



CENTRAL LUZON STATE UNIVERSITY



**IDENTIFICATION AND EVALUATION OF ENZYMATIC ABILITIES OF
ISOLATED FUNGI FROM AGRICULTURAL WASTE COMPOST**

ERZSA MAY ARIZALA SAMPER

An Undergraduate Thesis Submitted to the Faculty of the Department of
Biological Sciences, College of Arts and Sciences, Central Luzon
State University, Science City of Muñoz, Nueva Ecija,
Philippines, In Partial Fulfilment of the
Requirements for the Degree

BACHELOR OF SCIENCE IN BIOLOGY

JUNE2017



COLLEGE OF ARTS AND SCIENCES
Department of Biological Sciences

APPROVAL SHEET

The Undergraduate Thesis entitled **IDENTIFICATION AND EVALUATION OF ENZYMATIC ABILITIES OF ISOLATED FUNGI FROM AGRICULTURAL WASTE COMPOST** prepared and submitted by **ERZSA MAY A. SAMPER** in partial fulfilment of the requirements for the degree of **BACHELOR OF SCIENCE IN BIOLOGY** is hereby approved and accepted.


KRISTINE GRACE D. WAING, MSc

Adviser

6/13/2017
Date Signed


JERWIN R. UNDAN, PhD

Critic

6/12/2017
Date Signed


RICH MILTON R. DULAY, MSc
Department Research Coordinator

6/11/2017
Date Signed

Accepted in partial fulfillment of the requirements for the degree of **BACHELOR OF SCIENCE IN BIOLOGY**.


EVARISTO A. ABELLA, PhD

Department Chair

6/13/2017
Date Signed


ANNA MARIA LOURDES S. LATONIO, PhD

College Research Coordinator

6/12/2017
Date Signed


MYRNA R. UMAGAT, PhD

Dean

6/13/2017
Date Signed



BIOGRAPHICAL SKETCH

PERSONAL INFORMATION

Name: Erzsa May A. Samper
Age: 24
Sex: Female
Birthday: May 17, 1993
Birth place: Plaridel, Llanera, Nueva Ecija
Status: Single
Nationality: Filipino
Father: Ernesto Z. Samper
Mother: Lorylyn A. Samper



EDUCATIONAL BACKGROUND

Elementary: Llanera Central School,
Bagumbayan, Llanera, Nueva Ecija
With Honors
(2000-2006)

Secondary: General Luna National High School,
Gen. Luna, Llanera, Nueva Ecija
With Honors
(2006-2010)

Tertiary: Central Luzon State University, Science City of Munoz,
Nueva Ecija
(2012-2017)

SEMINARS ATTENDED

Chemistry is Fun held at University Auditorium on February 19, 2013 at Central Luzon State University, Science City of Munoz, Nueva Ecija.

Current Trends in Food Safety and Quality Assurance held at the University Gymnasium, Central Luzon State University, Science City of Munoz, Nueva Ecija on August 30, 2014.

1st CLSU-University of Tsukuba Bilateral Student Research Congress held on March 5, 2015 at the College of Arts and Sciences Little Theater, Central Luzon State University, Science City of Munoz Nueva Ecija, Philippines.

Harmonizing the ASEAN Integration through Research and Innovation held at



CAS Little Theater at Central Luzon State University, Science City of Munoz, Nueva Ecija, Philippines on March 25, 2015.

HIV: AIDS “Survival of the Fittest. The Human Culture Media” held at the University Auditorium, Central Luzon State University, Science City of Munoz, Nueva Ecija, Philippines on November 21, 2015.

Science and Technology Forum: Current Issues and Challenges of R&D in the Philippines held on February 19, 2016 at Philippine Carabao Center National Headquarters and Gene Pool, Science City of Munoz, Nueva Ecija.

Philippine Biodiversity and National Museum held at the University Auditorium, Central Luzon State University, Science City of Munoz, Nueva Ecija, Philippines on March 22, 2016.

Fostering Food Security and Sustainable Development Through Innovation, Collaboration and Interdisciplinary Research held on May 4, 2016 at CAS Little Theater, Central Luzon State University, Science City of Munoz, Nueva Ecija, Philippines.

APPRENTICESHIP

Bureau of Fisheries and Aquatic Resources (BFAR) Science City of Munoz, Nueva Ecija, Philippines. From April 12, 2015 to May 13, 2015.



