



**CENTRAL LUZON STATE UNIVERSITY**



**OPTIMIZATION OF CULTURE CONDITIONS FOR MYCELIAL GROWTH OF  
*Trametes hirsuta* COLLECTED FROM MAYOYAO, IFUGAO PROVINCE**

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An Undergraduate Thesis Submitted to the Faculty of the Department of  
Biological Sciences, College of Arts and Sciences, Central Luzon  
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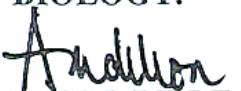
  
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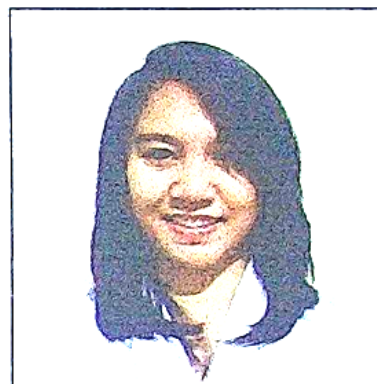
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## ABSTRACT

**ASUNCION, JAMILA MAISHA M.** Bachelor of Science in Biology, Department of Biological Sciences, College of Arts and Sciences, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines, July 2017. **OPTIMIZATION OF CULTURE CONDITION FOR MYCELIAL GROWTH OF *Trametes hirsuta* FROM MAYOYAO, IFUGAO PROVINCE**

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*Trametes hirsuta* is a medicinal macrofungus that belongs to family Polyporaceae, which is commonly known as hairy bracket, wood decaying fungus found in the decaying wood of pine trees. This study was undertaken to evaluate the growth performance of *T. hirsuta* on potato sucrose gelatin and different physical factors such as pH, aeration, illumination and temperature conditions. Potato sucrose gelatin supported the mycelial growth of *T. hirsuta* as indicated by the luxuriant mycelial growth. *T. hirsuta* recorded mycelial diameter with a mean of 90.00 mm after 6 days of incubation period. *T. hirsuta* grew best in pH 6.0 with a mean of 90.00 mm, incubated unsealed with a mean of 89.98 mm. *T. hirsuta* recorded the widest mycelial diameter in lighted condition at air-conditioned (23-25°C) with a mean of 90.00 mm.



LITERATURE CITED

- ADEJUMO, T.O. AND O.B. AWOSANYA. 2005.** Proximate and mineral composition of four edible mushrooms species from south western Nigeria. *African Journal of Biotechnology*, 4(10); 1084-1088.
- ADENIPEKUN, C.O. AND J.S. GBOLAGADE. 2006.** Nutritional Requirements of *Pleurotus florida* (Mont.) Singer, A Nigerian Mushroom. *Pakistan Journal of Nutrition*, 5 (6); 597-600.
- AHLAWAT, O.P., AHLAWAT, K. AND B.L. DHAR. 2005.** Influence of lignocellulolytic enzymes on substrate colonization and yield in mon osporous isolates and parent strains of *Volvariella volvacea*. *Ind. Journal of Microbiology*, 45(3); 205-10.
- AQUINIO, C.D. 2004.** Biophysiology of Golden shimeji (*Pleurotus cornucopiae*). Unpublished Undergraduate Thesis. Central Luzon State University, Science City of Muñoz, Nueva Ecija, 32-35.
- AYODELE, S.M. AND J.A. OKHUOYA. 2007.** Nutritional and phytochemical screening of *Psathyrella atroumbonata* Pegler, a Nigerian edible mushroom. *South African Journal of Science*, 105; 158-160.
- BUIGUT, S.K. 2002.** Mushroom production in sustainable small-scale farming system-opportunities and constraints: a survey of Uasin Gishu District. In: Proceedings of the Horticulture seminar on Sustainable Horticultural Production in the Tropics at Jomo Kenyatta.
- CARROAD, P.A. AND C.R. WILKE. 1977.** Exponential growth kinetics for *Polyporus versicolor* and *Pleurotus ostreatus* in submerged culture. *Applied and Environmental Microbiology*, 33(4); 871-873.
- CHANG, J.B., PARK, W.H., CHOI, E.C., AND B.K. KIM. 1988.** Studies on constituents of the higher fungi of Korea (LIV). Anticancer components of *Favolus alveolarius*. *Arch Pharmacol Research*, 11; 203-12.
- CHANG, S.T., AND J.A. BUSWELL. 1996.** Mushroom Nutraceuticals. World Rapid Science publishers. *J. Microbiol. Biotechnol.*, 12; 473-476.
- CHANG, S.T. 1999.** World production of cultivated mushrooms. *BioScience*.



