CHAPTER II

REVIEW OF LITERATURE

Fungi can be found in extreme environment including deserts and some of them are euryhaline (Vaupotic *et al.,* 2008). Some of them can tolerate ionizing radiation (Dadachova *et al.,* 2007) and can adapt in hydrothermal areas of ocean (Le Calvez *et al.,* 2009), sea sediments (Raghukumar, 1998). Fungi mostly are terrestrial but few are solely or partly aquatic like *Batrachochytrium dendrobatides* which is a parasite to amphibians and resulted in decline of amphibian population (Brem and Lips, 2008). Some fungi like deurtomyces are thermo tolerant. Mesophilic fungi can grow at or up to 65 ºC. They are also tolerant to wide range of pH (Megan, 2006). The highest mycorrizal association is found in association with the roots of *Poa attenuate* (Kotilínek *et al.,* 2017).

Mushroom cultivation gained importance from 17^{th} century for food and fodder (Botticher, 1941; Anderson, 1942; Gilbert, 1957; Giacomini, 1957). They have several enzyme complexes which facilitate them to use cheap raw material and substrates like pectin, cellulose and lignin that are considered to be unsuitable for animal feeds (Waksman, 1944). With the progress in new techniques like genomics, proteomics and combinational chemistry, the fungal resource can be exploited for array of chemicals, pharmaceuticals and industrial products (Manoharachary *et al.,* 2005). Out of 2000 edible species known, about 283 have been reported from India (Thiribhuvanamala *et al.,* 2011). Most mushrooms are yet to be described (Hawksworth, 2001; Kirk *et al.,* 2001).

Mushroom taxonomy has always been complicated due to their numerous overlapping characters. The species identification and delimitation is widely relied on morphological and microscopical description followed by molecular taxonomy. Nelsson *et al.,* (2006) concluded that the increase in dependence on the submitted sequence is not completely reliable in fungi due to incorrectly identified species which lack description and up to date annotation. Further in 2008, Nilsson and co authors studied the ITS regions of many reported species extensively & found that ITS though currently used widely to delimit species but it is also a choice for information regarding intraspecific variation. Schoch *et al.,* (2012) studied six DNA markers as barcodes for identification of fungi which included protein coding genes viz. cytochrome c oxidase, large and small subunit of RNA polymerase II, minichromosome maintainance protein coding genes, ITS and LSU. Only ITS and LSU were considered due to their capability in delimiting inter and intraspecific variation. ITS was superior in most of the

taxonomic groups and LSU was found to be superior than ITS in some groups. Also because of the technical challenge in wet lab setup (PCR amplification and sequencing), other four markers could not find much popularity among mushroom taxonomist.

Hosaka, (2011) studied the different drying temperature for high quality DNA in biological specimen and reported the quality of DNA to be independent of drying temperature in mushrooms.

Mushroom nutraceutical is a widely used concept and was termed by Chang and Buswell in the year 1996 for the medicinal properties of mushroom. Nutritionally, on the basis of protein content they are considered to be well above animal products (Arora, 1986; Breene, 1990). The proteins in mushrooms are easily digestible. The protein and other bio molecular composition determine its nutritive value. Proteins are composed of essential and non-essential amino acids and some mushrooms contain all the amino acids (Breene, 1990; Chang and Miles, 1989). Mushrooms are generally rich in lysine and tryptophan, but poor in sulphur containing essential amino acids (methionine and phenylalanine). Percentage of essential amino acids in some wild and cultivated mushrooms has been reported to vary from 2.6-7.6 % (Kreula *et al*., 1976). Mushrooms are known for their medicinal and nutritional values (Cochran, 1978) and pharmacological activities (Poucheret *et al.,* 2006).

Mushrooms are excellent source of protein, fibre and polysaccharides (Bonatti *et al.,* 2004; Agrahar Marugkar, 2005; Chihara, 1992; Lin, 1995; Cheung and Cheung, 2005) and different bioactive compounds like glycolipids, sesquiterpenes, polyketides, terpenes, steroids, tocopherols, ascorbic acid and carotenoids. They are also rich in linoleic acid, arachidonic acid and oleic acid (Wasser, 2002; Kues and Liu, 2000; Reis *et al.,* 2012; Hughes, 1962). Mushroom contains ergosterol instead of cholesterol which is further synthesised to vitamin D in human (Dooan *et al.,* 2013; Mattila *et al.,* 2001; Heleno *et al.,* 2010). Eritadenine a compound from mushroom have cholesterol lowering property and is also known to inhibit HMG-CoA reductase (Guillamon *et al.,* 2010). Mushrooms are also a good source of vitamins and micro elements (Guillamon *et al.,* 2010; Mattila *et al.,* 2001; 2002; Kalac *et al.,* 2013; Ries *et al.,* 2012; Mdachi *et al.,* 2004; Ouzouni *et al.,* 2009).