ACKNOWLEDGEMENT

To all the people who contributed their time, effort and knowledge just to finish this undergraduate thesis paper, the author would like to give her full appreciation and gratitude.

Most of all, the author would like to thank Almighty God for He made all things possible for the author to finish her undergraduate thesis paper.

To her adviser, Prof. Kristine Grace D. Waing for her patience in advising to make this paper better, in editing to correct all the flaws and by sharing her knowledge to enhance the understanding of the author regarding this paper and most of all her undying support in conducting this research.

To her critic, Dr. Jerwin R. Undan, for his suggestions, ideas and assistance in conducting the study and final defense.

To Mr. Rich Milton R. Dulay for the suggestions and for correcting the format of this paper.

To Mr. Frodie Waing of Philippine Rice Research Institute, Science City of Munoz, for he allowed the author to use the laboratory and other equipments needed in the conduct of the study.

To Mama, Papa, my siblings, Bernard and Baby Kent for their love, care and support which served as an inspiration to the author.

To Ate Jelyn, ate Jepay, ate Eva, kuya Dennis and kuya Jeff for their efforts in assisting the author in conducting this paper.



To Minette, Joseph, Joana and Janine for the friendship and helping the author in many ways just to finish her undergraduate thesis paper.

To Mam Janet Mercurio of Agricultural Science and Technology School for allowing the author to borrow petri plates in their laboratory to be used in this study.

The author could not be able to complete this undergraduate thesis paper without them. Thank you for the help and for the memories. God bless us all!

To those people who were not mentioned but played important role in this fruitful endeavor, her sincere appreciation is extended

ERZSA MAY A. SAMPER



TABLE OF CONTENTS

	PAGE
TITLE PAGE	i
APPROVAL SHEET	ii
BIOGRAPHICAL SKETCH	iii
ACKNOWLEDGEMENT	v
TABLE OF CONTENTS	vii
LIST OF TABLES	xi
LIST OF FIGURES	xii
LIST OF APPENDICES	xiii
LIST OF APPENDIX TABLE	xiv
LIST OF APPENDIX FIGURES	xv
ABSTRACT	xvi
INTRODUCTION	1
Background of the Study	1
Objectives of the Study	3
Significance of the Study	3
Scope and Limitation of the Study	4
Time and Place of the Study	5
REVIEW OF RELATED LITERATURE	6
Fungi	6
Ecological importance	7
Compost	8
Fungi as decomposers	9
Species of fungi	10
<i>Acremonium</i> species	10
<i>Arthrographis</i> species	10
<i>Aspergillus</i> spp.	11



<i>Basidiobolus ranarum</i>	12
<i>Bipolaris</i> species	12
<i>Botryotichum</i> species	12
<i>Conidiobolus</i> species	13
<i>Curvularia</i> species	13
<i>Doratomyces</i> species	13
<i>Mucor</i> species	14
<i>Nigrospora</i> species	14
<i>Paecilomyces</i> species	14
<i>Pithomyces</i> species	15
<i>Trichothecium roseum</i>	15
<i>Ulocladium</i> species	15
Fungal enzymes	16
Hydrolysis of starch	17
Hydrolysis of cellulose	18
MATERIALS AND METHOD	21
Isolation and Identification of Fungi	21
Collection of agricultural wastes	21
Dilution and plating	21
Purification	22
Screening of Enzymatic activity of Isolated Fungi	22
Cellulase activity	22
Amylase activity	22
Morphological Identification	23
Preparation and observation of microscopic slides	23
Identification key for fungal identification	23
Data Gathered	26
Statistical Analysis	26
RESULTS AND DISCUSSION	27
Fungal isolation and identification	27
<i>Aspergillus niger</i>	27
<i>Aspergillus flavus</i>	28
<i>Aspergillus fumigatus</i>	29
Cellulose degradation	31
Amylose degradation	34
SUMMARY, CONCLUSION AND RECOMMENDATION	35
Summary	35
Conclusion	36



Recommendation	36
LITERATURE CITED	37
APPENDICES	43



LIST OF TABLES

TABLE		PAGE
1	Cellulose degradation of isolated fungus from agricultural waste Compost after seven days of incubation	32
2	Amylose degradation of isolated fungi from agricultural waste compost after seven days of incubation	34