- CHANG, S.T. 2006.** Development of the culinary-medicinal mushrooms industry in China: past, present, and future. *Int. J. Medicinal Mushrooms*, 8; 1-17.
- CHANG, S.T. AND J.A. BUSWELL. 2003.** Mushrooms – A prominent source of nutraceuticals for the 21st Century. *Curr. Topics in Nutraceutical Res.* 1; 257-280.
- CHAUBEY, A., DEHARIYA, P. AND D. VYAS, D. 2010.** Solid waste management through oyster mushroom cultivation. *International J. of biozone*, 2(1-2); 369-372.
- CHENG, C.W., CHEN, C.K., CHANG, C.J., AND L.Y. CHEN, 2012.** Effect of Colour LEDs on Mycelial Growth of *Aspergillus ficuum* and Phytase Production in Photo-Fermentation. *Journal of Photochemistry and Photobiology*, 106; 81-85.
- CHIU, S. W., LAW, S.C., CHING, M.L., CHEUNG, K.W. AND M.J. CHEN. 2000.** Themes for mushroom exploitation in the 21st century: Sustainability, waste management, and conservation. *J Gen. and App. Microbiology*, 46; 269-82.
- CHU, K.K.W., HO, S.S.S., AND A.H.L. CHOW. 2002.** *Coriolus versicolor*: a medicinal mushroom with promising immunotherapeutic values. *Clin Pharmacol*, 42; 976– 84.
- CHUNG, K.S., KIM, S.S., KIM, H.S., KIM, K.Y., HAN, M.W. AND K.H. KIM. 1993.** Effect of Kp, an antitumor protein polysaccharide from mycelial culture of *Phellinus linteus* on the humoral immune response of tumor bearing ICR mice to sheep red blood cells. *Arch Pharmacol Res*, 16 (8); 336.
- DABA, A.S. AND O.U. EZERONYE. 2003.** Anti-cancer effect of polysaccharides isolated from higher basidiomycete mushrooms. *African Journal of Biotechnology*, 2(12); 672-678.
- DE LEON, A.M., REYES, R.G. AND T.E.E. DELA CRUZ. 2013.** *Lentinus Squarrosulus* (Mont.) Singer and *Polyporus Grammocephalus* Berk.: Newly Domesticated, Wild Edible Macrofungi from the Philippines. *Philippine Agricultural Scientist*, 96(4); 411-418.
- DIDUKH, M.Y., WASSER, S.P. AND E, NEVO. 2003.** Medicinal value of species of the family Agaricaceae Cohn (higher Basidiomycetes) current stage of knowledge and future perspectives. *International Journal of Medicinal Mushrooms*, 5; 133-52.
- DRECHSLER-SANTOS, E.R., GROPOSO, C. AND C. LOGUERCIO-LEITE. 2008.** Additions to the knowledge of lignocellulolytic basidiomycetes in forests from Santa Catarina, Southern Brazil. *Mycotaxonomy*. 103; 197–200.