Mushrooms are good alternate source of animal protein for vegetarian (Verma *et al.,* 1987). In mushrooms, proteins are the essential constituent (Chang and Buswell, 1996) and its content depends on size of pileus, substrates, harvest time, species and flush (Bano and Rajarathnam, 1982; Crisan and Sands, 1978; Biswas, 2012; Omer, 2017). Protein content of

different mushrooms is in the range of 19 to 40 % (Binding, 1978; Weaver *et al.,* 1977; Breene, 1990; Crisan and Sands, 1978; Li and Chang, 1982; Bano and Rajarathnam, 1988). It comprises of albumins, globulins, glutelins, prolamins and prolamin-like substances (Kalac, 2009; Omer, 2017; Petrovska, 2011). Mushrooms have the highest efficiency of protein conversion in per unit area and time which is better than any other source of protein. Mushrooms have higher protein content than many vegetables and wild plants (Bano and Rajarathnam, 1988; Kallman, 1991). Mushrooms are also known to be enriched with all the different amino acids that are essential (Hayes and Haddad, 1976).

Carbohydrates form the greater part of mushroom fruit bodies ranging from 50 to 65 % of the dry weight containing both free and bound sugars (Wani *et al.,* 2010). The free sugar is dominated by mannitol ranging up to 80 % of the total content (Tseng and Mau, 1999). Fresh mushrooms are also reported to have 0.91 % hemicellose, 0.59 % glycogen, 0.28 % reducing sugar and 0.9 % mannitol (Mc-Connell and Esselen, 1947; Omer, 2017).

Mushrooms have fat content in the range of 1.1 – 8.3 % on dry weight basis. In comparison to other biomolecules like protein and carbohydrates, mushrooms have low fat. The fat content includes different classes of compounds like phospholipids, sterols, mono-, di- and triglycerides (Huang *et al.,* 1989; Omer, 2017). The fat content is mainly composed of unsaturated fatty acids. The fatty acids are reported to have bactericidal activity (Minami, 1957; Zheng *et al*., 2005).

The mushroom fruiting body contains considerable quantity of mineral elements. In mushrooms K, P, Na, Ca, Mg are the major macro elements and Cu, Zn, Fe, Mo, Cd are major micro element (Bano and Rajarathanam, 1982; Kalac, 2009; Guillamón *et al.,* 2010; Omer, 2017). From the total ash content in mushrooms macro elements like Na, K, P and Mg constitute about 56 to 70 % (Li and Chang, 1982) with higher potassium content of 45 % of the total ash. The mineral content differ among species, age and the diameter of pileus. It also depends on substrate (Demirbas, 2001). It has been observed that the wild mushrooms had higher content of minerals compared to cultivated species (Aletor, 1995; Mattilla *et al.,* 2001; Rudawska and Leski, 2005). Manzi *et al.,* (1999) reported 6 %-10.5 % of the total dry matter forms ash content. Kalac, (2009) reported the ash content of 5-12 % with their concentration higher in cap followed by stipe and spores. The fruiting body assimilates different minerals from the substrates (Rajarathnam *et al.,* 2003; Kalac, 2009).

Free radicals are produced in the body from different metabolic process. The phenolic compounds are referred to have the ability to inhibit lipoxygenase, capture metal ions and scavenge free radicals (Mau *et al.,* 2004). Phenols and flavonoids are also correlated to antimicrobial and antioxidant properties (Barros *et al.,* 2007; Velioglu *et al.,* 1998). Phenols like caffeic acid and p-coumaric acid have potential health benefits with antioxidant activity. Phenols show properties like antibacterial, antifungal, anti-carcinogenic, anti-inflammatory, anti-allergic, anti-mutagenic, nematocidal activity etc (Clifford, 1999; Gulcin, 2006; Rice-Evans *et al.,* 1996; Ravn *et al.,* 1989; Oksana *et al.,* 2012; Rauha *et al.,* 2000; Basu *et al.,* 2017; Coyetaya *et al.,* 2009; Mau *et al.,* 2004; Barros *et al.,* 2007; Ferriera *et al.,* 2007).