LIST OF FIGURES

FIGURE		PAGE
1	Typical mycelium of a fungus	7
2	Clear zones observed on amylase activity of <i>Aspergillusniger</i> (Saleem and Ebrahim, 2014)	20
3	Cellulase activity of <i>Aspergillusniger</i> and <i>Trichodermareesi</i> (Syed et al., 2013)	20
4	<i>Aspergillusniger</i> (A) cultural characteristics and (B) morphological characteristics showing (a) conidiophore and (b) conidium	28
5	<i>Aspergillusflavus</i> (A) cultural characteristics and (B) morphological characteristics showing (a) conidiophore and (b) conidium	29
6	<i>Aspergillusfumigatus</i> (A) cultural characteristics and (B) morphological characteristics showing (a) conidiophores and (b) conidium	30
7	Clear zones observed from <i>Aspergillusniger</i> isolated from agricultural waste compost	32
8	Clear zones observed from (A) <i>A. niger</i> , (B) <i>A. flavus</i> , (C) <i>A. fumigatus</i> after 7 days of incubation	34



LIST OF APPENDICES

APPENDIX		PAGE
A	Statistical Analysis	44
B	Experimental Procedure	45



LIST OF APPENDIX TABLE

APPENDIX TABLE		PAGE
1	Analysis of variance of fungi capable of degrading amylose	44



LIST OF APPENDIX FIGURES

APPENDIX FIGURES		PAGE
1	Evaluation of enzymatic abilities of fungi from agricultural waste compost	45
2	Measuring of clear zones using digital vernier caliper	45
3	Observation of fungal isolates for morphological identification	45



ABSTRACT

SAMPER, ERZSA MAY A. Bachelor of Science in Biology, Department of Biological Sciences, College of Arts and Sciences, Central Luzon State University, Science City of Munoz, Nueva Ecija, Philippines, June 2017. **IDENTIFICATION AND EVALUATION OF ENZYMATIC ABILITIES OF ISOLATED FUNGI FROM AGRICULTURAL WASTE COMPOST.**

Manuscript No.: BIO-M_2nd17-046

Adviser: Kristine Grace D. Waing, M.Sc.

Fungi are important organisms involved in biogeochemical cycling within ecosystem and it is responsible for decomposing dead organic matter by reintroducing it into the environment.

Enzymes are organic catalyst that have the ability to fasten the metabolism or breakdown of organic molecules, there are different types of enzymes and specialization. In this study, amylose degradation and cellulose degradation of agricultural compost fungi were evaluated to their enzymatic activities and identified using morphological identification.

Nine fungal species were isolated from agricultural waste compost, only 3 of them have the ability to degrade amylose these are *Aspergillus fumigatus*, *Aspergillus flavus* and *Aspergillus niger*. The clear zones were measured and it showed that *Aspergillus niger* produce a larger clear zone with mean average of 30.20mm.

In hydrolysing cellulose, one species were identified that capable of hydrolysing cellulose. The identified fungi was *Aspergillus niger*. It was clearly observed that all the



isolated fungi belongs to genus *Aspergillus*, which means that this genus has a wide range of ability to degrade environmental decaying matters.



LITERATURE CITED

- ABU, E.A., ADO, S.A. and D.B. JAMES. (2005).** Production of amylase from fruit peel (1999).using *Aspergillus niger* by solid state fermentation. African Journal Biotechnology, 4:785- 790.
- AKPAN, I., BANKOLE, M.O., ADESEMOWO, A.M and LATUNDE-DADA, GO. (1999).** Production of amylase by *A. niger* in a cheap solid medium using rice bran and agricultural materials.Tropical Sciences, 39:fd77-79.
- AL-HINDI, RP.,NAJAD, A.R.and S.A. MOHAMED. (2011).** Isolation and identification of some fruit spoilage fungi; screening of plant cell wall degrading enzymes. African Journal of Microbiology, 5(4).
- ANUSUYA, D. and T. A. SRIDHARA. (2003).** Biodiversity of fungi during composting of lignocellulosic wastes .Journal Microbiology World, 5(1).
- BÊGUIN, P. and J. P. AUBERT. (1994).** The biological degradation of cellulose. Unite de Physiologiecellulaire, Department des Biotechnologies, Institut Pasteur, Paris, France. FEMS Microbiology Review,13(1):25-58.
- BOLLEN, G. J. (1985).** The fate of plant pathogens during composting of crop residue. In composting of agricultural and other wastes, Ed by Gasser, J.K.R., Elsevier. Applied Science Publishers, London, 282-290.
- CAFFAL, K. H. and D. MOHNEN.(2009).**The structure, functions, and biosynthesis of plant cellwall pectic polysaccharides. Carbohydrates Research, 344(14):1879-1900.
- CHESTEEN, K. (2012).** Determining the diversity of wetland fungi through molecular based species identification.*Honors theses*.Paper 20.
- COULSON, C. B., DAVIES, R. I.and D. A. LEWIS. (1960)** Polyphenols in plant humus and soil. I. Polyphenols of leaves, litter and superficial humus from mull and mor sites. Soil Science, 11:9-20.
- DE VRIES, R. P.and J. VISSER. (2001).** *Aspergillus* enzymes involved in degradation of plant cell wall polysaccharides. Microbiology Molecular Biology Review, 65(4):497-522.
- DEN BRINK, J. V. and R. P. DE VRIES. (2011).** Fungal enzymes sets for plant polysaccharide degredation. Applied Microbiology and Biotechnology,1477-1492.
- DIX, N. J and J. WEBSTER.(1995).** Succession of fungi on decaying cocksfoot culms



