut fiber, spent mushroom substrate(SMS), sand soil were used as casing materials to evaluate their effect on yield.
- Different compost formulations as well as composting duration were evaluated for fruit body production of *A. bisporus* and for improvement of their quality.
- Morphological and histological characteristics were studied with special reference to their fruiting body structure, gill and spore characters. Scanning electronic microscopy (SEM) of basidiospores of oyster and button mushrooms were studied. Mycelial growth pattern as well as growth rate of these mushrooms were studied on three different media.
- Molecular characterization (18S rDNA sequencing) of four species of *Pleurotus*, *Agaricus bisporus*, and *Calocybe indica* were carried out using primer pairs - ITS 1 and ITS 4 (for oyster and milky mushroom) ITS1 and ITS 6 (for button mushroom) . BLAST query of 18S rDNA sequences of these mushrooms were analyzed and identified as *Pleurotus. ostreatus*, *P. sajor-caju*, *P. djamor* and *P florida*, *Agaricus bisporus* and *Calocybe indica*.
- The sequences of the identified species were submitted in NCBI GenBank under the accession number KT768095, KT818506, KT 768094,KT826605, KT818508 and MF804327 for *P. ostreatus*, *P. sajor-caju*, *P. djamor* and *P. florida*, *A. bisporus* and *C. indica* respectively

- In North Bengal, *P. ostreatus*, *P. sajor-caju* and *P. florida* commonly cultivated. A new species namely *P. djamor*, the pink oyster mushroom introduced in this area and successfully cultivated in this area throughout the year.
- The seasonal productivity of all the mushrooms was evaluated. The results clearly indicate the variable seasonal productivity throughout the year. Depending upon the temperature, relative humidity and rainfall, the productivity was found to be different. In case of *P. ostreatus* and *P. sajor-caju*, it was found that through the year it can be cultivated with good productivity rate. But the production rate was less during June-September due to high humidity
- *P. djamor*, the pink oyster mushroom have been introduced in this area and being successfully cultivated in this area during winter season.
- In summer time the milky mushroom (*C. indica*) can be cultivated in plains regions of North Bengal as it requires high temperature and humidity
- The plains of North Bengal can be included to the area of *Agaricus bisporus* farming zone. In North Bengal, although there are few mushroom farmers available at present, if farmers are well advised, using the perfect stage of composting they will be able to improve button mushroom cultivation
- It was found that winter season is suitable for cultivation of *A. bisporus* in plans region of North Bengal but throughout the year in hills regions
- Seasonal productivity of *P. florida* and *P. djamor* was found to be quite similar. It was observed that the production rate decreased during May to September. And production rate increased during winter season in North Bengal
- Economy of North Bengal is based on tea productivity and leaf pruning is one of the important practices of tea plantation. Here the pruned tea leaves basically used as fuel by the tea workers. In the present investigation pruned tea leaves were dried and utilized for mushroom cultivation. Besides, tea leaf based compost was further used for cultivation of *A. bisporus* successfully. Tea waste was also used as casing of materials and it was found that it gave good result for mushroom cultivation especially for *A. bisporus* and *C. indica*.
- Tea waste also was used as casing of materials and it was found that it gave efficient result for mushroom cultivation especially for *A. bisporus* and *C. indica*.
- Biochemical constituents of the fruit body of mushroom also were influenced by the substrate on which it grows. It was also found that the casing materials also have the effect on biochemical constituents of fruit body of mushrooms

