Retraction

Retraction: Sequestration of Potential Enzymes from Mushrooms compost waste (IOP Conf. Ser.: Mater. Sci. Eng. 1145 012116)

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This article (and all articles in the proceedings volume relating to the same conference) has been retracted by IOP Publishing following an extensive investigation in line with the COPE guidelines. This investigation has uncovered evidence of systematic manipulation of the publication process and considerable citation manipulation.

IOP Publishing respectfully requests that readers consider all work within this volume potentially unreliable, as the volume has not been through a credible peer review process.

IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the Problematic Paper Screener [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1

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Sequestration of Potential Enzymes from Mushrooms compost waste

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Abstract. Mushrooms are type of white-rot fungi such as basidiomycetes, which degrades a lot of agro wastes by the secretion of precious bioconversion enzymes and produce the final enriched product. These enzymes take part in organic and inorganic waste remediation in the environment. This review analysed from the standpoint of scientists reserching in lignolytic enzyme production from various mushroom cultivation and also highlights the role of recent approaches within the production of giant volume of commercially important enzymes from biodegradable wastes. Then the proceeding work is to survey the novel lignolytic enzyme production aspects and their major characteristics, microbial sources such as basidiomycetes (white-rot fungi), downstream processing, relevant biochemical properties, diverse applications, enzyme mycotechnology and some recent research developments.

Keywords: Mushroom, Lignolytic enzymes, Agro wastes, Mycotechnology

1. Introduction

Mushroom basidiomycetes are capable of producing a wide variety of extracellular and intracellular enzymes that degrade agro-waste substances into low molecular weight compounds containing complex organic compounds. These compounds are water-soluble and have remarkable nutritive value. The enzymes secreted from these mushrooms are non-specific and it decompose variety of structurally different compounds. Most important agro wastes in cultivation of mushrooms are sugarcane bagasse, soybean husks, coffee husks and coffee pulp, wheat and rice bran, cassava bagasse, citric pulp, potato, sweet potato, sugar beet, and sweet sorghum, rice straw, wheat straw, Oil-processing mills wastes like coconut cake, etc. These help in the production of extracellular and intracellular enzymes from mushroom such as hydrolytic enzymes like cellulolytic enzymes (cellulases, xylanases, mannanases, laccases, beta-1,4 exoglucanase, beta-1,4 endoglucanase and beta-1,4 glucosidase), amylolytic enzymes (glucoamylases and α-amylases); pectinases, phytases or polygalacturonases, lignin peroxidase, manganese-dependent and independent peroxidases, proteolytic enzymes and other enzymes using different fermentation techniques. These enzyme productions are induced by some substance present in the specific agro waste substrates.
The mushroom produced ligninolytic enzyme has significant potential applications in various industries, including pesticides, pulp and paper, coal, wastewater treatment, solid waste treatment, and agriculture.

2. Major Substrates On Mushroom Based Enzyme Production

Production of biodegrading enzymes from mushrooms mainly depends on compounds and composition of various agro-wastes. It contains a lot of lignocellulosic compounds such as lignin, hemicellulose, and cellulose. These help to enhance the various enzyme productions from mushroom (Table 1).

