ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 07, Issue, 07, pp.13848-13856, July, 2017

ORIGINAL RESEARCH ARTICLE

Open Access

PSU MUSHROOM TECHNOLOGY GENERATION AND RESEARCH IN ILOCOS REGION

***Cesar G. Della**

Pangasinan State University Bayambang Campus, Bayambang, Pangasinan

ARTICLE INFO

Article History:

Received 09th April, 2017
Received in revised form
14th May, 2017
Accepted 26th June, 2017
Published online 22nd July, 2017

Key Words:

Mushroom,
Technology,
Research,
Ilocos.

ABSTRACT

Mushroom is one of the banner projects of the university envisioned to enhance the quality and quantity of products per unit of time as well as develop technologies that are low-cost and adaptable to the condition of Ilocos region and the availability of substrate materials for the production of mushroom. It is in this premise that the research and development agenda is formulated to serve as roadmap for the effective and efficient implementation of the project. The study used qualitative method of research focus on the mushroom technology generation and conducted researches. There were thirteen research studies conducted on straw mushroom (Volvariella volvacea) in Sn. Carlos and Sta. Maria Pangasinan, Philiphines from 1999 to 2010. The modality of the package of technologies was proven effective. Technologies on mushroom production are now available and will be continuously improved/enhanced to cater to the needs of the target clienteles. This study recommended to continuously conduct and update technology generation in the production of mushroom.

****Corresponding author:***

Citation: Cesar G. Della. 2017. "PSU Mushroom Technology Generation and Research in Ilocos Region", *International Journal of Development Research*, 7, (07), 13848-13856.

INTRODUCTION

Ilocos region is a potential mushroom growing region in the Philippines due to its favorable agro-climatic conditions and availability of agro-industrial and forest wastes from rice, corn and other cereals and wood shavings like sawdust for spawn and for growing tropical mushrooms like *Volvariella volvacea* (Bull. Ex. Fr.) Singer, *Pleurotus sajor-caju* (Fr.) Singer, *and Auricularia polytricha* (Mont.) Sacc. These three kinds of mushrooms are rather easy to grow on a small scale as compared to other mushrooms. With the enactment of RA 10068 otherwise known as the Philippine Organic Agriculture Act of 2010, mushroom can be positioned as one of the vegetables that can be produced organically. Mushrooms are a good cash crop; they are rather easy to grow and are brimming with protein, B vitamins and minerals. Time between spawning and harvesting can be as short as three weeks. Furthermore, after the cultivation, you can still use the substrate as a good soil conditioner (Olei, et al., 2005).

Moreover, some species of mushroom were even recorded to have nutriceutical properties so they are use as medicinal tonics (Higaki, 2000). In the same vein, a research project on fungus conducted to explore the nutritional aspects of mushrooms at the University of Alberta concluded that overall they have some powerful health benefits. One of the most significant health benefits is the potential role played in inhibiting different types of cancer tumours. Further, mushrooms provide more selenium than any other fruit or vegetable. Selenium contains a compound that is believed to decrease the incidence of some human cancers. In addition, the studies show that mushrooms also contain antioxidants, which are known to help reduce the risk of heart disease, various cancers and other chronic diseases. They also contain anti-inflammatory compounds similar to those in over-the-counter painkillers (Creighton, 2010). A group of government scientists recently discovered an antibiotic-producing microorganism from a type of mushroom species *Clitopilus passeckerianus* that produces the antibiotic called pleuromutilin that has been found to be effective in treating

diseases of livestock, particularly swine. Pleuromutilin also acts as the building block for the production of tiamulin, a biological compound effective in treating common hog diseases such as mycoplasmas, arthritis, enzootic pneumonia, and dysentery (Flores, 2008). In terms of production of mushroom CY 1996 to 1998 by province: La Union registered the highest production with 20,000 kilos in 1997, 27,441 kilos in 1998 and 22,371 in 1999; Pangasinan posted a production of 21,000 kilos in 1997, 21,071 in 1998 and 21,192 in 1999; Ilocos Sur produced 6,968 in 1997, 6,968 in 1998 and 6,968 in 1999. Ilocos Norte had no registered production during the period (NEDA, 2006). The data showed that with this volume of production alone, mushroom is not yet considered a regular commodity in the market, hence, the urgent need to develop innovative low-cost technologies that will enhance the production of this commodity.

The Pangasinan State University-Mushroom Research and Development Center (PSU-MRDC) or the Center, generally aim for the sustainable production, marketing, and distribution of high quality and adaptable strains of mushroom species accessible for marginalized farmers, students, people with disabilities (PWDs), entrepreneurs and mushroom growers. The Center specifically aims to: (1) serve as one site facility for instruction, research and venue for extension, trainings, dissemination services and production for faculty, students, PWDs and other stakeholders; (2) develop mushroom technologies that are adaptable to the semi-arid conditions of Ilocos region; (3) provide quality pure culture, sub-cultures, mother and planting spawns and fruiting bags, food, additional nutrients, generate income and jobs for the marginalized sectors in Ilocos region. One of the focus of the RDand E efforts is the mushroom commodity technology generation. Activities under technology generation included the culture media preparation, spawn production and mushroom cultivation. Mushroom as one of the priority Rand D commodities was also the focus of faculty and student-researchers, hence, numerous researches were completed on areas of substrates and growth analysis, spawn technology, and mushroom production.

