CHAPTER-II
HISTORICAL
Almost certainly prehistoric man used mushroom as food. He has been fascinated with this biological entity since time immemorial as the related references are available in most ancient literatures like Vedas and Bible. Theophrastus (372-287 BC), the great Greek philosopher wrote about the food value of mushrooms during middle ages when these comprised royal dishes for the Greek and Roman Empires. However, during the last three centuries, particularly after the artificial cultivation of button mushroom in France around 1650, mushroom have attained household popularity in Europe and America (Atkins, 1983) Chinese of course, were able to cultivate some other mushroom much before the white button mushroom which included *Auricularia auricula* in 1600 A.D. and *Flammulina velutipes* in 800-900 A.D..

The early history of mushroom cultivation is shrouded in antiquity. According to Singer (1961), growing of *Volvariella* (Paddy straw mushroom), in the primitive forms must be a very ancient art. Cheng and Tu (1968) stated that the method of cultivation species of Auricularia has been recorded in ancient Chinese publications such as the 'Liki.' about 300 B.C. and 'Lu Shih' about 239 B.C. Ito (1978) thinks that a primitive form of cultivation of shiitake was developed in China about 800 year ago. Bonnefons (1650) gave the first account of mushroom cultivation and Chamby (a French gardner) around 1810 started their cultivation in under ground guerries in Paris and suggested the possiblity of their year round production.
The authentic records available only for Agaricus bisporus (white button mushroom) state that cultivation of this mushroom species started in Paris region of France around 1650 by melon growers in open. Later mushrooms were grown on domestic scale in green houses in England in the 18th century (Callow, 1831) followed by cultivation in caves in early mid 19th century spreading at same time to other countries in Europe. The standard mushroom houses were built in U.S.A. in 1910 with the down of modern era of biological science. Consequent upon the development of microscope and microbiological techniques, some scientists paid attention to the cultivation of edible mushrooms, while a number of improvements in growing techniques were made by the farmers emperically. The most important contribution of the scientists was the preparation of pure culture and spawn which boosted and established mushroom production. Though Costatin and Lefort (1894) had developed a practical and dependable method of spore germination and spawn production in sterile condition by 1890, his publication did not reveal the practical details of the process. Therefore, it remained a secret till 1902 when Ferguson realized the importance of pure spawn production by germinating spores on suitable substrate and Dugger (1905), who developed technique for pure spawn production by culturing pileus tissue on a conventional medium. Soon after, pure culture spawn was taken up by scientists in all mushroom growing countries including South East Asia and Japan which improved their yield considerably.

The liberal policy of American scientists in the first quarter of 20th century stimulated other European mycologist who also under took study
of the scientific aspects of the factors governing production of *Agaricus bisporus* (white button mushroom). As a result of these studies, the cultivation of white button mushroom not only led to the establishment of the sound mushroom industry in Europe and U.S.A. but also extended to other non-traditional areas like Asia and Africa. Thus mushroom growing, which was considered by many a gamble in the past is no more a risky business today. The research supported to the industry has not only solved the various problems facing it but also analysed scientifically the different variables in the process leading to considerable increase in yield per unit area.

Publication of paper by Su and Seth (1940) on Indian mushroom farming clearly outlined the procedure of spawn production and cultivation of Volvariella. The work on cultivated mushroom was first started at the college of agriculture coimbatore (India) where these experiments were published by Thomas *et al.*, (1943). Later this was tried successfully with slight modification at many other centres in India (Asthana, 1947; Rath, 1961; Rama Krishna *et al.*, 1968; Gupta *et al.*, 1970; Munjal, 1973; and Purkayastha *et al.*, 1980.

Indian Council of Agricultural Research (ICAR) and the government of Himachal Pradesh started a scheme for experimental cultivation of white button mushroom at solan in 1961 and later strengthened it by providing the service of a FAO mushroom expert Dr. E. F. K. Mantel. The conversion of mushroom projects, solan into an ICAR coordinated mushroom research scheme with main centre at solan and 3 sub centres at Ludhiana, Bangalore and New Delhi started in 1970.