The bioactive compounds in mushrooms usually with low molecular weight compounds include phenolic acids that are mainly responsible for their antioxidant properties (Ferreira *et al.,* 2009). There are about 8000 diverse structures which represents the phenolic compounds. They contain an aromatic ring with one or more hydroxyl groups bound to them, it includes numerous subclasses comprising flavonoids, phenolic acids, stilbenes, lignins, tannins, and oxidized polyphenols (Crozier *et al.,* 2008; Barros *et al.,* 2009; Fraga, 2010; Carocho, 2013). Phenolic compounds are the product of metabolites that have various role in health and nutraceutical potential of mushrooms (Chan *et al.,* 2014). The antioxidant activity of mushrooms are correlated and dependent on the content of these compounds and are considered as an important constituent to appraise free radicals scavenging ability of mushroom extracts (Chan *et al.,* 2011; Bertalanic *et al.,* 2012; Skotti *et al.,* 2014; Velioglu *et al.,* 1998).

Antioxidants are beneficial compounds that protect cells from injury caused by free radicals (Omer, 2017). Free radicals are powerful oxidants with chemical entities that contain odd electrons. Free radicals have the capability to damage different components of the body, viz. lipids, proteins, DNA, sugars and are capable to cause mutations and cancers (Przybytniak *et al.,* 1999). The body have inbuilt mechanism to tackle the free radicals produced during metabolism, Enzymes like superoxide dismutase (SOD), catalase and glutathione peroxidase traps free radicals in the body but it is incapable to reduce the excess radicals, excess production of free radicals results in oxidative stress. The synthetic antioxidants have carcinogenic and toxic effect. Thus natural antioxidants through supplement would reduce the oxidative damage without causing any side effects. Mushrooms are rich sources of these antioxidants and protects against the damage by free radicals (Puttaraju *et al.,* 2006; Oyetayo *et al.,* 2007). This ability of mushrooms as antioxidant has

proven beneficial nutritionally and various bioactive compounds of mushroom are good choice for drug discovery (Guerra-dore *et al.,* 2007; Chennupati *et al.,* 2012; Puttaraju *et al.,* 2006; Oyetayo *et al.,* 2007). The use of nutraceutical is important in maintaining good health and quality of life and prevention of diseases (Ferreira *et al.,* 2009).

Mushrooms are also known for their medicinal properties (Wani *et al*., 2010). Mushrooms have activities like antihypertensive, immunomodulatory, antitumor, Type I Ribosome-Inactivation protein (Wang *et al.,* 1996; Yao *et al.,* 1998; Chang and Buswell, 1999; Chang and Miles, 2004). Medicinal mushroom like *Ganoderma lucidum* are prime example (Tam *et. al.,* 1986 and Yip *et al.,* 1987). Extracts of different mushrooms are known to have potential effect on sarcoma like waxy cap mushroom (Ohtsuka and Asami, 1997). *Schizophyllum commune* (Borchers *et al.,* 1999). Different mushrooms are considered to possess properties to strengthen immune system and protect against cancer (Borchers *et al.,* 1999). Water soluble polysaccharides of mushrooms show antitumor potentials (Yoshioka *et. al.,* 1975).

Polysaccharides are the major compounds with medicinal properties in mushrooms. Lentinan from *Lentinus edodes* have antitumor activities, anti-ageing properties, anti-viral properties (Chihara *et al.,* 1992; Jones, 1990; Omer, 2017). Mushrooms are also used against epilepsy, skin diseases, heart diseases, rheumatoid arthritis, diarrhoea, dysentery, liver disease, gall bladder diseases, urinary infections (Bahl, 1983; Buswell and Chang, 1993). Mushrooms have been considered as conventional cancer treatment. It is also used in treatment of haemorrhoids, stomach ailments, headache, high blood pressure, smallpox, asthma, wound healings and cardiovascular diseases (Chandalia *et al.,* 2000; Yang *et al.,* 1993; Chang and Buswell, 1996; Oso, 1997; Fasidi and Olorumaiye, 1994; Delena, 1999). Different pharmaceutical components with potential health benefits such as beta glucans and polysaccharides have been derived from mushrooms (Wasser and Weis, 1999; Sadler, 2003). Mushrooms find its importance in Chinese traditional medicinal practice for centuries (Sharma, 2008; Gunde-cimerman, 1999).