III. The comparison of the sporulation and grow of some primary sporophytes on stem, leaf, blade and sheath. Transaction of the British Mycological Society, 43, 85-89.

DIX, N. J and J. WEBSTER. (1994). Fungal ecology. Department of Biological and Molecular Sciences University of Stirling, UK and Department of Biological Sciences University of Exeter, UK, 94-72667.

DOMSCH, K. H. and W. GRAMS. (1969). Variability and potential to decompose pectin, xylan and carboxymethyl cellulose. Soil Biology and Biochemistry, 1:29-36.

DUSTBAN, M., SCHRAFT, H, and W, QIN. (2009). Fungal bioconservation of lignocelluloses residues; opportunities and perspectives. International Journal Biological Sciences, 5:578-595.

EBRINGEROVA, A., HROMADKOVA ,Z., PETRAKOVA, E. and M. HRICOVINI.(1990). Structural features of a water-soluble L-arabino-D-xylan from rye bran. Carbohydrates Research, 198(1):57-66.

FLANAGAN, P. W. (1981) Fungal Taxa, physiological groups and biomass: a comparison between ecosystems, in The Fungal Community, (eds D. T. Wicklow and G. C. Carroll), Marcel Dekker, New York, 569-92.

FOGARTY, W. M. (1983). Microbial amylases. In microbial enzymes and Biotechnology. London, U.K: Applied Science Publishers Ltd.

FOGARTY, W. H. and C. T. KELLY. (1979). Starch Degrading enzymes of microbial origin, in Progress in Microbiology, Elsevier, 15:87-150.

FRANKLAND, J. C. (1982). Biomass and nutrient cycling by Decomposers Basidiomycetes: their Biology and Ecology, (eds J.C Frankland, J.N. Hedger and M.J. Swift), British Mycol. Soc. Symposium 4, Cambridge University Press, Cambridge, 241-61.

FUN WITH MICROBIOLOGY. Thunderhouse4-yuri.blogspot.co.id/2012/02/aspergillus-flavus.html?=1.

FUN WITH MICROBIOLOGY. Thunderhouse4-yuri.blogspot.co.id/2012/01/aspergillus-fumigatus.html?=1.

FUN WITH MICROBIOLOGY. Thunderhouse4-yuri.blogspot.co.id/2010/06/aspergillus-niger.html?=1.

GILLESPIE, J., LATTEP, P. M. and P. WIDDEN.(1988). Cellulolysis of cotton by



fungi in three upland soils, in cotton strip assay: An index of decomposition in soils, (eds A. F. Harrison, P. M. Latter and D. W. H. Walton), Institute of Terrestrial Ecology Grange-over-Sands, UK, 60-7.