| Type of waste                  | Other supplements | Species of mushroom | Enzymes                                                |
|--------------------------------|-------------------|---------------------|-------------------------------------------------------|
| Sugarcane bagasse,             | Rice bran         | Lentinula edodes    | Lignocellulolytic enzymes                             |
| Sugarcane molasses             |                   |  |                                                           |
| Rice bran                      | -                 | Lentinus sp., L.   | Ligninase                                             |
|                                |                   |   strigellus and P. |                                                       |
|                                |                   |   sanguineus        |                                                       |
| Rice bran                      | Wheat bran        | Pleurotus sapidus   | Lignocellulolytic enzymes                             |
| Paddy straw                    | -                 | Pleurotus djamor var.| Cellulases, Hemicellulases, |
|                                |                   |   roseus            |   Xylanases, Lipase, Manganese                       |
|                                |                   |  |   peroxidase and Laccase                              |
| Paddy straw                    | Coir pith (Cocos  | Pleurotus djamor var.| Cellulases, Hemicellulases, |
|                                | nucifera)         |   roseus            |   Xylanases, Lipase, Manganese                       |
| Cotton waste                   | -                 | P. sajor-caju       | Cellulytic enzymes                                   |
| Cotton waste                   | Wheat straw       | P. pulinonarius     | Lignocellulolytic enzymes                             |
| Orange residue                 | -                 | P. pulmonarius      | Pectinase, Laccase, Manganese peroxidase, β-glucosidase and β-xylosidase |
| Orange waste                   | -                 | P. ostreatus        | Endo-1,4 glucanase ,Laccase and Manganese peroxidase |
| Barley residue                 | Cassava residue   | Lentinus crinitus   | Laccase, Manganese peroxidase and Lignin peroxidase   |
| Landfill slurry                | -                 | L. tigrinus         | Manganese peroxidase                                 |
| Malt extract                   | Glucose           | L. tigrinus         | Manganese peroxidase                                 |
| Sawdust                        | Wheat bran        | Pleurotus eryngii   | Manganese peroxidase                                 |
| Sweet sorghum bagasse          | -                 | Coriolusversicolor  | Lignolytic enzymes                                   |
| Wheat bran                     | -                 | Trametesversicolo   | Lignolytic enzymes                                   |
| Mandarin peels | Mandarin tree leaves | Pleurotus dryinus | Cellulase, Xylanase, Laccase and Manganese peroxidase |
|---------------|---------------------|------------------|---------------------------------------------------|
| Coffee pulp   | -                   | Pleurotus djamor, Pleurotus ostreatus and P. pulmonarius | Lignocellulolytic enzymes |
| Tomato, Potato and Red pepper residues | -                   | Pleurotus ostreatus | β-glucosidase, Xylanase, Laccase, Manganese independent and Manganese dependent peroxidase |
| Oak wood      | Oatmeal             | Lentinus edodes   | Gluco-amylase, Pectinase, Acid protease, and Laccase |
| Oak sawdust   | Coffee spent-ground | Grifola frondosa  | Lignocellulolytic enzymes |
| Water hyacinth (Eichhornia crassipes) | -                   | Pleurotus djamor var. roseus | Cellulases, Hemicellulases, Xylanases, Lipase, Manganese peroxidase and Laccase |
| Leaves of Typha angustata | -                   | Pleurotus djamor var. roseus | Cellulases, Hemicellulases, Xylanases, Lipase, Manganese peroxidase and Laccase |
| Groundnut plant (Arachishypogaea) | -                   | Pleurotus djamor var. roseus | Cellulases, Hemicellulases, Xylanases, Lipase, Manganese peroxidase and Laccase |
| Coir pith (Cocos nucifera) | -                   | Pleurotus djamor var. roseus | Cellulases, Hemicellulases, Xylanases, Lipase, Manganese peroxidase and Laccase |
| Coffee pulp   | -                   | Lentinula edodes   | Cellulases, Laminarinases and Xylanases |

**Sugarcane waste**

Researcher in [1] illustrates sugar cane waste increase the lignocellulolytic activity of mushrooms during their cultivation. Researcher in [2] reported that sugarcane bagasse as an enriched nutrient medium for various fungal cultures; it can replace expensive media in the market. Researcher in [3] showed that, 3:1 ratio of sugar cane with black gram husk was the most excellent solid substrate and support for enzyme production in mushroom cultivation. Researcher in [4] indicated mixtures of sugar cane with orange bagasse are enhancing the production of high-level extracellular enzyme production during mushroom cultivation.

**Paddy waste**

Rice is major carbohydrate food in the World. In India plentiful rice milling industry will be available, Rice husk, paddy straw, and rice bran are the major by-product of these rice milling industry, it will be widely disposed of by burning and land dumping. These cause many environmental troubles in the world. These contain the high amount of lignocellulosic content when compare to other agro-industrial waste. Researcher in [5] reported that all over the world there are 600,287 hectares of areas has been used to produce 2,050,306 tonnes of paddy, 60 % (v/w) moisture content of the rice husk helps to produce highest cellulase enzyme in solid state fermentation. Researcher in [6] reported that, the ratio of 5:3:2 mixture rice bran, rice husk, and the gram hull are suitable for protease enzyme production from mushroom cultivation. Researcher in [7] demonstrated that Combination of wheat bran with rice bran enhance the production of milk clotting enzyme throughout mushroom cultivation. Researcher in [8] reported that Rice husk contain higher cellulose content, it plays a major role in a
production of cellulase enzyme through solid state fermentation technique. Researcher in [9] viewed that, Presents of high nutrients of rice husk is favourable for mushroom-based enzyme production.