Antibiotics act by disrupting and inhibiting metabolic processes, cell wall synthesis, protein synthesis, replication or disrupting membrane permeability (Fuchs *et al.,* 2004; Tenover *et al.,* 2006). The over use or inappropriate use of antimicrobial drugs have resulted in resistance by many micro organisms like *Klebsiella spp., E. coli, Staphylococcus aureus, Enterococcus, Acinetobacter and Pseudomonas spp.* etc (Harbarth *et al.,* 2001; Segal-Maurer,

1996; Kempf *et al.,* 2012). Eventually the pathogens develop resistance towards the effective dose of antibiotics and gradually saturation is reached (Peres-bota, 2003; WHO, 2000; WHO, AMR 2010; Klein *et al.,* 2007; Steinkraus *et al.,* 2007). Unavailability of imperative drugs and the risks associated with resistant microbes have led to implementation of control procedure by WHO to check the increase in resistant microbes. Mushrooms can be a good source for drugs with different bioactive compounds (Liu, 1993).

Zacharia *et al.,* (2017) reported the comparison of biochemical constituents of commonly cultivated mushrooms of Kerela and found them to be rich nutritionally with minerals and amino acids. Keles *et al.,* (2011) studied the antioxidant properties of twenty four wild edible mushrooms from turkey and found that methanolic extracts have good activity. They correlated the antioxidant potential with the phenolic content.

Barua *et al.,* (1997) reported five wild edible mushrooms from Meghalaya. Khaund *et al.,* (2013) reported eleven wild edible mushrooms consumed by Khasi tribes of Meghalaya based on morphological characters. Das *et al.,* (2017) reported thirteen wild edible species from Tripura which included different species of *Lentinus, Pleurotus, Termitomyces, Craterellus, Macrolepiota, Schizophyllum, Tricholoma* and *Volvariella.*

Dutta *et al.,* (2011) reported the genus *Volvariella* from West Bengal. They described three species *V. gloiocephala, V. pusilla, V. volvacea*. Senthilarasu *et al.,* (2012) described a novel species *V. sathei* from India. Li *et al.,* (2009) reported a new species of *V. nivea* a white species from Southern China. Justo & Castro, (2010) and Vizzini *et al*., (2011) described *V. dunensis* based on morphological and molecular characterization.

Paisey *et al.,* (2015) reported nutritional and morphological characters of *Volvariella* from West Papua. Pathak, (1975) reported species of *Volvariella* from Central Africa which included *V. acystidiata, V. congolensis*, *V. striata* and *V. mammosa.* Haq *et al.,* (2011) studied the biochemical content of *V. volvacea* in different substrates and reported that the nutritional quality is dependent on the substrate it grows.

Sharma *et al.,* (2015) reported that twenty recognised species of *Lentinus* have been documented from India. Manimohan *et al.,* (2004) studied nine species of *Lentinus* from Kerela and described *L. dicholamellatus* as a novel species. Karunarathna *et al.,* (2010) studied eight species of *Lentinus* from Thailand which included three novel species *L. concentricus*, *L. megacystidiatus* and *L. roseus.* They described the morphological and

microscopical characters with molecular phylogeny. Sharma *et al.,* (2015) studied taxonomy, phylogeny, cultivation and biological activities of *Lentinus sp.* from Andaman and Nicobar island and found that wild *L. sajor-caju* have considerable amount of Cu, Zn, Mg and carbohydrates but were poor in protein, fat, Na and Fe in comparison to the cultivated *L. sajor-caju*.

Dembitsky *et al.,* (2010) reported the fatty acid and amino acid content of fifteen wild edible mushrooms and mentioned that alanine, arginine, glutamine and glutamic acid to be the major constituents and fatty acids being dominated by linoleic acid, palmitic acid and oleic acid.

Cheung and Cheung, (2005) reported antioxidant potential of *Lentinus edodes* and *Volvariella volvacea* with different extract subfractions and found dichloromethane sub fraction of methanolic extract of *V. volvacea* showed good antioxidant activity against lipid peroxidation with IC_{50} value of 0.109 mg/mL. Gan *et al.,* (2013) studied the antioxidant potentials of different edible mushrooms and reported phenolic content, ferric reducing antioxidant potential and DPPH radical scavenging activity higher in aqueous extract and flavonoid content higher in 60 % methanolic extract. Arbaayah *et al.,* (2013) studied antioxidant properties of wild edible mushrooms and reported DPPH scavenging activity to be better in first flush.