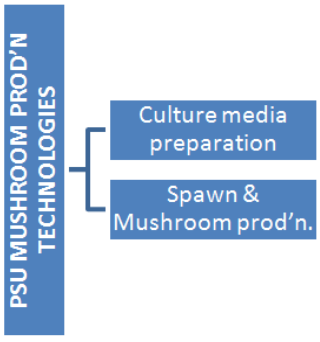

Figure 1. Mushroom Technology Generation Agenda for PSU Mushroom Project Technologies

Research and Development

Technology Generation

Mushroom research activities in PSU started in 2000 and still working on the development of other areas of the commodity. Technologies developed both for culture media, spawn and mushroom production or cultivation for *Volvariella volvacea*, *Pleurotus spp.* and *Auricularia polytricha* were results of findings from scientific research conducted by the faculty, staff and student researchers in the PSU-MRDC Sta. Maria Campus and researchers of PSU San Carlos City. This year (2013) one of the completed researches is the study entitled "*Construction of PSU-MRDC Rice Husk-Fired Steam Boiler Facility for Mushroom Production*". The technologies are designed to be low-cost and rural-based using agro-industrial wastes as raw materials and fuel.

Production Component

The Center intensified the production of mushroom product for the sustainable operation of the project and serve as show window for farmers, unemployed graduates, students, OSY, PWDs and entrepreneurs. Supply the mushroom requirements of PSU Sta. Maria community and its service areas. From CY 2006 to the present, despite of the fact that the priorities of the project were on Rand D, but still it was able to establish its niche as producer of quality pure culture, spawn and fruits for the stakeholders and generated income for the sustainable operation of the Center. The income generated is used for the operation of the project and procurement of equipment, supplies and materials.

RESULTS AND DISCUSSION

The PSU Mushroom Research and Development Center

The PSU-MRDC research and development activities started its humble beginning in May 2000 and housed in the Biology laboratory of PSU Sta. Maria Campus. A seed capital of P2,000.00 was used for the acquisition of supplies and materials and the construction of makeshift-light materials fruiting house. This was constructed out from the income generated by the project. Likewise, income generated was used to pay the labor services of a working student to assure the sustainable operation of the project. It was then called the PSU-Mushroom Research and Development Laboratory (PSU-MRDL), however, in 2003 it eventually evolved into now the PSU-Mushroom Research and Development Center (PSU-MRDC).

The Center, became fully operational in February 2003 with the release of the P850,000 fund from the income of the university and construction of a 25m x 20m laboratory building nestled in a 6,000 sq. m. lot located in the PSU Integrated Sustainable Techno-Demo Farm of the college and enclosed by a concrete perimeter fence. Within the confines of the Center are the laboratory/inoculation room where strains of cultured mushrooms are stored; office of the project manager and staff; lecture room that can accommodate 30 trainees in one setting and a comfort room. This was the output of a project proposal submitted and approved by the Office of the President for the construction of a one-site facility for instruction, research, extension and production endeavors of the university.

The PSU-MRDC Mushroom Production Technologies

The PSU-MRDC Mushroom Production Technologies were generated from CY 2000 to present attuned on the Ilocos region's semi-arid condition. The PSU San Carlos City started its mushroom Rand D in 1999 before the operation of the PSU MRDC (PSU-MRDL then) in PSU Sta. Maria. The technologies developed were products of painstaking researches of the project manager, staff, students of the two agricultural campuses and in collaboration with other mycology experts in the Philippines.

Table 1. Mushroom researches conducted from CY 1999 to 2009 in PSU

Topics	Year										
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Volvariella volvacea Researches:							1				
1.Processed Chicken Manure as Additive for the Growth and Basidiocarp Production of *Volvariella volvacea*											
2.Agro-industrial and Forest Wastes for Mycelial Growth, Chlamydospore Formation and Basidiocarp Production of Straw Mushroom (*Volvariella volvacea*)									1	1	1
3.Sizes of Bedding Materials for Basidiocap Production of Volvariella volvacea							1				
4.Effect of Different Substrates on Spawn Mycelial Development and Basidiocarp Production on *Volvariella volvacea*						1					
5.Levels of Molasses and Urea as Additives on mycelia Growth and Basidiocarp production of *Volvariella volvacea*							1				
6.Methods of Substrate Preparation and Different Levels of Molasses for *Volvariella volvacea* Spawn and Basidiocarp Production						1					
7.Effect of Vigotriz-M on the Growth and Yield Performance of Mushroom (*Volvariella volvaceae*	1										
8.Effect of Different Rates of Urea-refined Sugar Solution on the Growth and Yield Performance of Mushroom (*Volvariella volvaceae*)	1										
9.Yield Response of Mushroom (*Volvariella volvaceae*) Applied with Different Levels of Urea Using Waterlily as Substrate			1								
10.Growth Performance of Mushroom (*Volvariella volvaceae*)	1										
11.Growth and Yeild Performance of Mushroom (*Volvariella volvaceae*) with Different Rates of Urea	1										
12.Performance of Mushroom (*Volvariella volvaceae*) Fertilized with Different Rates of Farmate	1										
13.Molasses and Urea Additives on Mycelial Growth and Basidiocarp Production of Mushroom (*Volvariella volvacea*)							1				
Pleurotus spp. Researches											
1.Effect of Different Types of Culture Media and Inoculum Sizes in the Production of Mushroom (*Pleurotus pulmonarius*)								1			
2.Effect of Different Types of Culture Media in the Mycelial Growth of *Pleurotus pulmonarius*							1				
3.Comparative Study of Pure Culture and Mother Grain Spawn Performance of *Pleurotus sajor caju*"								1			
4.Effect of Different Substrate Media and Fruiting Bag Exposure on Basidiocarp Production of Abalone Mushroom (*Pleurotus pulmonarius*)							1				
Auricularia polytricha Research:						1					
1.Bag-Type Formulation of Ear Mushroom (Auricularia polytricha) by Different Combinations of Agro-Industrial Wastes											

Table 2. Summary Table on the Use of Chicken Manure as Additive for the Growth and Basidiocarp Production of *Volvariella volvacea*