- GUIMARÃES, L. H. S., PEIXOTO-NOGUERA, S. C., MICHELIN, M. RIZZATTI, A. C. S., SANDRIUM, V. C., ZANOELO, F. F., AQUINO, A. C. M. M., JUNIOR, A. B. and MDL. T. M. POLIZELI. (2006).** Departamento de Biologia - Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto - USP; Departamento de Bioquímica e Imunologia, Pós Graduação em Bioquímica - FMRP/USP; Instituto de Química, Pós Graduação em Biotecnologia, Araraquara - UNESP. *Brazilian Journal of Microbiology* 37:474-480.
- HAWKSWORTH, D. L., KIRK, P. M., SUTTON, B. C. and D. N. PEGLER. (1995).** *Ainsworth and bisby's dictionary of the fungi.* Wallingford, U.K.: CAB International.
- HUMBER, R.A. (1996).** Fungal pathogens of the Chrysomelidae and prospects for the used of their biological control. In *Biology Chrysomelidae. Vol. IV*, in press. SBP academic publishing, The Hague.
- HUNG, L. L and J. M. TRAPPE. (1983).** Growth and variation between and within species of ectomycorrhizal fungi in response to pH *in-vitro*. *Mycologia*, 75, 234-41.
- JENSEN, V. (1974).** Decomposition of angiosperm tree litter. *Biology of plant litter decomposition* (Edbu Dickinson, C.H and Pugh, G.J.F). Academic press, London, 69-104.
- KASTNER, M and B. MAHRO. (1996).** Fungal enzymes set for plant polysaccharide degradation. *Applied Microbiology Biotechnology*, 91(6):1477-1492
- KHAJEH K., SHOKRI, M. M., ASHGAN, S. M., MORADIAN, F. and A. GHASEMI. (2006).** Acidic proteolytic digestion of α -amylase from *Bacillus licheniformis* and *Bacillus amyloliquefaciens*: stability and flexibility analysis. *Enzyme Microbial Technology*, 38:422-428.
- KUBICEK, C. P., HERRERA-ESTRELLA, A., SEIDL-SEIBOTH, V., MARTINEZ, D. A., DRUZHININA, I. S., THON, M., ZEILINGER, S., CASAS-FLORES, S., HORWITZ, B. A., MUKHERJEE, P. K., MUKHERJEE, M., KREDICS, L., ALCARAZ, L. D. and Z., AERTS, et al., (2011).** Comparative genome sequence analysis underscores mycoparasitism as the ancestral life style of *Trichoderma*. *Genome Biology*, 12(4):R40.
- LARONE, D.H. (1995).** *Medically important fungi: a guide to identification.* (fourth ed.) ASM Press.



- LOPEZ J., LI, Q. and I. P. THOMPSON. (2010).** Biorefinary of waste orange peel. *Critical Review Biotechnology*, 30(1):63-69.
- MACFADDIN, J. F. (2000).** Biochemical test for identification of medica bacteria, 2nd ed. Lippincott Williams and Wilkins, Philadelphia, PA.
- MAÑOSA, S. D and F. T. TALAUE. (2007).** Breaking through Biology. 839 EDSA, South Triangle, Quezon City.
- MARTENS-UZUNOVA, E. S and P. J. SCHAAP. (2009).** Assesment of the pectin degrading enzyme network of *Aspergillus niger* by functional genomics. *Fungal Genetics Biology*, 46(Suppl 1):S170-S179.
- MARTINEZ, D., R. M., BERKAHENRISSAT, M., SALOHEIMO, M., ARVAS, S. E., BAKER, J., CHAPMAN, O., CHERTKOV, P. M., COUTINHO, D. and E. G, CULLEN, et al., (2008).** Genome sequencing and analysis of the biomass-degrading fungus *Trichoderma reesei* (syn. *Hypocrea jecorina*) *Nature Biotechnology*, 26(5):553-560.
- MISHRA, B.K. and S.K. DADHICH. (2010).** Production of amylase and xylanase enzymes from soil fungi of Rajasthan. *Journal*, 1:131-136.
- PANDEY, A., SOCCOL, CR. and D. MITCHELL. (2000).** *Process Biochemistry*. 35, 1153-1169.
- PATEL, A. K., NAMPOOTHRI, K.M., RAMCHANDRAN, S., SZAKACS, G. and A. PANDEY. (2005).** Partial purification and characterization of alpha amylase produce by *A. oryzae* using spent brewing grains. *Indian Journal Biotechnology*, 4:336-341.
- PATEL, C., YADAV, S. and S. DAVE. (2013).** Studies on biodiversity of fungal endophytes of indigenous monocotaceous plants and evaluation of their enzymatic potentialities. *International Journal of Scientific and Research Publications*, 3:2250-3153.
- PEDERSON, H. and J. NIELSEN. (2000).** Comparative studies on the amylase and cellulase production of *Aspergillus* and *Penicillium*. *Applied Microbiology Biotechnology*, 53, 278-281.
- PITT, J.I. and A.D. HOCKING. (2009).** Fungi and Food Spoilage. (third ed.) SpringerLink: Springer e-Books. *Microbiology*, 69: 454-459.
- PITT, J.I. and A.D. HOCKING. (2013).** Fungi and Food Spoilage.