Other agro industrial waste
Other then paddy and sugarcane waste there several agro industrials wastes are used in the production agro waste degrading enzymes during mushroom cultivation. Researcher in [10] illustrates. Due to the high protein content of bean straw helps to increase the highest xylanase enzyme production in Pleurotus spp. Cultivation. Researcher in [11] showed that agro-waste from citrus juice production industry contain insoluble carbohydrates, it is an attractive substrate for biologic conversion to value-added products. Researcher in [12] viewed that, rather than banana waste, citrus fruit waste as suitable substrate for cultivation of P. ostreatus and P.sajor-caju in the production of β-glucosidase enzyme. Researcher in [13] reported that Activity of cellulase, lipase and laccase enzymes from Pleurotus djamor var. roseus mushroom was increased in their growth on paddy straw, paddy straw with coir pith and coir pith. Researcher in [14] demonstrate the cellulase activity was maximum in the cultivation of Volvariella diplasia mushroom on paddy straw. It is reported that Cltivation of L.edodes strain in barley straw enhances the enzyme production such as cellulase, laminaranases, and xylanases, respectively. It is revealed that Xylanase enzyme activity was higher than cellulase enzyme during P.sajor-caju mushroom cultivation on rice straw. Researcher in [15] illustrates cultivation of Pleurotus Eryngii on four different substrates such as ramie stalks, kenaf stalks, cottonseed hulls and bulrush stalks were the improved production of cellulases, hemicellulases and ligninases enzymes. Wheat straw is the best substrate for lignocellulosic enzyme production from edible mushroom Lentinus tigrinus edible mushroom.

3. Factors Influencing for Enzyme Production Through Mushroom Cultivation

There are various factors were influence the enzyme production during mushroom cultivation on agro-industrial waste. These factors are pH, temperature, Incubation time, carbon and nitrogen ratio of substrates, the moisture content of substrates etc (Table 2).

| Factors                  | Substrate                             | Species of mushroom | Enzyme                   |
|-------------------------|---------------------------------------|---------------------|--------------------------|
| Stimulators              | CuSO₄, Mn²⁺, Veratryl alcohol and Xylidine | Mandarin peels and Mandarin tree leaves | Pleurotus dryinus | Cellulase, Xylanase, Laccase and Manganese peroxidase |
| Substrate thickness      | 0.4-2.0 cm                            | Sugarcane Pressmud  | P.sajor-caju             | Cellulase |
|                         | 0.8 cm                                | Sugarcane Pressmud  | P.sajor-caju             | β-glucosidase, Endo- β-1,4-glucanase and Exo- β-1,4-glucanase |
| Incubation period        | 8 days                                | Malt extract        | Volvariella              | Cellulase and Xylanase |
|                         | 10th day                              | Sugarcane bagasse powder and it’s extract | P.ostreatus             | Laccase |
| Day(s)  | Material(s)                          | Fungi          | Enzymes                             |
|---------|--------------------------------------|----------------|-------------------------------------|
| 13th    | Sugarcane bagasse powder and it’s extract | *P. ostreatus* | Manganese peroxidase                |
| 28th    | Barley residue and Cassava residue    | *Lentinus crinitus* | Manganese peroxidase               |
| 12 days | Mandarin peels and Mandarin tree leaves | *Pleurotus dryinus* | Cellulase, Xylanase, Laccase and Manganese peroxidase |
| 20 and 15 days | Banana plant Leaves portion | *Pleurotus ostreatus* | Laccase and Lignin peroxidase       |
| 20 days | Banana plant Leaves portion          | *Pleurotus ostreatus* | Xylanase                           |
| 10 days | Banana plant Pseudostem portion      | *Pleurotus ostreatus* | Laccase                             |
| 20 days | Banana plant Pseudostem portion      | *Pleurotus ostreatus* | Lignin peroxidase                  |
| 20 days | Banana plant Pseudostem portion      | *Pleurotus ostreatus* | Xylanase                           |
| 10th    | Banana plant Leaves portion          | *P. sajor-caju* | Laccase                             |
| 10-20 days | Banana plant Leaves portion       | *P. sajor-caju* | Lignin peroxidase                  |
| 10th    | Banana plant Leaves portion          | *P. sajor-caju* | Xylanase                           |
| 10-20 days | Banana plant Pseudostem portion     | *P. sajor-caju* | Laccase                             |
| 20 days | Banana plant Pseudostem portion      | *P. sajor-caju* | Lignin peroxidase                  |
| 40 days | Banana plant Pseudostem portion      | *P. sajor-caju* | Xylanase                           |
| 31.5 days | Tomato, Potato and Red pepper residues | *Pleurotus ostreatus* | Xylanase, β-glucosidase, Laccase, Manganese dependent and Manganese independent peroxidase |