Treatment	Ave. No. of Days to Develop Primordia	Ave. Size of Stipes of Harvested Caps (cm)	Ave. Size of Harvested Buttons (cm)	Ave. Size of Pileus of Harvested Basidiocarp	Ave. Number of Harvested Caps	Ave. No. of Harvested Buttons	Ave. Weight of Harvested Caps & Buttons	Remarks
T1 – Water Alone	10.33	11.60	2.01	8.73^{c}	76.33^{c}	62.67^{b}	1.38^{c}	6
T2 – 200g CM/170.330L H_2O	12.00	12.49	2.03	9.36^{c}	77.67^{c}	63.67^{b}	1.58^{bc}	5
T3 - 400g CM/170.330L H_2O	11.00	12.56	2.05	10.99^{bcd}	94.67^{cd}	67.33^{b}	182^{bc}	4
T4 – 600g CM/170.330L H_2O	10.66	12.86	2.10	11.51^{abc}	99.67^{cd}	68.33^{b}	1.91^{abc}	3
T5 – 800g CM/170.330L H_2O	10.33	12.92	2.14	11.53^{ab}	110.00^{b}	$71.33a^{b}$	2.03^{ab}	2
T6 – 1000g CM/170.330L H_2O	10.33	13.70	2.18	12.11^{a}	133.67^{a}	79.33^{a}	2.54^{a}	1
Level of Significance	NS	NS	NS	*	**	*	*	

TECHNOLOGY GENERATION

The technologies that were generated were products of long and tedious researches conducted by the project manager, staff and theses studentsfrom 1999 to 2010 in the Center and researchers from PSU San Carlos City. Funding in the implementation of the studies were sourced-out from the PSU Rand D fund, CHED Fund, DA RFU 1 thru the HVCDP, LGU fund and from the income generated by the project and partly from the students. Biology students from the other universities utilize the outputs of research of the Center and source-out pure culture, spawns for the implementation of their undergraduate thesis. Further, the Saint Louis University Biology students were allowed to conduct their research in the Center and the project manager as consultant.

Table 3. Summary Table on the Use of Agro-Industrial and Forest Wastes for Mycelial Growth, Chlamydospore Formation and Basidiocarp Production of Straw Mushroom (Volvariella volvacea)

Treatment	Ave. No. of Days to Complete Mycelial Ramification	Ave. No. of Days to Develop Primordial	Ave. Number of Days in the Dev't. of Primordia	Actual Prod'n Per Ave. Wt. of Harvested Mushroom Bodies (kg)	Ave. Wt. (Kg) of Harvested Open Caps (Based on 10 samples)	Ave. Wt. (kg) of the Harvested Buttons (Based on 10 samples)	Ave. Diameter of Buttons (cm) Diameter
T1 – 70% TM+20% SD+10% RB	38.65	12.00	12.00	4.40	3.00	1.41	1.40
T2 – 70% MC+20%SD+10% RB	57.17	12.66	12.66	3.26	2.32	0.94	1.32
T3 - 70% IPIP+20%SD+10% RB	47.01	16.00	16.00	2.58	1.75	0.83	1.23
T4 – 70% RS+20%SD+10% RB	40.76	12.66	12.00	4.81	3.08	1.73	1.50
Level of Significance	**	**	NS	*	*	*	NS

Mushroom Technologies Generated

The following were the technologies generated as a result of long and tedious research undertakings from 1999 to 2013:

Culture Media Production Technology

Preparation of "Starter" or Pure Culture (*Pleurotus spp*.)

Mushroom generally cultured on a variety of culture media and on different agar formulation. In the study conducted by Della, Della and Limon (2006) entitled "Comparative Study of Pure Culture and Mother Grain Spawn Performance of *Pleurotus sajor caju*" used the Potato Sugar Agar (PSA) as culture media. In another study conducted by Della, Della and Cuenca (2005) entitled "Effect of Different Types of Culture Media in the Mycelial Growth of *Pleurotus pulmonarius*" utilized different culture media and size of the inoculum to determine the growth of mycelia. One of the eight culture media used was PSA compared with two other culture media (Coconut Water Sugar and Rice Bran Sugar Agar). Results of the study revealed that the different types of culture media enhanced the growth of mycelia and in the colonization of the surface area of the agar bottle. It was found out that Rice Bran Sugar Agar (RBSA 15mm^2) registered the fastest growth of mycelia and attained the shortest number of days to attain full mycelial colonization.

Rice Bran Sugar Agar. To prepare the **RBSA**, the following are the procedures:

- Weigh a 250 grams of rice bran, preferably D2, 1 liter tap water, casserole, rhum bottles, ordinary cotton, and 20 grams shredded gelatine bars sold in the market and 20 grams sugar.
- Boil the rice bran in water (at least 10-15 minutes).
- Remove the rice bran then measure and use the resulting broth to make exactly 1,000 ml decoction.
- Return the broth to the casserole, add the shredded gelatine bars.
- Add 20 grams white sugar then stir until agar and sugar are totally melted.
- Pour the resulting solution into the bottles, filling each bottle to about 1 inch from the bottom.
- Plug each bottle with cotton and cover with ¼ sheet of paper then fasten with rubber band.
- Sterilize the bottles for 1 hour at 15 psi in a pressure cooker

Preparation of Mother Grain (Sweet Sorghum) Spawn for *Pleutotus spp*

The mother grain using sweet sorghum as seed is used to inoculate the sterilized substrates to be used as planting spawns. The following are the procedures in the preparation of the mother grain spawn:

- Wash 1 kg sweet sorghum seeds until the water become clear then soak overnight. Dead seeds or those that float should be removed.
- The following day, wash the seeds and boil for about 15 – 20 minutes until they expand but not quite broken.
- When the grains have swelled and majority have been broken, remove from heat. Spread out the seeds on the sheets of old newspapers. Cool and air dry the seeds overnight or 12 hours. Avoid too much drying the seeds or too wet so as not to affect mycelial growth.
- Fill the clean rhum bottles up to the lower neck then plug in each of the bottle with cotton. Secure the bottle with ¼ paper and rubber band.
- Sterilized the bottles for one hour at 15 psi (121 ^{0} C) in a pressure cooker.
- Once cooled, transfer a mycelial plug in each of the bottle. The whole procedure should be done aseptically in the laminar flow or transfer chamber. Incubate the

Composting of the Substrates Using Corn Cob Substrate for *Pleurotus spp*

The following are the procedures in the composting of the substrates:

- For a 100 kgs composted substrates, mix seventy eight (78) kgs of corn cob with 10 kgs of rice bran during the first mixing then 10 kgs during bagging on the 6-7 days.
- Add 1 kilo molasses (or 1 kilo brown sugar) and 1 kg lime to the mixture. The substrates and additives should be mixed thoroughly.
- Add enough water to hold the substrates together.
- Cover the mixture with polyethylene plastic or sacks to facilitate the composting period. Substrates will be turned/mixed on the 3rd day of composting. Composting process should be continued up to 6-7 days. On the 6th to 7th day of composting, add the remaining 10 kilos of rice bran (D2) then turned/mixed before bagging.

Bagging and Sterilization of the Substrate

The following are the procedures in the bagging of the substrates:

- Pack the substrates tightly/firmly in a 7"x12" heat resistant polypropylene bags.
- Punched down the substrates using fist for compaction but not too hard as it will affect the colonization of mycelia on the whole fruiting bag.

- Weigh the fruiting bag at 1 kilo per bag leaving 4 inches left unfilled where a .5 inch x .5 inch pvc pipe to serve as neck will be placed.
- Plug the opening with cotton and secure it with ¼ paper and rubber band.
- Pasteurized the bags in a 200 bag capacity fabricated drum steamer for 8 hours. This is enough to completely eradicate the contaminants such as bacteria, viruses, spores of other fungi that will compete with the *Pleurotus* mycelia.

Inoculation of the Substrate and Incubation of the Fruiting Bags

The following are the procedures in the inoculation and incubation of the fruiting bags:

- Once the sterilized bags are cooled, the fruiting bags will be inoculated with pure culture or with mother grain spawn on the anterior opening where the pvc pipe's hallow space when cotton plug is removed.
- Once the mycelia reached the bottom of the bags, allow the mycelia to mature for 5 weeks before letting them fruit. This will assure the maturity of the fruiting bag before allowing to fruit.

Fruiting of the Fully Colonized Bags

- Fully colonized bags will be brought to fruiting house, hanged using plastic ropes one after the other vertically.
- PVC pipe and cotton plug will be removed at the uppermost part of the bags and opened or using a scissor, cut the anterior end of the fruiting bag.
- A temperature range of 25^0C and 85% relative humidity will be facilitated by spraying the floor with clean water using a knapsack sprayer from time to time or a canal will be provided where clean water can be stored.
- Mushroom can be harvested 5 days after the opening of the fruiting bags.

Harvesting the *Pleurotus* Basidiocarp or Fruit

- Mushroom will be harvested 5 days after opening the fruiting bags. Harvesting can be done by grasping the stipe (stalk) and gently twisted and pulled.
- After harvesting, the surface will be scraped thinly but gently then sprayed with clean water using a knapsack sprayer. Mushroom will continue to fruit under favourable environmental conditions which is 25^0C – 30^0C as long as the substrates appears white.
- When the fruiting bag appears colorless and soft, remove the bags from the fruiting house since this is an indication that the mycelia are no longer alive.

Spawn Production Technology

Rice Straw-Based Spawn Production for *Volvariella volvaceae*

The following are the procedures in spawn production:

- Gather rice straw substrates from rice farms immediately after threshing.
- Chop the substrates using a sharp bolo in 2 cm length.
- Weigh dry rice straw and other materials like sawdust and add rice bran, lime and molasses depending on the total amount of substrates to be combined. The ratio is 13.875 kg uncomposted rice straw: 225 g molasses: 300 g rice bran: 300 g lime.
- Soak the rice straw in a clear water mixed with 225 g molasses using a 200 liters capacity drum for 12 hours. After 12 hours, remove the rice straw from the drum then allow to drain for 5 minutes.
- Once drained, mix the rice straw with 300 g sawdust, 300 g rice bran and 300 g lime. The mixture is now ready for bagging.
- Use 7" x 12" polypropylene bag for bagging. Fill the bags with 500 g mixture (not totally compacted). Insert pvc pipe with diameter ¾ inch measuring at least 1 cm into the bag. Plug the pvc pipe with cotton and then secure it with ¼ paper and rubber band.
- Pasteurize the bags using a fabricated sterilizer for 8 straight hours to be assured of eliminating the harmful microorganisms in the substrates. After sterilization, allow the substrates to stand and cool for 12 hours or overnight.
- Once cooled, inoculate the bags with pure culture of *Volvariella volvaceae* mycelia plug at the inoculating room following strict sanitation to avoid contaminations of bags.
- Incubate inoculated bags inside a dark cabinet to allow the proliferation of mycelia within the substrates until the spawned bags are full of web-like mycelia growth which gradually changes into brownish masses of chlamydospores.