Daba *et al.,* (2003) reported the use of components from mushroom with anticancer properties like polysaccharide, mitake extracts, schizophyllan, active hexose correlated compounds and lentinan from *Lentinus edodes.*

Wasser, (2002) reported the antitumor properties and also immunomodulating polysaccharides which included species from *Cantharellaceae* and *Plutaceae.* Hobbs, (1997) in his book medicinal mushrooms for cellular defence, immunity and longevity described many mushrooms with medicinal properties.

Venkatachalapathi *et al.,* (2016) described the use of many mushrooms by Irula tribal healers for treating fever, cough and fungal infections which included species from *Lentinus, Lycoperdon, Termitomyces, Auricularia, Ganoderma and Pleurotus.* It was also reported that *T. heimii* have wound healing capabilities and *L. sajor-caju* have anticancer and cholesterol lowering properties. Wani *et al.,* (2010) stated many health benefits of mushrooms by virtue of their bioactive components and use as drugs.

The nutritional content of *V. volvacea* have been studied by many different authors like Roy *et al.,* (2014), they reported moisture content, protein, vitamins, fat, carbohydrate and amino acids. Adedokun & Akuma, (2013) reported moisture to vary among substrates. They also reported carbohydrates, lipids, protein, ash and fibre content. Paisey *et al.,* (2015) compared nutritional content of *V. volvacea* from two different places and found it to differ in its constituents. Mshandete & Cuff, (2007) reported fat, protein, ash and carbohydrate content and minerals like Na, K, P, Mg, Ca, Zn, Fe, Mn, Cu but Co was not detected in *V. volvacea*. Omer, (2017) reported protein and mineral content of *V. volvacea*. Crisan & Sands, (1978) reported the amino acid, protein and fat content in *V. volvacea*. Adejamo *et al.,* (2015) reported ash, protein, fibre, fat and carbohydrate content. Salamat *et al.,* (2017) reported protein, fat, ash and carbohydrate content. Brinda *et al.,* (2017) reported protein, carbohydrate, lipids, ash and fibre content.

Huang *et al.,* (1989) reported the fatty acid content in *V. volvacea* which was found to be dominated by linoleic acid, palmitic acid and oleic acid. Nhi *et al.,* (2012) reported protein, moisture, lipid, ash and carbohydrate content, they also reported free and bound phenolics with DPPH radical scavenging activity. Kalava *et al.,* (2012) reported the extract of *V. volvacea* to have hepatoprotective potential. Bedi *et al.,* (2017) reported the total phenolic, flavonoid, ash, carbohydrate and moisture content in *V. volvacea*. Arora *et al.,* (1991) reported the amino acid content in *V. volvacea*. Punitha *et al.,* (2014) reported total phenolic, flavonoid, DPPH radical scavenging activity, reducing power, ABTS radical scavenging activity, superoxide scavenging activity and nitric oxide scavenging activity in methanolic and aqueous extract of *V. volvacea*.

Shoeb *et al.,* (2017) studied the extracts of *Termitomyces heimii* for DPPH radical scavenging activity and fatty acid profile and they found 55 % unsaturated fatty acid. The fatty acid profile was dominated by palmitic acid and linoleic acid with 36 % each respectively. They also studied the antimicrobial potential against *B. cereus, B. megaterium, B. subtilis, E. coli*. The extracts were not potent against *S. aureus* and *P. aureus*.

Abd Malek *et al.,* (2012) studied the fatty acid profile in different fraction of ethyl acetate in *T. heimii*. Singha *et al.,* (2017) reported the nutritional profile of *T. heimii.* They studied moisture content, protein content, lipid, ash and carbohydrate content. The nutritional content of *Termitomyces sp.* like protein, fat, ash, carbohydrate and moisture content was also reported (Ijioma, 2015; Due *et al.,* 2016 & Johnsy *et al.,* 2011). Atri *et al.,* (2014) reported

carbohydrate, fat, protein, fibre, ash, moisture, phenols and flavonoids content of *T. heimii*. They also reported the mineral content which included Ca, Cu, Fe, Mg, Mn, Se and Zn. Puttaraju *et al.,* (2006) reported the total phenolic, reducing power and radical scavenging activity of ethanolic and aqueous extract of *T. heimii*.

Kumari *et al.,* (2017) reported DPPH radical scavenging activity, reducing power and antimicrobial activity of *T. heimii.* They screened four microbes which included *S. aureus, K. pneumonae, E. coli and Pseudomonas sp.* against different concentration and reported to have good inhibition.