- DULAY, R.M.R., KALAW, S.P., REYES, R.G., CABRERA, E.C. AND N.F. ALFONSO. 2012.** Optimization of Culture Conditions for Mycelial Growth and Basidiocarp Production of *Lentinus tigrinus* (Bull.) Fr., A New Record of Domesticated Wild Edible Mushroom in the Philippines. *Journal of The Philippine Agricultural Scientist*, 95(3); 278–285.
- DULAY, R.M.R., GAGARIN, W.S., ABELLA, E.A., SOFRONIO, P.K., AND R.G. REYES. 2014.** Aseptic Cultivation and Nutrients Compositions of *Coprinus comatus* (O.F. Müll.) Pers. On *Pleurotus* Mushroom Spent. *Journal of Microbiology. Biotechnology Research*, 4 (3); 1-7.
- ELMASTAS, M., ISILDAK, O., TURKEKUL, I., AND N. TEMUR. 2007.** Determination of antioxidant activity and antioxidant compounds in wild edible mushrooms. *Journal of Food Composition Analysis*, 20; 337–345.
- FOGEL, R. AND P. ROGERS. 2012.** “Shelf fungi.” Fun Facts About Fungi. Utah State University Intermountain Herbarium.
- FRIES, E. M. 1828.** *Elcnchus fungorum* x. *Cryphiswaldiac*.
- FUJITA, H., OGAWA, K., IKUZAWA, M., MUTO, S., MATSUKI, M. AND S. NAKAJIMA. 1988.** Effect of PSK, a protein-bound polysaccharide from *Coriolus versicolor*, on drug metabolizing enzymes in sarcoma-180 bearing and normal mice. *International Journal of Immunopharmacology*, 10; 445– 50.
- GALAMGAM, H. 2009.** Biophysiology of Himematsutake (*Agaricus blazei*) Strain 2. *The Journal of Tropical Biology*, 7, 42.
- GASPAR, P.J., TOMIZAWA, M.M., SCHWAN R.F., RINKER D.L. AND E.S. DIAS. 2011.** Nutritional Requirements for Growth of *Agaricus brasiliensis*. *Journal of Acta Scientarium Biological Sciences*, 33 (1); 93-97.
- GORIN, P.A.J., BARRETO-BERGTER, E. AND G.O. ASPINALL. 1983.** (Ed.), *The Polysaccharides*, 2, Academic Press, Orlando, Florida, USA, 365-409.
- HAN S.N., WU, D., LEKA, L.S. AND S.N. MEYDANI. 1996.** Effect of mushroom (*Coriolus versicolor*) extract on the immune response of young and old mice. *FASEB J*, 10; 3200.
- HASEBE, K. 1991.** “Genetic studies on mutants and agronomic characters in shiitake, *Lentinus edodes* (in Japanese with English summary)” *Rep Tottori Mycology Institute*, 29; 1-69.



- HASHIOKA, Y., KOMATSU, M. AND I. ARITA. 1961. "Morphological and physiological characters of hybrid fruiting-bodies in *Lentinus edodes* (in Japanese)" Rep Tottori Mycology Institute, 1; 69-84.
- HOWARD, R.L., ABOTSI, E., JENSEN VAN RENSBURG, E.L. AND S. HOWARD. 2003. Lignocellulose biotechnology: Issues of bioconversion and enzyme production. African Journal of Biotechnology, 2(12); 603-619.
- HIBBETT, D.S., TSUNEDA, A. AND S. MURAKAMI. 1994. The secotioid form of *Lentinus tigrinus*, Genetics and development of a fungal morphological innovation. American Journal of Botany, 81(4); 466-478.
- JATAV, R.S., GUPTA, A.K., DOSHI, A. AND A.K. MEENA. 2012. Studies of Different Physical Factors on Mycelial Growth of Blue Oyster Mushroom [*Hypsizygus Ulmarius* (Bull.) Redhead]. International Journal of Agricultural and Statistical Sciences, 8 (1); 347-354.
- JISKANI, M.M. 2001. Energy potential of mushrooms. DAWN Econ. Bus. Rev., 4.
- JO, W.S., KANG, M.J., CHOI, S.Y., YOO, Y.B., SEOK, S. J. AND H.Y. JUNG. 2010. Culture conditions for mycelial growth of *Coriolus versicolor*. Mycobiology, 38(3); 195-202.
- JONATHAN, S.G., FASIDI, I.O. AND E.J. AJAYI. 2004. Physico-chemical studies on *Volvariella esculenta* (Mass) Singer, a Nigerian edible fungus. Chem., 339-42.
- JUNIOR, N.M., ASAIL, T., CAPELARIL, M., AND L.D.P. MEIRELLES. 2010. Morphological and Molecular Identification of four Brazilian Commercial Isolates of *Pleurotus* spp. And Cultivation on Corncob. *Brazilian Archaeological and Biological Technology*, 53(2); 397-408.
- KARPENKO, Y.V., REDCHITZ, T.I., ZHELTONOZHSKY, V.A., DIGHTON, J., AND N.N., ZHDANOVA. 2006. Comparative responses of microscopic fungi to ionizing radiation and light. *Folia Microbiology*, 51; 45-49.
- KIBAR B.AND A. PEKSEN. 2011. Nutritional and environmental requirements for vegetative growth of edible ectomycorrhizal mushroom *Tricholoma terreum* Journal of Zemdirbyste Agricultur, 98 (4); 409-414.
- KIDD, P.M. 2000. The use of mushroom glucans and proteoglycans in cancer treatment. *Alternative Medicine Review*, 5; 4-27.