Tobacco Midrib-Based Spawn Production (*Volvariella volvaceae*)

- The following are the procedures in spawn production using tobacco midribs:
- Chop the tobacco midribs into 2 cm length. If the material is obtained from tobacco redrying plant, the size is ideal for spawn production and is ready for soaking.
- Soak the previously chopped tobacco midribs in clean water for 3 days.
- Wash the substrates with tap water to remove the smell of fermentation.
- Maintain at least 55% water content (physically determined if no water runs off while squeezing)by squeezing excess water.
- Mix 20% sawdust to tobacco midribs and 10% rice bran. Place five hundred (500) grams of the mixed substrates in a 6" x 10" heat resistant polypropylene bag. Packing should not be too tight nor too loose to allow efficient sterilization.
- Sterilize the bags in a fabricated drum sterilizer for 60 minutes, however, in a moist sterilizer above atmospheric pressure at 15 psi, 121°C for 60 minutes. If using a fabricated drum sterilizer with 200 bag capacity, it should be sterilized for 8 hours.
- Once cooled (which usually takes overnight) inoculate the sterilized substrates with mycelia block from a pure culture of *Volvarilla volvaceae* . Inoculation should be done in an aseptic transfer chamber/laminar flow hood.
- Incubate the inoculated bags at 30 - 35°C to allow the proliferation of the mycelia of *Volvarilla volvaceae* into

the substrate. Ready to spawn bags are full of web-like mycelia growth which gradually changes into brownish masses of chlamydospores.

Madre de Cacao and Ipil-Ipil Leaves-Based Spawn Production

The following are the procedures in spawn production for madre cacao and ipil-ipil leaves:

- Gather leaves from Ipil-Ipil and Madre de Cacao trees. Dry the leaves for 3 days.
- Place the dry leaves in a sack and pound it continuously until the leaves are turned into smaller pieces.
- Soak the substrates in a drum of clean water for 2 days.
- After 2 days, wash the substrates in a running water to remove the smell of fermentation. Squeeze out excess water maintaining 55% water content.
- Mix the substrates with sawdust (20%) and rice bran (20%).
- Pack the mixture in a 7" x 12" heat resistant polypropylene bags.
- Sterilize the bags in a fabricated drum steamer (200 bags capacity) for 8 hours.
- Cool the bags for 8 – 12 hours.
- Once cooled (which usually takes overnight) inoculate the sterilized substrates with mycelia block from a pure culture of *Volvarilla volvaceae* . Inoculation should be done in an aseptic transfer chamber/laminar flow hood.
- Incubate the inoculated bags at 30 - 35°C to allow the proliferation of the mycelia of *Volvarilla volvaceae* into the substrate. Ready to spawn bags are full of web-like mycelia growth which gradually changes into brownish masses of chlamydospores.

***Volvariella volvaceae* Outdoor Cultivation Technology**

Collection of banana Leaves, Rice Straw or Water Hyacinth as Bedding Materials

- Site selection – an excellent site is one that is not directly hit by intense sunlight and rain.
- The area should be free from pests such as ants, termites, snails, and crickets. If production is undertaken during rainy season, use GI sheets or cogon grass as sheds of the beds from intense rainfall.
- Bundle banana leaves or rice straw measuring 1 ½ ft in length and 4 inches in diameter. One hundred bundles are enough for the 2 m x 1.5 ft. bed and 5 layers at 20 bundles per layer.
- Soak the bundled substrates in clean water for 12 – 24 hours to soften the strands of the dry banana leaves/rice straw to facilitate faster proliferation of mycelia.
- Arrange the bundled substrates side by side until the first layer is completed. Place thumb size spawns on both sides of the bed 3 inches from the edge and 4 inches in between spawns. Repeat the process up to the fifth layer. For ease of harvesting the fruits, trim the edges of the layers.
- Cover the beds with polyethylene plastic or sacks so that the required temperature and humidity will be maintained. Make an opening on one side when the temperature is high. During fruiting stage, maintain a temperature of 30 - 32°C and right humidity.
- Harvest mushroom in its egg stage (buttons) if necessary, however, mushrooms can be harvested as open caps. The first phase of mushroom production (first flushing usually last for 5 days. After 5 days, no mushroom will come out. This is the incubation period.

Sprinkle water over the bed and seal it with plastic cover to build up the temperature. The mushroom bed will produce mushroom after 7 – 14 days rest period.

Researches Conducted on *Volvariella volvacea* (Bull. ex. Fr.) Singer

Straw/banana mushroom (*Volvariella volvacea*) is the kind of mushroom that was widely researched on by faculty, staff and students of PSU Sta. Maria and San Carlos City from CY 1999 to 2009. In can be premise that this kind of mushroom is the favorite delicacy of the rural folks, availability of the technology and accessibility to source of planting material and because of the proximity of the PSU MRDC. It can be gleaned from Table 1 that there were thirteen (13) research studies conducted on straw mushroom (*Volvariella volvacea*) from 1999 to 2010, four (4) for *Pleurotus spp.*and one (1) *Aulicaria polytricha* "taingang daga". One (1) study is still on-going which is being conducted in the Center by the SLU Biology students.

Processed Chicken Manure (PCM) as Additive for the Growth and Basidiocarp Production of *Volvariella volvacea* (Bull. ex. Fr.) Singer/Della, CG, Della, ES and Maramag, AB.

Traditionally, farmers use commercial fertilizer like urea as source of nitrogen to fertilize the bedding materials to enhance the growth of mushroom fruits (basidiocarp) research findings has proven that when consumed in the long-term is detrimental to health. It is in this premise that the study was conducted to determine the growth and basidiocarp production of *Vovariella volvacea* using processed chicken manure as additive when bedding materials are soak in water for straw mushroom cultivation. Specifically, the study aimed to: (1) determine which of the different levels of chicken manure as additive is best for the growth and basidiocarop production of straw mushroom; (2) evaluate the quantity of basidiocarp produce from the different levels of chicken manure as additive in terms of number of open caps and buttons harvested; and (3) determine the cost-effectiveness using chicken manure as additive for mycelia growth and basidiocarp production of Volvariella using cost and return analysis as tool. Based on the result obtained, the use of higher rates of chicken manure as additive in soaking the bundled substrates (1,000 grams in 170.330 liter of water) would enhance the growth and basidiocarp production of *Volvariella volvacea* in terms of the size of the pileus and stipe, weight and the number of harvested fruits. This can be attributed to the rich organic matter, nitrogen, phosphorous and potassium present in the chicken manure which enhances the growth and basidiocarp production of Volvariella volvacea.