Important contribution has been made by Indian scientists in this field and the successful cultivation of *Agaricus bisporus* on horse dung and wheat straw was demonstrated by Sohi *et al.* in 1965. They standarized the preparation of synthetic compost based on wheat straw, suitable for North Indian conditions. Bels *et al.* 1967 and Coates Smith (1972) stated the importance of humidity and air movement in mushroom house. Krishnamurthy and Lalitha Kmary 1968, reported the suitable bed of 3½'×3½'×3½' size for straw mushroom cultivation. Munjal suggested that *Agaricus bisporus* contains 86.5% water, 3.95% protein, 0.19% Fat, 4.1% extract matter, 1.1% fibre and 1.26% Ash contents calculated on fresh weight basis. A part from these, thiamine, niacin, riboflavin, ascorbic acid, Panthothenic acid, biotin and minerals like calcium, Phosphorus, Potassium, iron and copper were also extracted. Hayes in 1969, studied nature of microbial stimulus affecting sporophore formation. Munjal and Chatterjee (1971) reported few species of fungi from the bed during rainy season. They found that light dusting of agrosan G. N., Cereson and Thiram gave an effective control against those fungi. Mantel *et al.* (1973) used decomposed spent compost, decomposed farm yard manure and loam soil mixture as casing material. Munjal (1973) developed advance technique for the production of quality spawn of *Agaricus bisporus* and *Volvariella spp.* Seth *et al.* (1973) reported the technique for combating the dry bubble disease of white button mushroom. Thyagarajan (1973) reported starch to be the best source of carbon, the analysis of which with different spawn gave a positive indication of its role in increase of yield with the increase in its
level in spawn base. Mantel (1973) stated that casing soil can be best disinfected with formaldehyde treatment. Chandra (1974) noted the effect of growth regulators (I.A.A., G.A.), and ultraviolet and infrared radiations on the growth of five fungi. Jandaik and Kapoor (1975b) isolated eighteen amino acids from the mushroom and compared with their known value in *Pleurotus ostreatus* and *Agaricus bisporus*. Gupta *et al.* (1975) surveyed various mushroom houses and found a green mould disease in spawn tray which was identified as *Chaetomium olivaceum*. Shandilya *et al.* (1975) presented a brief account of five pests of *Agaricus bisporus* observed in different mushroom farms in H.P. and Delhi. Seth (1975a) recorded a bacterial blotch disease of mushroom caused by *pseudomonas tolassii* at Solan. Purkayastha and Chandra (1975a) studied the fructification and growth characteristics of *Termitomyces eurhizus* and *Volvariella volvacea*. They also studied the environmental and nutritional requirement for normal growth of *Agaricus compestris*, *Calocybe indica* and *Lentinus subnudus*. Krishna Mohan (1975) indicated that horse dung and cowdung compost and paddy straw were equally good for production of spawn but the yield was 30% higher on horse dung compost than other two types of spawn. Ramaswami and Kandaswamy (1975) found that a mixture of paddy chaff and rice bran in equal quantity was the best medium for preparation of spawn. Kumar *et al.* (1975) advised that *Agaricus bisporus* required 2% gypsum, 6% calcium carbonate and Jawar or wheat grain for its successful spawn production. Kaul and Kacharoo (1975) used ethyl methane sulphonate in 1.0, 0.5, 0.25 per cent concentrations for high
growth of Agaricus bisporus; Wuest et al. (1991) showed disposal and uses of spent compost of A. bisporus. Van Grivanson (1991) searched the evidences for transmission of La France disease in A. bisporus by ds-DNA. Tiwari and Pandey (1991) have successfully cultivated white button mushroom (Agaricus bisporus) on horse dung in the climatic conditions prevailing in Bangalore. Chemical sterilization technique of substrate has been created at NCMRT, solan by Vijay is accepted worldwide. Thapa, et al. (1991) observed the occurrence of sepedonium yellow mould (sepedonium chrysopermmum) in mushroom (Agaricus bisporus) beds. Dhar (1991) suggested mushroom farm design suitin Indian condition. Sharma (1992a) reported mycoflora of casing soil. Gupta and Vijay (1991) advised post- composting supplementation in Agaricus bisporus under seasonal growing conditions. A tremendous amount of work has been done on role of thermophilic fungi in nutrition and compost preparation for A. bisporus (Gupta and Vijay, 1992). Sohi (1992) suggested importance of edible mushroom in Indian diet and factors responsible for low production of cultivated mushroom Sharma (1992a) reported compost and casing mycoflora from mushroom farm of Northern India. Sharma and Vijay (1993) noticed competitor moulds as serious threat to Agaricus bisporus cultivation in India. Saini (1993) suggested mustard straw as a good substrate for the cultivation of white button mushroom. Vijay and Gupta (1994) reported the microflora of Agaricus bisporus compost. Savoie et al. (1995) observed the conversion of nitrogen into stable organic forms which is readily available to mushroom mycelium during its growth but not to further
ammonification. Vijay and Gupta (1995) suggested to improve the physical structure of the substrate where required quantity of air is provided to the growing mycelium. Vijay (1996) reported thermophilic fungi developed during course of composting played an important role in decomposition of plant residues and formed a selective substrate for the development of *Agaricus bisporus* at the practical exclusion of the composting organisms. Miller (1997) suggested the modification of compost structure in such a fashion that it held sufficient water without water logging which served as water reservoir for mushroom growth. Vijay and Gupta (1997) worked on cultivation of white button mushroom. Shwet Kamal (1999) made studies on pathology and control of yellow mould syndrome occuring in compost beds of white button mushroom (*Agaricus bisporus*). Ahlawat *et al.* (1999) investigated 'Wet spot', a common bacterial contamination problem in mushroom spawn, often resulting in severe losses. Spawn of the button mushroom (*A. bisporus*) showing 'Wet spot' type of contamination was examined for bacterial contaminants. Out of four initial isolates selected on the basis of colony characteristics, three were found capable of causing similar type of spawn contamination. All the three isolates were identified as different strains of the same species, *Bacillus subtilis*. Singh et al., (1999) dried white button mushroom at 50, 60, 70, 80, 90, 100 and 110°C by hot air oven. Where minimum change in quality of mushroom was noticed at 60°C. Dehydration and redehydration ratios were found to be 15:2:1 and 1:2:65 respectively at 60°C. The Drying rate pattern was also studied at this temperature and the critical moisture content
was found to be 43.4%. Shwet Kamal et al. (2000) reported the devastating effect of yellow-mould diseases on button mushroom cultivation in India which caused complete crop failures in cases of early and severe infections. The fungi involved in the disease were identified as *Myceliophthora lutea* (Const.), *Sepedonium chrysospermum* (Bull.) Fries and *Sepedonium maheshwarianum*. Results indicated that the test pathogens were better producer of cellulases and hemicellulases but poor in laccase and Polyphenol oxidase production. *Agaricus bisporus* was good producer of Laccase and polyphenol oxidase but was poor in cellulases with negligible F Pase. Vijay et al. (2000) reported *Sepedonium maheshwarianum* as a strong competitor of *Agaricus bisporus* which drastically reduces the yield. In this connection, it was suggested that when chicken manure was added in the compost prepared by long method that should be free from *Sepedonium maheshwarianum*. Suman (2001) noted that amongst 52 single spore isolates developed from parent strain 5-11 of *Agaricus bisporus*, 10 isolates were further screened for yield and other quality traits on long method of compost under seasonal growing conditions, isolates A-16 and A-18 recorded 62.07 and 31.09 per cent higher yield over the parent strain 5-11 (control) respectively. In addition, isolate A-16 produced solid and compact fruit bodies that did not open as fast as often observed in 5-11. Shwet Kamal et al. (2000) reported the role of lytic enzymes produced by yellow mould causing organisms viz., *Myceliophthora lutea* (coust.), *Sepedonium chrysospermum* (Bull.) Fries