Alvis *et al.,* (2013) reported different phenolic and flavonoid compounds from mushrooms against nine different microbes and determined the MIC (Minimum Inhibitory Concentration) values, they also found that compounds like 2,4-dihydrobenzoic acid, syringic acid and vanillic acid binds to Penicillin binding protein 2a (PBP2a) by *in silico* docking studies.

Afiukwa *et al.,* (2015) reported the amino acid profile of *L. sajor-caju* and found glutamic acid was dominant among the amino acids. Sharma *et al.,* (2015) studied protein, carbohydrate, fat and mineral content which included minerals like Na, Fe, Cu, Mg, Zn, K and Mn in *L. sajor-caju*. Reneses *et al.,* (2016) reported the nutritional profile of *L. sajor-caju* and found it to be rich in fibre, crude protein and carbohydrate. Sharma *et al.,* (2014) reported the fatty acid profile of *L. sajor-caju* and found higher content of palmitic acid. They also reported the phenolic content and some amino acids. Arvind *et al.,* (2011) & Oyeleke *et al.,* (2017) studied the nutritional profile of *L. sajor-caju* and the results varied significantly in their studies. Acharya *et al.,* (2017) studied DPPH scavenging activity, phenolic and flavonoid content of *L. sajor-caju*.

Singdevsachan *et al.,* (2013) reported the nutritional content of *L. sajor-caju* like phenols, flavonoid, ABTS radical scavenging activity, DPPH scavenging activity, minerals like P, K, Mn, Co, Ni and Fe. They also studied the antibacterial potential against *Vibrio cholera* and *Staphylococcus aureus* with methanolic, aqueous and ethanolic extract and found methanolic extract to be more potent against *S. aureus* than ethanolic extract, aqueous extract was not potent and there was no inhibition against *V. cholera* by any of the extracts. Atri *et al.,* (2017) determined the amino acid profile in *L. sajor-caju* and found lysine was dominant among the essential amino acid and threonine was not detected among the essential amino

acids. Alanine was in higher concentration in non essential amino acids. Glutamic acid, aspartic acid and serine were not detected.

Previously many authors have studied the antimicrobial potential of mushrooms. Iwaiokun *et al.,* (2007) determined antimicrobial activity of *Pleurotus sp.* against eight gram positive and eight gram negative bacteria. Kalyoncu *et al.,* (2010) studied ten wild mushrooms against six microbes. Alves *et al.,* (2012) reported the mushroom extracts to be more potent against gram positive bacteria than gram negative bacteria. Smolskaite *et al.,* (2015) studied eight mushrooms against two microbes and Ramesh *et al.,* (2010) studied six mushrooms against four microbes. Ayodele & Idoko, (2011) demonstrated the effects of four mushroom extracts viz. *Lentinus squarrosulus, Psathyrella atroumbonata, Coprinellus micaceus* and *V. volvacea* against *E. coli, S. aureus, A. flavus and P. notatum*. Appiah *et al.,* (2017) reported the antimicrobial potential of four mushrooms against twelve microbes. Further the antimicrobial potential of different mushrooms have been studied by Nwachukwu & Uzoeto, 2010; Giri *et al.,* 2012; Akyuz *et al.,* 2010; Ishukawa *et al.,* 2001; Beelman *et al.,* 2003; Cao *et al.,* 2003; Shen *et al.,* 2017; Guo *et al.,* 2004; Yamac & Bilgili 2016; Rao *et al.,* 2009; Barros *et al.,* 2007; Santoyo *et al.,* 2009; Reid *et al.,* 2016; Jonathan & Fasidi, 2005.

Mushrooms are rich and have diverse groups of compounds. Different authors have studied the compounds from mushrooms adopting *in silico* method and docking analysis to determine different activities like antimalarial by Pegu *et al.,* 2014. Anti-viral (HIV-I protease) by Nosrati & Behbahani, 2015. Thirty four compounds from mushroom as antimicrobial against bacterial proteins Penicillin Binding Protein 1a, Alanine racemase, D-alanine-D-alanine synthetase, Isoleucyl-tRNA synthetase, DNA gyrase, Dihydropteroate synthetase and Dihydrofolate reductase by Alves *et al.,* 2013. Also it was stated that Wortmanin a compound from fungi is effective as antifungal agent by Singh *et al.,* 2015. Borah *et al.,* (2015) studied twenty two compounds from mushroom for their anticancer property with an anticancer protein (MDM2).