**Optimum pH**

| pH 4.5 to 5.0 | CzapekDox medium | *P. florida* | Endoglucanase, Exoglucanase and β-glucosidase |
| pH 2.6 to 4.5 | Barley residue and Cassava residue    | *Lentinus crinitus* | Manganese peroxidase               |
| pH 3.0 to 5.0 | Wheat straw | *L. tigrinus* | Ligninases                        |
| pH 5.0      | Lupinhull and Sawdust                 | *Pleurotus ostreatus*, *Lentinus edodes and Flammulina velutipes* | Polygalacturonase                 |
| pH 8.6      | Lupinhull and Sawdust                 | *Pleurotus ostreatus*, *Lentinus edodes and Flammulina velutipes* | Pectatelyase                     |
| Optimum Temperature | Substrate | Enzymes/Metabolites |
|---------------------|-----------|---------------------|
| 25°C | Sugarcane Pressmud | *P.sajor-caju* | Endo-β-1,4-glucanase, Exo-β-1,4-glucanase and β-glucosidase |
| 35 to 40°C | CzapekDox medium | *P.florida* | Endoglucanase and Exoglucanase |
| 35±2°C | - | *Volvariella* | Cellulolytic/Hemicellulolytic enzymes |
| 40°C | Barley residue and Cassava residue | *Lentinus crinitus* | Manganese peroxidase |
| 24±2°C | Paddy straw, Wheat bran, Sawdust and Rice bran | *Auriculariapolyt richa* | Exo β-1,4 glucanase, Endo β-1,4 glucanase, Polyphenol oxidase and Laccase |
| 27°C | Guaiacol (2-methoxyphenol) | *P.ostreatus* | Manganese peroxidase |
| 27°C | Veratryl alcohol to veratraldehyde (3,4-dimethoxybenzaldehyde) | *Agrocybe aegerita* | Lignin peroxidase |
| 40°C | Wheat straw | *L.trigrinus* | Ligninases |
| C:N ratio | Synthetic medium | *Lentinula edodes* | Lipase |
| 30:01:00 | Ramie stalk | *Flammulina velutipes* | Cellulases, Hemicellulases, peroxidase and Laccase |
| 102:01:00 | Wheat straw | *P.sajor-caju and Pleurotus ostreatus* | Laccase and Carboxymethyl cellulase |
| Substrate concentration | Sugarcane molasses | *Lentinula edodes* | Lignocellulolytic enzymes |
| 30g | Rice bran | *Lentinula edodes* | Lignocellulolytic enzymes |
| 20 and 30% | Rice bran supplemented with Sawdust | *Lentinula edodes* | Lignocellulolytic enzymes |
| 20% | Rice bran supplemented with *Andropogontectorum* straw | *Lentinussubnudus* | Lignocellulolytic enzymes |
| 50% | Barley residue and Cassava residue | *Lentinus crinitus* | Laccase, Manganese peroxidase and Lignin peroxidase |
| 50% and 50% | Mandarin peels and Mandarin tree leaves | *Pleurotus dryinus* | Laccase |
| 6% | Mandarin peels and Mandarin tree leaves | *Pleurotus dryinus* | Cellulase and Xylanase |
| 4% | Mandarin peels and Mandarin tree leaves | *Pleurotus dryinus* | Manganese peroxidase |
| 2% | Mandarin peels and Mandarin tree leaves | *Pleurotus dryinus* | Laccase |
| 1:1 ratio | Paddy straw with Rice bran | *Auriculariapolyt richa* | Laccase |
| Ratio          | Substrate Description                                      | Fungi/Enzyme                        | Enzymes                        |
|---------------|------------------------------------------------------------|------------------------------------|--------------------------------|
| 3:1 ratio     | Paddy straw with Rice bran                                 | Auriculariapolyt richa             | Polyphenol oxidase              |
| 1:1 ratio     | Paddy straw with Coir pith                                 | Pleurotus djamor var. roseus       | Lipase                         |
| 50%           | Ramie stalk                                                | Flammulina velutipes               | Cellulase, Hemicellulase and Laccase |
| 40%           | Banana pseudostem                                          | P.ostreatus                        | Hemicellulolytic enzymes        |
| 17.50%        | Banana pseudostem                                          | P.ostreatus                        | Cellulytic enzymes              |
| 10%           | Banana pseudostem                                          | P.ostreatus                        | Ligninolytic enzymes            |
| 31%           | Banana pseudostem                                          | P.sajor-caju                       | Hemicellulolytic enzymes        |
| 12.40%        | Banana pseudostem                                          | P.sajor-caju                       | Cellulytic enzymes              |
| 6%            | Banana pseudostem                                          | P.sajor-caju                       | Ligninolytic enzymes            |
| 2:1 ratio     | Wheat straw with Wheat bran, Paddy straw with Wheat bran and Viticulture waste with Wheat bran | P.ostreatus                        | Laccase                        |
| 2:1 ratio     | Wheat straw with Wheat bran                                | P.sajor-caju                       | Laccase                        |

