1. INTRODUCTION

Microbe, an omnipresent creature, exerts its influence on major biological processes that take place in nature. Inspect of its minute size, the contribution upon various disciplines is multifarious. Historically, biotechnology was an art rather than a science, exemplified in the manufacture of wines, beers, cheese, etc., where the techniques of manufacture were well worked out and reproducible but the molecular mechanisms were not understood. Biotechnology though executing many traditional processes also encompasses the reproduction of oriented foods such as soy sauce and tempeh and sewage treatment where the use of microorganisms has been developed somewhat empirically over countless years. Microbial technology, probably one of the oldest scientific practices, can be traced back to some 6000 years to the time when beer and wine production apparently began in ancient Egypt (Dasilva et al., 1987). Modern biotechnological processes now encompass a wide range of new products including antibiotics, vaccines and monoclonal antibodies, the production of which has been optimized by improved fermentation process (Smith, 1996). The European Federation of Biotechnology (EFB) considers biotechnology as the integration of natural sciences and organisms, cells, parts thereof and molecular analogies for products and services (Smith, 1996).

Among the microbial flora, eukaryotic, heterotrophic fungus has rooted the major scenario in the field of biotechnology. Fungi are an extremely diverse group of heterotrophic organisms that are exploited by humans for various biotechnological applications. They are used in the production of food, beverages, organic acids, enzymes, polysaccharides and antibiotics and other pharmaceuticals and as agents of biological control of pest insects, fungi, and weeds and in biomass conversion (Onions et al., 1981; Berry, 1988; Heong and Berka, 1990). In fungal taxa, yeasts have been exploited from long back in the field of brewing, baking, energy food production and bioremediation. New applications are likely to be seen earliest in the area of healthcare and medicine, followed by that of agriculture and food technology (Smith, 1996).
Biotechnological industries will be based largely on renewable and recyclable materials and so can be adapted to the needs of a society in which energy is ever increasingly expensive and scarce. Microorganisms employ both constitutive and inducible enzymes to degrade and synthesize a great variety of chemical compounds, not only for their viability and reproduction, but also for their secondary metabolism. The fungal components produced during fermentation were categorized as (i) Primary and secondary metabolites (ii) Enzymes and (iii) Biomass (fungal cells).

**Primary metabolites**

Metabolites produced during tropophase, which are essential for the microbial growth or energy yielding catabolism, such as organic acids and ethanol are known as primary metabolites. The organic acids are either the terminal products of EMP pathway (glycolysis) (lactic acid and propionic acid) or the products of incomplete oxidation of sugars (citric acid, itaconic acid and gluconic acid). A third type is also obtained from the dehydrogenation of alcohol in the presence of oxygen (acetic acid) (Riviere, 1977). The production of acetic acid and gluconic acid by fermentation with *Zygosaccharomyces rouxii* was well documented (Kazuhiro *et al.*, 1998). The production of alcohol by fermentation of sugars and starch using *Saccharomyces cerevisiae* is an ancient art and is often considered being one of the first microbial processes used by man (Smith, 1996). Ethanol a valuable commodity for fuel was produced industrially by *Saccharomyces cerevisiae* (Rank *et al.*, 1995).

**Secondary metabolites**

Secondary metabolites (antibiotics, toxins, alkaloids, steroids, etc.) are produced during the idiophase of microbial growth and are not required for their metabolic activity. The production of penicillin by *Penicillium notatum* and *P.chrysogenum* (Dubey, 1993), cyclosporin production by *Beuveria niwea* (Borreel *et al.*,1976), ergot alkaloids by *Claviceps purpurea* (Berde and Sturmer, 1978) and asperlicin production by *Aspergillus alliaceus* (Cheng *et al.*. 1985) are some examples of secondary metabolites produced by fungi.
**Enzymes**

Enzymes are complex functional protein molecules present in living cells, where they act as catalyst in bringing out chemical changes in substances. Although enzymes are produced only in living cells, many can be separated from the cells and can continue to function in vitro. Due to its catalytic nature, enzymes have an array of industrial applications. Enzyme technology contributes to most vital problems with which modern day society is confronted like food production, energy shortage and preservation and improvement of the environment (Smith, 1986).

**Food Industry**

Enzymes are exploited to process raw materials and produce new and traditional food products, to increase the efficiency and ease of food processing and to enhance the quality of the final product (Finkeltstein and Christopher Ball, 1992). Some examples are protease enzyme obtained from *Aspergillus oryzae* in bread doughing (ter Haseborg, 1988), amylases and glucoamylases of *Aspergillus niger, A.oryzae* and *Rhizopus oryzae* in saccharification of starch (Mc Cleary *et al.*, 1989), breweries (Pollack, 1987) and vinegar production (Godfrey, 1985), pectic enzymes of *Aspergillus oryzae* in fruit and juice processing (Fogarty and Kelly, 1983) and coffee and tea fermentation to remove the mucilage coat from coffee beans and improve foaming nature in instant tea products (Godfrey, 1985).