- KIM, D.H., YANG, B.K., JEONG, S.C., PARK, J.B., CHO, S.P. AND S. DAS. 2001.** Production of a hypoglycemic, extracellular polysaccharide from the submerged culture of the mushroom, *Phellinus linteus*. *Biotechnol Lett*, 23(7); 513.
- LABARERE, J. AND U. GEMINI. 2000.** Collection, Characterization, Conservation and Utilization of Mushrooms Germplasm Resources in Africa. In: Labarere and Gemini (eds) *Characterization, Conservation, Evaluation and Utilization of Mushrooms Genetic Resources for Food and Agriculture*. The Global Network on Mushrooms, under the aegis of FAO, 17-34.
- LARRAYA, L.M., ALFONSO, M., PISABARRO, A.G., AND L. RAMIREZ. 2003.** Mapping of genomic regions (quantitative trait loci) controlling production and quality in industrial cultures of the edible basidiomycete *Pleurotus ostreatus*. *Application on Environmental Microbiology*, 69(6); 3617-3625.
- LI, X.Y., WANG, J.F., ZHU, P.P., LIU, L., GE, J.B. AND S.X. YANG. 1990.** Effects of protein-bound polysaccharide against some microorganisms 155 Immune enhancement of a polysaccharides peptides isolated from *Coriolus versicolor*. *Acta Pharmacol Sinica*, 11; 542- 5.
- LIAO, Y. M. 1990.** Nutritional and environmental conditions for the growth of *Coriolus versicolor*, a wood decaying and medical fungus. *Journal of Agricultural Research, China*, 39(3); 190-203.
- LINDEQUIST, U., NIEDERMEYER, T.H.J., AND W.D. JULICH. 2005.** Pharmacological potentials of mushrooms.
- MAGINGO, F.S., ORIO, N.M., AND A.K. KIVAISI. 2004.** Cultivation of *Oudemansiella tanzanica* nom. prov. on agricultural solid wastes in Tanzania. *Mycologia*, 96; 197-204.
- MANZI, P., GAMBELLI, L., MARCONI, S., VIVANTI, V. AND L. PIZZOFERRATO. 1999.** Nutrients in edible mushrooms: an inter-species comparative study. *Food Chemistry*, 65; 477-482.
- MAO, X.W. AND D.S. GRIDLEY. 1998.** Effects of extract of *Coriolus versicolor* and IL-2 against three tumor lines. *FASEB J*, 12; 5149.
- MARCELO, V.A., 2011.** Biophysiology of *Agrocybe aegerita* (V. Brig.) Singer. Unpublished Undergraduate Thesis. Central Luzon State University, Science City of Muñoz, Nueva Ecija.