Agro-industrial and Forest Wastes for Mycelial Growth, Chlamydospore Formation and Basidiocarp Production of Straw Mushroom (*Volvariella volvacea* (Bull. ex. Fr.) Singer) *Della, CG. Della, ES and Patacsil, RB*

The study was conducted to evaluate the effect of agro-industrial waste combinations in the mycelia growth and

chlamydospore formation and basidiocarp production of *Volvariella volvacea*. Specifically, it aimed to: (1) determine which of the substrate combinations result to a faster mycelia growth; (2) determine which of the agro-industrial waste combinations will enhance the formation of chlamydospore; (3) determine which of the agro-industrial waste substrate combinations will increase basidiocarp production; (4) determine the biological efficiency of the different substrate combinations will give the highest yield and net income.Result of the study showed that the different agro-industrial waste combinations have highly significant effect on the mycelia growth and chlamydospore formation. Statistical analysis on basidiocarp production showed that spawn substrate combinations have significant differences on the average weight of harvested mushroom, average diameter of stipe and diameter of pileus, average diameter of the buttons. The different substrate combinations are not significant, however, on the length of production period, length and diameter of mushroom buttons. Based on the cost and return analysis for Phase I (Spawn Preparation) tobacco midrib, madre de cacao, and ipil-ipil gave the highest return on investment (ROI) of 92.77%, on the other hand, Phase II (Mushroom Production), rice straw obtained the highest ROI with 183.07%. Based on the result of the study, tobacco midrib as substrate for spawn production gave better result in the average number of days to complete mycelial ramification of the spawn bag, average number of days on chlamydospore formation and average number to develop primordia. Rice straw, on the other hand, gave better result in the actual production per average weight of harvested mushroom bodies, average number of harvested mushroom, average size of stipe and diameter of button.

Sizes of Bedding Materials for Basidiocap Production of Volvariella volvacea (Bull. ex. Fr.) Singer

The study was conducted to determine the effect of different sizes of bedding materials for basidiocarp production of *Volvariella volvacea*. Specifically, it aimed to determine which of the different sizes of bedding materials was superior in terms of primordial development. Moreover, to determine which of the sizes of bedding materials will greatly support the growth of basidiocarp and determine the profitability of the different treatments included in the study. Results of the study revealed that the different sizes of bedding materials have highly significant effect on the average number of days to the appearance of the primordia. Statistical analysis on the weight of harvested basidiocarp revealed that Treatment 6 (1.5 feet long (18 inches) x 4 inches diameter) obtained the highest total yield of harvested basidiocarp, largest length of stipe and the number of harvested mushroom.

Effect of Different Substrates on Spawn Mycelial Development and Basidiocarp Production on *Volvariella volvacea* (Bull. ex. Fr.) Singer/*Della, CG, Della, ES and Calderon, CC, 2004*

This study was conducted to evaluate the effect of different spawn substrates combined with sawdust and rice bran on the mycelia growth and basidiocarp production of *Volvariella volvacea*. The different treatments were tobacco midrib, madre cacao, ipil-ipil, rice straw , corn cob and sawdust. The Completely Randomized Design was used in Spawn Mycelial Development Stage while RCBD was used in the Basidiocarp Production. Result of the study showed highly significant effect on the mycelial growth. Statistical analysis on the basidiocarp production showed that spawn sunstrates have significant effect on the average weight of the harvested nushroom, average diameter of stipe and diameter of pileus and average length of the buttons. On cost and return analysis for Spawn Mycelial Development, tobacco midrib obtained gave the highest net income while on Basidiocarp Production, Rice Straw obtained the highest net income.

5Levels of Molasses and Urea as Additives on Mycelial Growth and Basidiocarp Production of *Volvariella volvacea* (Bull. Ex. Fr.) Singer/*Della CG and Della ES. 2005*

The study was conducted to determine the effect of different concentrations of molasses and urea on the mycelial growth and basidiocarp production of straw mushroom. It aimed to determine the effect of level of additives in terms of mycelial ramification, the level of additives that gave the best performance in terms of basidiocarp production and the highest profitability. The study employed the Complete Randomized Design (CRD) with 10 treatments and 3 replications each. The Randomized Complete Block Design, on the other hand, was used with 3 replications for the straw mushroom basidiocarp production. Results of the study showed that Treatment 5 (30g molasses +15g urea) obtained the highest length of mycelia 25 days after inoculation. On the other hand, Treatment 6 (30g molasses and 30g urea) obtained the lowest of mycelia 25 days after inoculation. On the average weight of the harvested mushroom, Treatment 7 (20g molasses and 45g urea) gave the highest mean weight.