**Effect of chemical substrate concentration**

| Concentration | Substrate                        | Fungi/Enzyme | Enzymes/Activities                                      |
|---------------|----------------------------------|--------------|---------------------------------------------------------|
| 3%            | Carboxyl methyl cellulose (CMC)  | P.florida    | Cellulase                                                |
| 0.50%         | Malt extract                     | P.florida    | Endoglucanase and Exoglucanase                          |
| 0.50%         | Malt extract                     | P.ostreatus  | Cellulase                                                |
| 0.50%         | Malt extract                     | Volvariella  | Cellulase and Xylanase                                  |
| 0.20%         | Xylan and Xylose                 | Flammulina velutipes and Pleurotus eryngii | Xylanase |

**Moisture content**

| Moisture | Substrate             | Fungi/Enzyme                     | Enzymes/Activities                                             |
|----------|-----------------------|----------------------------------|----------------------------------------------------------------|
| 85%      | Orange residue        | P.pulmonarius                    | Pectinase, Laccase, Manganese peroxidase, β-glucosidase and β-xylosidase |
| 90%      | Barley residue and Cassava residue | Lentinus crinitus                  | Laccase, Manganese peroxidase and Lignin peroxidase              |

**pH**

Enzyme activity will be affected by undesired pH value of growth substrates used for mushroom-based enzyme production. It is demonstrated, that pH 4.0 to be the best optimum pH for xylanase enzyme production during oyster mushroom (*Pleurotus* sp.) cultivation and their activity increased at pH 6.0. Optimum pH for beta-glucosidase enzyme production from *Agaricus bisporus* mushroom is 4.0. It is reported that Optimum pH for exo-beta-1, 3-glucanases production from *Flammulina velutipes* mushroom was 6.1. Activities of CMCases, xylanase, and β-glucosidase from *P.sajor-caju* grown on rice and wheat straw were increased at pH 4.8. It is revealed that the activity of laccase enzyme from the edible mushroom *Lentinula edodes* increased at pH 3.0 to 7.0. Laccase enzyme from
edible mushroom *Pleurotus Sajor-caju* were reach maximal activity at pH 2.1. It is reported that Activity of aflatoxin-degradation enzyme from *Pleurotus ostreatus* mushroom was increased at Optimum pH 4.0-5.0. It is revealed that Maximal activity of manganese peroxidase was obtained at pH 5.4-5.5 during initial growth stages of *Agaricus bisporus* mushroom.

**Temperature**
It is illustrated that the production of endoglucanase and exoglucanase enzyme from *Pleurotus florida* was found at an optimum temperature between 35 to 40°C. It is demonstrated that the optimum temperature for cellulolycytic/hemicellulolytic enzymes production by *Volvarilla* was 35 ± 2°C. The optimum range of temperature for cellulase enzyme from the cultivation of *P. sajor-caju* was most active at 45°C; xylanase had maximum activity at 45°C; for beta-glucosidase, the maximum was at 40°C.

It is showed that the optimum temperature for the lingo-cellulosic enzyme produced from *A. polytricha* mushroom was 24 ± 2°C. The optimum temperature of lignocellulosic enzymes produced during growth and fruiting of the edible fungus *Lentinus tigrinus* on wheat straw were activated at 40°C. It is illustrated, the optimum temperature for highest production lignocellulolytic enzyme from *Flammulina velutipes* mushroom were 18-24°C.