- Chemical constituents of three edible mushrooms, *Agaricus bisporus*, *Calocybe indica* and four species of *Pleurotus* were evaluated by GC-MS analysis. The common compounds such as phenolic, flavonoid and total free amino acid content responsible for antioxidative activity were determined in methanolic extract of these mushrooms. The GC-MS analysis revealed that the presence of phenolic derivatives, organic acids and essential fatty acids in these three mushrooms which are associated with some beneficial health activities like antioxidant. Fumaric acid, acetic acid, malic acid were detected as organic acid in the mushroom samples.
- Antioxidant activity of selected four species of *Pleurotus*, *A. bisporus* and *C. indica* were also estimated and it was found that all four species showed very high amount of antioxidant activity such as DPPH scavenging activity, ferric reducing power activity. Among the cultivated *Pleurotus* species, *P. djamor* and *P. ostreatus* showed comparatively higher antioxidant activity.
- The oral administration of mushroom suspension helps in regaining the body weight as well lowering the plasma glucose level. Blood urea, creatinine, triglyceride, cholesterol as well as liver enzymes like serum glutamic pyruvate transaminase (SGPT) and serum glutamic oxaloacetic transaminase (SGOT) were also estimated and the oral treatment of *P. djamor* and *P. ostreatus* found to be very effective in recovering the other blood parameters
- Contaminants were found to be a very serious problem during the cultivation of *Pleurotus species*. Several fungal species like *Coprinus*, *Fusarium sp* as well as *Trichoderma*; bacterial species like *Pseudomonas* and pests like Sciarid, phorid and Beetle fly drastically affected the growth and yield of *Pleurotus*. Management strategies like application of bavistin, phenyl, carbandazium and formaldehyde were adopted which reduces the effect of the fungal as well as bacterial genera. Racks of the mushroom production unit were covered with nylon nets which helped in reducing the attack of flies on the substrates
- As the agriculture world drifts into practicing “Organic farming”, the need to embrace the use of Bio-fertilizer, the use of SMC should be encouraged and the SMC generated from mushroom farm can be well utilized to contribute in organic agriculture field
- Spent mushroom substrate is an important byproduct of mushroom cultivation and this spent mushroom substrate were applied as fertilizer for crop improvement. *Capsicum chinense*, *C. annuum*, *Solanum lycopersicum* and some leafy vegetables

*Coriandrum sativum*, *Amaranthus* sp. and *Spinacia oleracea* were tested using the spent mushroom substrates (SMS) which was found to be very effective as a soil conditioner and also helped in increasing growth and yield of crop plants in compare to untreated plants. Spent mushroom compost (SMC) amendment in soil significantly increased the bell pepper yield in addition to improving the quality. Incidence of soil borne fungal diseases decreased to a considerable level due to the incorporation of SMS in soil. As a whole, SMC and its combination helped in increasing yield by increasing the fruiting life of the plant and quality of *Capsicum* along with decreased levels of disease incidence.

- SMC of button mushroom was further used in mandarin plants (*Citrus reticulata*) as soil amendment against root rot pathogen (*Fusarium oxysporum*). Disease severity was reduced by application of SMC which was evident with increased activity of defense enzymes (PAL, POX, and  $\beta$ -1,3-glucanase and chitinase) and cellular localization of  $\beta$ -1,3-glucanase and chitinase were confirmed by indirect immunofluorescence using PABs of chitinase and glucanase and FITC conjugates.
- The organic manure can be used as alternative of inorganic fertilizer for development of sustainable agriculture. SMC amendment in soil significantly increased the bell pepper yield in addition to improving the quality. Incidence of diseases especially soil born decreased to a considerable level due to the incorporation of SMS in soil. As a whole, SMC and its combination helped in increasing yield by increasing the fruiting life of the plant and quality of capsicum along with decreased levels of disease incidence
- SMS also used for disease suppression of root rot mediated wilting disease of citrus plant (*Citrus reticulata*)
- Large number rural educated unemployed youth as well as women self-help groups of North Bengal were facilitated with proper training about mushrooms cultivation and spawn preparation. Publicity and awareness camp about mushrooms and its health benefits were also displayed at the Krishi Mela organised by the Department of Agriculture, Govt. of West Bengal.
- In a developing country like India where the unemployment rate is very high, mushroom cultivation can be recommended to the youth in order to make several unemployed to earn a living.