Methods of Substrate Preparation and Different Levels of Molasses for *Volvariella volvacea* Spawn and Basidiocarp Production/*Della, CG, Della, ES and Divina, RB, 2004*

The study was conducted to determine which methods of substrate preparation and different levels of molasses would give the best performance in terms of highest mycelia growth and chlamydospore formation, size of pileus and stipe, weight of basidiocarp produced, biological efficiency and net income. Factorial in Complete Randomized Design was employed in spawn production and Factorial in Randomized Complete Block Design in basidiocarp production were used to analyze the data gathered. Factor A represents the two methods of substrate preparation, namely, composted and uncomposted rice straw. Factor B represents the different levels of molasses used per treatment, namely: T1 (no molasses); T2 (75 g molasses); T3 (1,540g molasses), T4 (225g molasses); T4 (225g molasses); T5 (300g molasses); and. T6 (375g molasses). Based on the result of the study, the use of 75g molasses using either composted or uncomposted rice straw obtained the best mycelia growth while the used of composted substrates at 300g molasses obtained the best chlamydospores formation. Best growth of primordial was obtained using composted substrate regardless of levels of molasses used. Weight of basidiocarp produced was highest using 150g molasses under composted substrates while 225g molasses under uncosposted substrates. On the other hand, highest biological efficiency was obtained using uncomposted substrate with 150g molasses. However, uncomposted substrate with 225g molasses obtained the highest net income.

Effect of Vigotriz-M on the Growth and Yeild Performance of Mushroom (*Volvariella volvaceae*)/*Marylene Macaraeg,1999*

The study was conducted on the effect of the different rates of vigoritz M in the production of mushroom using four treatments (T1- control, T2- 4 tbsp, T3 – 8 tbsp, and T4 – 12

tbsp) of Vigoritz M per 16 L of water. These were laid out in the nursery following the Complete Randomized Design with three replications. Based on the results of the study, the different rates of Vigoritz M significantly affected the number of harvested open mushroom and weight of the buttons. The rest of the parameters did not register significant differences. It could be observed that the application of 4 tbsp of Vigotriz per 16 L water requires 9 days to produce pinheads and 4 days thereafter, the mushrooms were already harvestible. Besides, this treatment also gave the highest mean of 163 buttons and 154 harvested open mushroom with the harvested weight of 2.02 kg button and 2.19 kg open mushroom per treatment with the biggest diameter of 8.84 cm.

Effect of Different Rates of Urea-Refined Sugar Solution on the Growth and Yield Performance of Mushroom (*Volvariella volvaceae*)/*Elena De Vera, 1999*

The study made use of four treatments (T1 – control, T2 – 2 tbsp, T3 – 3 tbsp, T4- 4 tbsp) of urea refined sugar solution to evaluate its effect on the performance of mushroom and to determine the appropriate rate that would give the highest yield. These treatments were laid out following the Randomized Complete Block Design (RCBD) with three replications. Results of the study reveal that the different rates of urea refined sugar solutions did not affect significantly all the parameters gathered. However, it was found out that the application of 2 tbsp of urea refined sugar solution per gallon of water formed pinheads the earliest of 7.67 days or at the span of 7 days and 16 hours and the earliest to harvest 5 days from pinhead formation, produced the highest mean of 4.67 buttons and 27.67 open mushroom, bigger diameter (5.48 cm) weight of open mushroom (433.33 g) and total yield (650 g) per treatment.

Yield Response of Mushroom (*Volvariella volvaceae*) Applied with Different Levels of Urea Using Waterlily as Substrate/*Lyn Peralta, 2001*

The study was conducted with the use of four treatments (T1 – control, T2 – 2 tbsp, T3 – 3 tbsp, T4- 4 tbsp) of urea levels per gallon of water to determine their effects on mushroom production and the best level of urea suited for mushroom production. Based on the findings of the study, only the number of harvested open mushroom was significantly affected by the different levels of urea. The rest of the parameters gathered were not significantly affected. However, mushroom bed fertilized with 3 tbsp urea per gallon water had the highest yield of 4.20 kg per bed having more and heavier weights of harvested buttons and open mushroom.

Growth Performance of Mushroom (*Volvariella volvaceae*)/*Julio Barboza, 1999*

A study on the different rates of complete fertilizer (14-14-14) was conducted purposely to know the yield performance of mushroom and identify the best level of complete fertilizer suited for mushroom production. The research study made use of four treatments (T1 – control, T2 – 3 tbsp, T3 – 3 tbsp, T4 – 4 tbsp) 14-14-14 per gallon of water. These were conducted following the Complete Randomized Design (CRD) with three replications. Results of the study reveal insignificance of applying complete fertilizer on the parameters gathered except on the weight of harvested open mushroom and total yield per bed. However, despite of the insignificant differences, it was found out that the application of 2 tbsp 14-14-14 per gallon of water gave the highest yield with a mean of 750 g as shown by obtaining the biggest diameter (6.12 cm), heaviest weight of open mushroom (575 g).

Growth and Yield Performance of Mushroom (*Volvariella volvaceae*) with Different Rates of Urea/*Nelda Balanag, 1999*

The study was conducted with the use of four treatments (T1 – control, T2 – 2 tbsp, T3 – 3 tbsp, T4- 4 tbsp) of urea mixed with 12 liter of water to determine the effect of the different rates of urea on the growth and yield performance of mushroom. These were conducted following the Complete Randomized Design (CRD) with three replications. Results of the study reveal the significance of applying urea to mushroom bed in order to produce a considerable yield. From the findings of the research venture, only the weight of the harvested buttons did not register significant difference, all the rest were significantly affected. However, it was found out that the application of 3 tbsp of urea per 12 L water significantly produced pinheads earlier, with the period of 9 days and 8 hours from spawning, produced highest number and heaviest weight of harvested mushroom per treatment.

Performance of Mushroom (*Volvariella volvaceae*) Fertilized with Different Rates of Farmate/*Mary Jane Perez, 1999*

This research study made use of four treatment (T1 – control, T2 – 4 ml, T3 – 8 ml, T4-12 ml) of Farmate mixed with 16 L of water to determine the effect of the different rates of Farmate on the growth and yield performance of mushroom. The different treatments were laid out using Randomized Complete Block Design (RCBD). Results of the study reveal that the different rates of Farmate did not significantly affect parameters gathered. However, it was found out that application of 8 ml per 16 L of water produced the heaviest yield of 806.67 g per treatment as evidently shown by giving the highest mean number (27) and weight (753.33 g) of open mushroom with biggest diameter of 6.22 cm.