**Concentration of substrate**
It has been reported, Extracellular cellulase enzyme productions from *P. ostreatus* were increased at 1 to 6% concentrations of wheat straw. Several substrates containing up to 55% coffee spent ground were suitable for enzyme production from edible mushroom *P. ostreatus* . The combined substrates of paddy straw+wheat bran (3:1) were best for lingo-cellulolytic enzyme production from wood ear mushroom. Higher- titer of cellulase enzyme production from *P. ostreatus* were increased by adding different levels of the substrate such as carbon source of avocado ranging from 0 to 10%. It is revealed that Lignocellulosic enzymes from *Pleurotus djamor var. roseus* was active in 1:1 ratio of substrates such as paddy straw, water hyacinth, leaves of *Tachustica*, groundnut plant, coir pith and coir pith amended with paddy straw. The highest xylanase enzyme production by *Pleurotus eryngii* and *Flamulina velutipes* was obtained with 0.2% xylan and xylose as sole carbon sources for both species.

The highest lignocellulolytic enzyme production was obtained by *Flammulina velutipes* mushroom grown on the substrate containing 50% ramie stalk, 20% cottonseed hulls, 25% wheat bran, 4% cornstarch and 2% CaCO3. It is that analyzed, 1:1 ratio of substrate mixtures such as thatch grass, banana fronds, wheat straw, sage; banana+sage, banana+grass, banana+wheat straw, and sage+grass were suitable for highest lignocellulolytic enzyme production from basidiomycetes. Ravikumar et al., (2012) investigates, Protease enzyme production from medicinal mushroom *Pleurotus Sajor-caju* was to be maximal when 4.0% of wheat bran was used as a substrate.

**Incubation period**
The time required for enzymes production from *P. pulmonarius* was followed for up to 45 days. Higher enzyme production by the cultivation of *Pleurotus ostreatus* on agroindustrial wastes was occurred since 31.5 days. Highest activity of the lignocellulolytic enzyme produced by the edible mushroom *Grifola frondosa* (maitake) was achieved at days 20-30. Varieties of lingo-cellulolytic enzymes production was highest at 21.0 days during wood ear mushroom grown on paddy straw + wheat bran. It is reported that endo 1, 4-beta-glucanase, exo 1, 4-beta-glucanase, endo 1, 4-beta xylanase and beta-glucosidase increased during *Pleurotus eryngii* growing on its substrates at 30 days.

Laccase, manganese peroxidase and lignin peroxidase enzymes activity from edible mushroom were increased after 14 days of incubation. The Maximum activity of xylanase enzyme from *Pleurotus sp.* was observed on pre-treated paddy straw as well as wheat straw with plant extracts i.e neem oil and Ashoka leaves extracts on the 25th day in invivo condition.

**Nitrogen and Carbon sources**
pH of the fermentation medium for enzyme production from mushrooms was controlled by selected C/N ratio of its substrates. The optimum C/N ratio for lignocellulolytic enzyme production from *F. velutipes* mushroom was 30/1. The lignocellulolytic enzyme production from mushroom was increased at 50% ramie stalk containing C/N ratio of 30/1. It is reported that, various carbon sources like citric acid, sucrose, inositol and lactose supported enzyme production from ectomycorrhizal mushroom *Cantharellus tropicalis*.

**Metal ions**

The presence of Na2+ ion was inactivated the protease of *Pleurotus Sajor-caju* but Ca 2+, Cu2+, Mg2+ and Zn2+ enhanced the enzyme activity. The different Cu concentrations were inducing the laccase enzyme production from edible straw mushroom, *Volvariella volvacea* in 14-day culture.

**Chemical reagents**

The activity of fibrinolytic enzyme from *Schizophyllum commune* BL23 was strongly inhibited by EDTA, and 1, 10 phenanthroline but which was activated in the presence of protease inhibitors such as PMSF (phenylmethylsulfonyl fluoride) and SBTI (soybean trypsin inhibitor) . The presence of inducers such as ferulic acid, 2,5-xylidine, veratric acid and 4-hydroxybenzoic acid were increased laccase enzyme production from *V. volvacea* mushroom, then 4-hydroxybenzaldehyde were induced lower level of laccase enzyme production but the enzyme activity was inhibited by presence of p-coumaric acid, syringic acid, vanillic acid, homovanillin or catecho.

4. Conclusion

The production of lignocellulolytic enzymes through mushroom cultivation on various agricultural waste residues are related to the number of factors, which may act individually or have interactive effects on mycosynthesis of enzymes. The combination of the best air-temperature, pH, Concentration of substrates, Carbon and nitrogen content of different substrates, Incubation period, various metal ions and Chemical reagents were provided a synergistic effect for optimizing the lignocellulolytic enzyme production from mushroom cultivation. This review points out the various influencing factors for production of lignocellulolytic enzymes from mushroom cultivation on novel agro-industrial wastes residues.

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