**Dairy industry**

Microbially produced enzymes now find its use in dairy industry. Microbial lipase are used to enhance ripening of blue mould chesses (Danish Blue, Roquefort) and lactase in break down of lactose to glucose and galactose (Smith, 1996).

**Tea industry**

Tea, the non-alcoholic beverage is prepared from the plant *Camellia sinensis*. Based on manufacturing process, tea was classified as green tea (non-fermented), Oolong tea (partially fermented) and black tea (fermented). Tea fermentation involves the mixing up of polyphenoloxidase with the catechin in the tea leaves for the formation of black tea.
components (Sanderson, 1972). Improvement of tea quality by addition of exogenous microbial enzymes during tea fermentation was reported by Senthilkumar et al. (2000) and Marimuthu et al. (2000). Supplementation of exogenous enzymes to improve the tea quality was in a primordial state.

**Pharmaceutical industry**

The vast bulk of pharmaceutical drugs presently on sale are synthetic chemicals derived either directly by chemical syntheses or by chemically modified molecules derived from biological sources. Biopharmaceuticals are generally recombinant protein drugs, recombinant vaccines and monoclonal antibodies (for therapeutic roles). These biopharmaceuticals are becoming increasingly relevant in biological applications but are still only a part of pharmaceutical industry (Smith, 1996).

**Textile industry**

Amylase enzymes of fungal origin were widely used to remove starch, which is an adhesive or size on threads of certain fabrics to prevent damage during weaving. Traditionally, desizing using strong chemicals has prevailed. Microbial enzymes are highly preferable for desizing, since they are able to withstand working temperatures up to 100 - 110 °C (Smith, 1996).

**Leather industry**

Traditionally protease enzyme from dog and pigeon faeces was used to treat leather to make it pliable by removing certain protein components (Bating process). At present trypsin from microbial sources was employed for bating and also to remove hair from hides and skins (Smith, 1996).

**Detergent industry**

Protease and amylase were used to pre-soak the fabrics and direct liquid applications. Enzymes in detergents were achieved good levels where in, used to improve washing results. Cellulase has recently entered the detergent market and acts directly on the...
fabrics and removes the micro fibrils or broken strands of fibres that create fuzziness (Smith, 1996).

**Paper Industry**

Present day biobleaching of kraft pulp uses large amounts of chlorine and chlorine chemicals. By products from using these chemicals are chlorinated organic substances, some of which are toxic, mutagenic, bioaccumulating and cause cancer in biological systems (Bajpai and Bajpai, 1996). Manganese peroxidase and laccase of *T. versicolor* were exploited for the biobleaching and delignification of hard wood kraft pulp, which resulted in increased good quality pulp (Selvam, 2000). Paice *et al.* (1989) reported that bleaching of kraft pulp with the white rot fungus *Trametes versicolor* resulted in chemical savings.

**Fungal biomass**

Apart from the application of fungus in bioprocess technology by producing novel components, it also holds a prominent role in the production of single cell protein and for the water treatment process.

**Single cell protein (SCP)**

Conventional agriculture may well be unable to supply sufficient food, in particular protein, to satisfy high demands. The search for sources of protein is recently pursued. New agricultural practices are widespread, high protein cereals have been developed; the cultivation of soya beans and groundnuts is ever expanding. Protein may be extracted from liquid wastes by ultra filtration and now the use of microbes as protein producers has gained wide experimental success. This field of study is known as single cell protein or SCP production, referring to the fact that most of the microbes are used as producers which grow as single or filamentous individuals rather than a multicellular organisms (Smith, 1996). Eating microbes may seem strange, but people have long recognized the nutritional value of some large fungi, “mushrooms” (*Agaricus bisporus*) possessing 47% of protein. Other forms like *Lentinula edodes* (shii take mushroom), *Pleurotus* spp. (oyster mushroom) and *Volvariella volvacea* (paddy straw mushroom) are now
expanding rapidly in the field of mushroom production. Mushrooms are among the oldest of all cultivated crops. There are at least 10,000 species of mushroom, of which 600 are edible and twenty five are produced commercially (Ammirati et al., 1985). Industrial production of SCP from renewable raw materials were *Saccharomyces cerevisiae, Candida utilis, Fusarium graminarium, Trichoderma viride, Kluveromyces fragilis* which produce high amounts of mycoproteins (Dasilva et al., 1987).

**Water treatment technology**

Among the microbial community, fungi occupy a key role in the wastewater treatment process. Though chemical treatment is still in process today, it affords a high input for salvation. A variety of biological treatment systems have been developed ranging from cesspits, septic tanks and sewage forms to gravel beds, percolating filters and activated sludge process coupled with anaerobic digestion. These treatments imply to reduce the amount of biologically oxidisable organic compounds producing a final effluent or out flow that can be discharged into the natural environment without any adverse effects (Smith, 1996).