- MAYER, P. AND J. DREWS. 1980.** Effect of a protein-bound polysaccharide from *Coriolus versicolor* on immunological parameters and experimental infections in mice. *Infection*, 8; 13–21.
- MILLIKEN, C.E., MEIER, G.P., WATTS, J.E.M., SOWER, K.R. AND H.D. MAY. 2004.** Microbial anaerobic demethylation and dechlorination of chlorinated hydroquinone metabolites synthesized by basidiomycete fungi. *Appl. Environ. Microbiology*, 70(1); 385-392.
- MOLITORIS, H.P. 2002.** Pilze in Medizin, Folklore und Religion. *Feddes Repertorium*. 113; 165-182.
- MURUGESAN, A.G., VIJAYALAKSHMI, G.S., SUKUMARAN, N. AND C. MARIAPPAN. 1995.** Utilization of water hyacinth for oyster mushroom cultivation. *Bioresource Technology*, 51(1); 97-98.
- NAKALEMBE, I., KABASA, D. AND D. OLILA. 2009.** Indigenous knowledge and usage of wild mushrooms in Mid-Western, Uganda. *African Journal in Animal Biomedical Science*, 4(1); 63–73.
- NWANZE, P.I., KHAN, A.U., AMEH, J.B. AND V.J. UMOH. 2005.** The effect of the interaction of various oil types with different spawn grains on carpophore wet weights and stipe and pileus diameters of *Psathyrella atroumbonata*. *Journal of Applied Science*, (In Press).
- OBODAI, M., CLELAND-OKINE, J. AND K.A. VOWOTOR. 2003.** Comparative study on the growth and yield of *Pleurotus ostreatus* mushroom on different lignocellulosic by-products. *Journal of Industrial Microbiology and Biotechnology*, 30; 146–149.
- OOI, V.E.C., AND F. LUI. 1999.** A review of pharmacological activities of mushroom polysaccharides. *International Journal of Medicinal Mushrooms*, 1; 195–206.
- OSO, B.A. 1975.** “Mushrooms and the Yoruba People of Nigeria,” *Mycologia*. 67 (2); 311-319.
- PARK, Y.D., WHANG, W.K., HUH, J.D., KIM, S.H. AND W.M. PARK. 1989.** Comparisons of physiological characteristics in *Coriolus versicolor* intraspecific strains. *Korean Journal of Mycology*, 17; 7-13.
- PHILIPPOUSSIS, A., ZERVAKIS, G. AND P. DIAMANTOPOULOU. (2001A)** Bioconversion of lignocellulosic wastes through the cultivation of the edible mushrooms *Agrocybe egerita*, *Volvariella volvacea* and *Pleurotus* spp. *World Journal of Microbiology and Biotechnology*, 17(2); 191–200.



- PHILLIPS, R. 2006.** Mushrooms. Pub. McMillan, ISBN 0-330-44237-6, 317.
- PRASHER, I.B. AND R. CHAUHAN. 2013.** Factors for the growth, ligninolytic enzymes and tartaric acid production of *Grammothele fuligo*, CIBTech Journal of Biotechnology, 2(4); 65-71.
- PROKOP, S. AND J. ALBERT. 2010.** Potatoes, nutrition and diet, International year of the potato, 10.
- REYES, R., GRABLAND, W. AND U. RAU. 2009.** Coconut water as a novel culture medium for the biotechnological production of *Schizophyllum*. Journal of Nature Studies, 7(2).
- RIBAS, L.C.C., DE MENDONÇA, M.M., CAMELINI, C.M., AND C.H.L. SOARES. 2009.** Use of spent mushroom substrates from *Agaricus subrufescens* (syn. *A. blazei*, *A. brasiliensis*) and *Lentinula edodes* productions in the enrichment of a soil-based potting media for lettuce (*Lactuca sativa*) cultivation: growth promotion and soil bio-remediation. Bioresource Technology, 100; 4750-4757.
- SANCHITA, S. 2008.** Training report on Mushroom Cultivation ICAR Research Complex for Eastern Region, Patna, Indian. Food Chem., 23-31.
- SANMEE, R., DELL, B., LUMYONG, P., IZUMORI, K., AND S. LUMYONG. 2003.** Nutritive value of popular wild edible mushrooms from northern Thailand. Food Chem. 82; 527-532.
- SAPARRAT, M.C.N., GUILLÉN, F., ARAMBARRI, A.M., MARTINEZ, A.T. AND J.M. MARTINEZ. 2002.** Induction, isolation, and characterization of two laccases from the white rot basidiomycete *Coriolopsis rigida*. Appl. Environ. Microbiology, 68(4); 1534-1540.
- SIVAPRAKSAM, K. AND B. RAMARAJ. 1991.** Studies on some factors influencing the yield of *Pleurotus* mushroom. Indian Mushrooms. Proc. Nat. Symp. Mushrooms, 127-132.
- SONG, C.H., JEON, Y.J., YANG, B.K., RA, K.S. AND H.I. KIM. 1998.** Anticomplementary activity of endo-polymers produced from submerged mycelial culture of higher fungi with particular reference to *Lentinus edodes*. Biotechnol Lett, 20; 741- 4.