(seconded.)SpringerLink: Springer e-Books. Microbiology, 69: 432-434.

- RIDLEY, B. L., O'NEILL, M. A. and D. MOHNEN. (2001).** Pectins: structure, biosynthesis, and oligogalacturonide-related signalling. *Phytochemistry*, 57(6):929967.
- ROYSE, D. J. (2003).** Influence of precipitated calcium carbonate (CaCO₃) on Shiitake (*Lentulaedodes*) yield and mushroom size. *Bioresources Technology*, 90(2):225-8.
- SALEEM, A. and M.K.I.H. EBRAHIM. (2014).** Production of amylase by fungi isolated from legume seeds collected in AlmadinalAlmunawwarah, Saudi Arabia. 8(2):90-97;doi:10.1016.
- SCHELLER, H.V. AND P. ULVSKOV. (2010).** Hemicellulases feedstocks division. Joint Bio Energy Institute, Lawrence Berkeley, National laboratory, Emeryville, California. *Annual Review Plant Biology*.61:263-89.
- SIU, R. G. H. (1951).** *Microbial Decomposition of Cellulose*, Reinhold, New York.
- SWIFT, M. J. (1982).** Basidiomycetes as components of forest ecosystems, in *Decomposer Basidiomycetes: their Biology and Ecology*, (eds J. C. Frankland, J. N. Hedger and M. J. Swift), British Mycological Symposium, Cambridge University Press, Cambridge, 307-37.
- SYED, S., RIYAZ-UL-HASSAN, S.and S. JOHRI. (2013).** Microbial biotechnology division, CSIR-Indian Institute of Integrative Medicine, Canal road, JamuTawi, India.

TYPICAL MYCELIUM OF A FUNGUS.

<https://www.google.com/search?q=structure+of+fungi+under+microscope&tbm=isch&tbo=u&source=univ&sa=X&ved=0ahUKEwjz4ImvxJ7UAhWrrlQKHdigAeQQsAQIJA&biw=1366&bih=627#imgrc=YnSnUvPGPLMLU>

TREE OF LIFE WEB PROJECT. (2006). The university of Arizona college of agriculture and life Sciences and the university of Arizona library. 21 April 2006. <http://toloweb.org/tree/>.

U.S MICRO-SOLUTIONS, INC. (1996-2015). 1075 South Main Street, Suite 104. Greensburg, PA 15601. <http://www.usmicro-solutions.com/referencelibrary/fungallibrary.html>.

VAN VLIET, A. J. H. (2010). Societal adaptation options to changes in phenology. In: Hudson, I.L., Keatley, M.R. (Eds.), *Phenological Research. Methods for*



Environmental and Climate Change Analysis. Springer, Dordrecht, Germany, 75-98.

- VARALAKSHMI, K.N., KUMUDINI,B.S., NANDINI,B.N., SOLOMON, J.,SUHAS,R., MAHESH, B.and A.P. KAVITHA. (2009).** Production and characterization of α -amylase from *Aspergillus niger* JGI 24 isolated in Bangalore. Journal Microbiology, 58: 29-36.
- XU, C., A. S. LEPPANEN., P. EKLUND., P. HOLMLUND., R. SJOHOLM., K. SUNDBERG and S. WILLFOR. (2010).** Acetylation and characterization of spruce (*Piceaabies*) galactoglucomannans. Carbohydrates, 345(6):810-816.
- WAING, K.G.D., GUTIERREZ, J.M.,GALVEZ,C.T. and J.R. UNDAN. (2015)** Molecular identification of leaf litter fungi for cellulose degradation. Mycosphere 6(12), 139-144.
- WAING, K.G.D., ABELLA, E.A., KALAW, S.P.K., WAING, F.P and C.T. GALVEZ. (2015).** Studies on biodiversity f leaf litter fungi of Central Luzon State University and evaluation of their enzyme producing ability. Current research in Environmental and Applied Mycology, 5(3):269-276.
- WONG, D.(2008).** Enzymatic deconstruction of backbone structures of the ramified regions in pectins. Protein Journal, 27(1):30-42.