Molasses and Urea Additives on Mycelial Growth and basidiocarp Production of Mushroom (*Volvariella volvacea*)/*Della, C.G., Della, E.S. and Cahulao, RU.2006*

The study was conducted **to determine the effect of different concentrations** of molasses and urea on the mycelia growth and basidiocarp performance of *Volvariella volvacea*. Specifically, it aimed to determine the ccombination that combination that is superior in terms of mycelia ramification, the combinations that gave the best performance in terms of basidiocarp production and the cost effectiveness of the different combinations that were used in the study. The study employed the CRD with 10 treatments with 3 replications each for spawn production and RCBD with 3 replications for straw mushroom production.

Results of the study showed that Treatment 5 (30g molasses + 15g urea) obtained the highest length mycelia of 17.49 cm at 25 days after inoculation while Treatment 6 (30g molasses + 30g urea) obtained the lowest length of 5.14 cm at 25 days after inoculation. On the average weight of the harvested mushroom fruit, Treatment 7 (30g mol + 45g urea) registered the highest mean of 1.31 k while Treatment 6 (30g mol +30g urea) obtained the lowest mean weight of 0.52 k.

Conclusión

Based on the strategies and initiatives undertaken the generation of technology made more efficient and effective through the different package of interventions. The modality of the package of technologies was proven effective and is expected to be replicated by other SUCs and organizations/associations who are looking for a doable and low-cost technology for dissemination to their respective service areas that would generate income for their institutions and to their clienteles. Technologies on mushroom production are now available and will be continuously improved/enhanced to cater to the needs of the target clienteles, thus, providing them with an avenue to improve their living conditions which will serve as drivers in the economic development.

Recommendation

The following are recommended: 1) continuous conduct of technology generation; 2) update technologies as well as the IEC materials regularly to be at par with needs of the industry; 3) intensify the source-outing of funds to become more catalytic and will benefit the greater number of people belong to the marginalized sectors of the society,

REFERENCES

Barboza, Julio. 1999. Growth Performance of Mushroom (*Volvariella volvaceae*). PSU San Carlos City.

Balanag, Nelda 1999. Growth and Yeild Performance of Mushroom (*Volvariella volvaceae*) with Different Rates of Urea. PSU San Carlos City.

Creighton, Judy. 2010. Mushrooms found to contain powerful health benefits. The Canadian Press.

Della, C.G and Della, E.S, 2003. Ang Pagtatanim at Pagaani ng Kabuting Pamaypay (*Pleurotus*/Oyster/Abalone Mushroom) Technoguide. PSU-MRDC, Sta. Maria, Pangasinan.

Della, C.G and Della, E.S, 2010. Ang Pagtatanim at Pagaani ng Kabuting Dayami. Technoguide. PSU-MRDC, Sta. Maria, Pangasinan.

Della, C.G and Della, E.S, 2010. Ang Pagtatanim at Pagaani ng Kabuting Pamaypay (*Pleurotus*/Oyster/Abalone Mushroom) Technoguide. PSU-MRDC, Sta. Maria, Pangasinan.

Della, C.G and Della, E.S, 2006-3. Culture Media Preparation, Spawn Production and Cultivation. Technoguide. PSU-MRDC, Sta. Maria, Pangasinan.

Della, C.G., Della, E.S. and Patacsil, R. 2007. Agro-Industrial and Forest Wastes for Mycelial Growth, Chlamydospore Formation and Basidiocarp Production of Straw Mushroom (*Volvariella volvacea*). PSU-MRDC Sta. Maria, Pangasinan.

Della, C.G, Della, E.S. and Cahulao, R.U. 2005. "Molasses and Urea Additives on Mycelial Growth and Basidiocarp Production of Mushroom (*Volvariella volvacea*)." PSU-MRDC Sta. Maria, Pangasinan.

Della, C.G., Della, E.S. and Calderon, C.C. 2004. "Effect of Substrate Combinations on Mushroom (*Volvariella volvacea*) Chlamydospore Formation and Basidiocarp Production." PSU-MRDC, Sta. Maria, Pangasinan.

Della, C.G., Della, E.S. and Maramag A.B. 2005. "Processed Chicken Manure as Additive for the Growth and Basidiocarp Production of *Volvariella volvacea."* PSU MRDC Sta. Maria, Pangasinan.

Della, Elisa S., Della, C. and Divina. 2004. "Methods of Substrates Preparation and Different Levels of Molasses for *Volvariella volvacea* Spawn and Basidiocarp Production". PSU MRDC Sta. Maria, Pangasinan

Flores, Helen. 2008. Antibiotic-producing mushroom discovered. The Philippine Star. July 18, 2008.

Higaki, Miyato, et al. 2000. Mushroom Science and Technology in Central Luzon, Philippines for Food Security in the 21st Century. CLSU, Munoz, Nueva Ecija, Philippines.

Macaraeg, Marylene. 1999. "Effect of Vigotriz-M on the Growth and Yield Performance of Mushroom (*Volvariella volvaceae*)." PSU San Carlos City.

Peralta, Lyn. 2001. "Yield Response of Mushroom (*Volvariella volvaceae*) Applied with Different Levels of Urea Using Waterlily as Substrate". PSU San Carlos City.

Perez, Mary Jane. 1999."Performance of Mushroom (*Volvariella volvaceae*) Fertilized with Different Rates of Farmate." PSU San Carlos City.

Oei, Peter and Nieuwenhuijsen, Bram van. 2005. Small-Scale Mushroom Production. First Edition. Agromisa Foundation and CTA.

****