and *Sepedonium Maheshwarianum* (Mukerjee) in the pathogenesis and death of mushroom mycelium. The interaction seen in nutrient poor medium exhibited coiling and penetration of *Myceliophthora Lutea* hyphae into *Agaricus bisporus* hyphae while antagonism and necrosis were observed in case of *Sepedonium chrysospermum* and so such type of symptoms were seen in case of *S. Maheshwarianum*. The lytic effect of 1-3, β-exoglucanase and 1-3 (4) β-endoglucanase enzymes on *Agaricus bisporus* (5-11) mycelia has also been studied which showed positive effect. Kaur (2001) reported that *Dectylium dendroides*, a cob web disease causing fungus when grown during cultivation of *Agaricus bisporus* in presence of four fungicides, namely carbenzadizine, dithiocarbamate, prochlorozmanganese and thiobendazole on Potao Dextrose agar medium showed its complete inhibition at 25, 15, 20 and 15 ppm respectively. These concentrations, when tried on *Agaricus bisporus* showed 16.4% and 13.4% suppression with carbenzadizine and prochlorez manganese while no inhibitory effect was observed in case of dithiocarbamate and thiobendzazole. The fungicides when further added at three stages of *Agaricus bisporus* cultivation at given concentrations they did not suppressed the yield. Khanna et al. (2001) stated that when growth promoting chemicals namely cysteine hydrochloride, ethylene glycol, hydroxylamine hydrochloride, glycerol and monoethanolamine were sprayed on mushroom beds daily at the rate of 500 ppm and 1000 ppm and weekly at the rate of 3500 ppm and 7000 ppm. An enhancement in yield from 4.8 to 22.3% was recorded.
when 1000 ppm of each chemical was sprayed daily. Four metal ions (Cu$^{2+}$, Fe$^{2+}$, Mg$^{2+}$ and Zn$^{2+}$) were added at the rate of 5 ppm at spawning as well as at the time of casing of the mushroom beds, the increase in yield was recorded in all treatments. Saharan and Guleria (2001) reported that *Agaricus bitorquvis* (Quel.) sacc. is emerging as a promising species of Mushroom. Yet no serious efforts have been made to increase the production per unit area. Supplementation of Mushroom compost at spawning and casing have provided an opportunity to increase the production of Agaricus bisporus. However, in practice the supplementation also increases the risk of crop failure in consequence of heat production and weed moulds in the compost, if not properly treated before application. Supplements after treating with different concentrations of formaldehyde have been added to the compost at spawning for increasing *A. bisporus* yield by various workers Randle et al. (1986) and Gerrits (1984,1986). Singh and Kanaujia (2001) studied cultivation of *A. bisporus* at Faizabad and observed the effect of compost supplementation with different concentration of inorganic salts which increased the yield of mushroom at significant levels. Bhatt and Singh (2002) studied the chemical control of Mycopathesites of button mushroom, in which 223 samples of compost, casing material and fruiting of button mushroom (*Agaricus bisporus*) were examined. The incidence of *Mycogone perniciosa, Hypomyces rosellus* and *Verticillium fungicola* varied from 5.56-13.35, 6.52-17.85 and 2.17-25.00 per cent, respectively. The pathogen *M. perniciosa* proved to be most detrimental causing
100 per cent loss in yield when inoculated in casing. However, other two fungi, *V. fungicola* and *H. rosellus* were found to be causing loss in yield by 69.75 and 76.20 per cent, respectively. Significantly higher yields were recorded when sporrgon (0.075%) was added in casing against *M. perniciosoa* and *V. fungicola*. Bavistin (0.025%) + Formalin (0.2%) was effective against *H. rosellus* and resulted in increase mushroom yield.