The biological treatment of wastewaters by microbes involves the following process.

**Bioconversion**

Fungal bioconversion as a means of performing regio - and stereo specific chemical reaction are extensively utilized by the pharmaceutical and fine chemical industries in the production of chiral compounds and other useful metabolites (Finkelstein and Ball, 1992). The reactions of fungal bioconversions are hydrolytic, oxidation, condensation and reduction process that takes place in the steroid and alkaloids compounds (Holland, 1981; Rosazza and Duffel, 1986).

**Biodegradation**

Biodegradation is transformation of complex compounds into simple products. some times mineralisation by microbes. Microbes serve as potential candidates for the biological transformation of xenobiotic compounds that are introduced in to the ecosystem. Prolonged exposure of microbes to specific polluting compounds like oils and
polychlorinated biphenyls (PCBs) can be converted into less harmful products (Smith, 1996). *Phanaerochaete chrysosporium*, a white rot fungus is a widely used degrader for lignocellulosic materials (Smith, 1996). *Fomes lividus*, *Thelephora* sp. and *Trametes versicolor* were exploited for lignin and dye degradation (Selvam, 2000).

**Biosorption**

Biosorption is the process used to recover metals and radionuclides by physico chemical interaction of metal ions with the cellular components of the biologicals. Biosorption of metals has been recently receiving a great deal of attention due to its scientific novelty and application potential. Live and non-living biomass of *Saccharomyces cerevisiae* was used for uptake of uranium, zinc, copper and cadmium (Volesky and Phillips, 1995). Biological material can be developed into a good system for the removal of metallic pollutants because of its cost effectiveness and degradable nature.

Based on the preliminary observations, in the present study the tea fungus obtained from tribal people of Kolli hills, Tamil Nadu, India was tried for black tea quality improvement, for the control of CCl₄ induced hepatotoxicity, as SCP for poultry and as a biosorbent for the removal of Fe(II), As(III) and As(V) from ground water.

**Tea fungus**

Tea fungus is a symbiont of two yeasts, *Pichia* sp. NRRL Y-4810 and *Zygosaccharomyces* sp. NRRL Y-4882 and a bacterium *Acetobacter* sp. NRRL B-2357. Tea fungal association tends to differ from country to country by possessing various strains of acetic acid bacteria (*Acetobacter xylinum*, *A. xylinoides* or *Bacterium gluconium*) and yeasts (*Schizosaccharomyces pombe*, *Saccharomyces luduigii*, *Zygosaccharomyces rouxii*, *Candida* sp. or *Pichia membranaefaciens*) (Hesseltine, 1965; Kozaki et al., 1972; Anon, 1983; Blanc, 1996; Liu et al., 1996; Chen and Liu, 1997). The fungal tea is consumed widely in Russia, Japan, Poland, Bulgaria, Germany, Manchuria and Indonesia and is known in different names like Teaschwamm, Kombucha, Wunderpilz, hongo, cajnij, fungus japonicus and teek wass. The botanical name of tea fungus was given by Lindau, as "*Medusomyces gisevii*". The fungus grows well in tea medium containing high concentration of sucrose (Hesseltine, 1965) by forming
The fungal mat represents a symbiotic relationship between bacteria and yeasts (Chen and Liu, 2000). The film formed only when the three organisms were present together. When Acetobacter was used alone, gas was produced and the film was not formed. When the three organisms were combined no gas was produced and the film formed rapidly. The tea fungus broth is composed of two portions, a floating cellulosic pellicle layer and the sour liquid broth. Acetic acid and gluconic acid are the major components of the liquid broth (Blanc, 1996). Fermentation was traditionally carried out by inoculating a previously grown culture into a freshly prepared decoction and incubated statically under aerobic conditions for 7-10 days at room temperature (28 ± 2 °C). Consequently a pleasantly sour and slightly sparkling beverage called kombucha or teek wass is produced (Chen and Liu, 2000). The beverage has been claimed to be a prophylactic agent and beneficial to human health (Blanc, 1996).

The antibacterial activity of kombucha tea was investigated against a number of pathogenic microbes. Staphylococcus aureus, S.epidermis Shigella sonnei, Escherichia coli, Aeromonas hydrophila, Yersinia enterolitica, Pseudomonas aeruginosa, Enterobacter cloacae, Campylobacter jejuni, Salmonella enteritidis, S. typhimurium, Bacillus cereus, Helicobacter pylori and Listeria monocytogenes were found to be sensitive to kombucha (Steinkraus, 1996; Sreeramulu et al., 2000). Numerous popular media features in the united states have highlighted the beverage and its uses, including the New York Times and Miami Herald, suggesting that Kombucha consumption can reduce blood pressure, relieve arthritis, increase the immune response and cure cancer (Neill, 1994; Jacobs, 1995).