- SUGANO, N., CHOJI, Y., HIBINO, Y., YASUMURA, S. AND H. MAEDA. 1985.** Anti-carcinogenic action of an alcohol-insoluble fraction (LAP1) from culture medium of *Lentinus edodes* mycelia. *Cancer Lett*, 27; 1– 6.
- TERASHIMA, K., MATSUMOTO, T., HAYASHI, E. AND Y. FUKUMASANA-KAI. 2002.** “A genetic linkage map of *Lentinula edodes* (shiitake) based on AFLP markers” *Mycological Research*, 106; 911-917.
- TOKIMOTO, K. AND M. KOMATSU. 1995.** “Selection and breeding of shiitake strains resistant to *Tricoderma* spp” *Canadian Journal in Botany* 73:S962-S966.
- TONIAL, T.M., PANDEY, A., CHIARELLO, M.D. AND C.R. SOCCOL. 2000.** Cultivation of *Volvariella volvaceae* to produce biomass from potato and cassava processing residues by submerged fermentation. *Indian Journal in Microbiology*, 40; 35-40.
- ULLRICH, R, NÜSKE, J., SCHEIBNER, K., SPANTZEL, J., AND M. HOFRICHTER M. 2004.** Novel haloperoxidase from the Agaric Basidiomycete *Agrocybe aegerita*. *Appl Environ Microbiol.*, 70; 4575–4581.
- VALENTÃO, P., ANDRADE, P. B., RANGEL, J., RIBEIRO, B., SILVA, B. M., BAPTISTA, P. AND R.M. SEABRA. 2005.** Effect of the conservation procedure on the contents of phenolic compounds and organic acids in chanderelle (*Cantharellus cibarius*) mushroom. *Journal of Agriculture and Food Chemistry*, 53; 4925-4931.
- WAHID, M., SATTAR, A. AND S. KHAN. 1988.** Composition of wild and cultivated mushrooms of Pakistan. *Mush. J. Tropics*, 8(2); 47-51.
- WASSER, S.P. 2002** Medicinal mushrooms as a source of antitumor and immunomodulating polysaccharides. *Appl Microbiol Biotechnol.*, 60; 258–274.
- WESSELS, J.G.H., MULDER, G.H. AND J. SPRINGER. 1987.** Expression of dikaryonspecific and non-specific mRNAs of *Schizophyllum commune* in relation to environmental conditions and fruiting. *J. General Microbiology*, 133; 2557-2561.
- WONG, J.Y. AND F.Y. CHYE. 2009.** Antioxidant properties of selected tropical wild edible mushrooms *J. Food Compost. Anal.* 22; 269-277.
- XAVIER, A.M.R.B., TAVARES, A.P.M., FERREIRA, R. AND F. AMADO. 2007.** *Trametes versicolor* growth and laccase induction with by-products of pulp and paper industry. *Electronic Journal of Biotechnology*, 10(3); 444-451.



**YANG, Q.Y., JONG, S.C., LI, X.Y., ZHOU, J.X., CHEN, R.T. AND L.Z. XU. 1992.** Antitumor and immunomodulating activities of the polysaccharide-peptide (PSP) of *Coriolus versicolor*. *J Immunol Immunopharmacol*, 12; 29– 34.

**ZERVAKIS, G.I., MONCALVO, J.M., AND R. VILGALYS. 2004.** Molecular phylogeny, biogeography and speciation of the mushroom species *Pleurotus cystidiosus* and allied taxa. *Microbiology*, 150; 715-726.