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Comparative Studies of the Effects of Natural and Artificial Buffered Wastes on *Pleurotus ostreatus* and *Ganoderma lucidum* Performances

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Abstract

Comparative studies of the effects of natural and artificial buffers on *Pleurotus* and *Ganoderma* performances grown on empty fruit bunch of oil palm (EFBOP) were carried out using standard microbiological methods. *Ganoderma lucidum and Pleurotusostreatus* were cultivated on both natural buffer (decay banana pseudostem extract T1) and artificial buffer (agricultural lime T2)). Biweekly observations were done for 42 days for complete colonization. It was observed that the ramification rates of *Pleurotusostreatus* grown on natural and artificial buffers when measured had the following data; natural buffer waste (T1) as11.5, 13.9, 15.6, 16.9, 17.8, and 19.7cm while the artificial buffered wastes (T2) had7.2, 9.9, 12.1, 14.8, 15.4 and 17.1cm. The fruiting bodies of *Pleurotus* grown on T1 and T2 were observed and weighed for 3 weeks. T1 yielded 184, 307, and 500kg on the 1st, 2nd, and 3rd flushes respectively while T2 showed 127, 170, and 230kg respectively on the 1st, 2nd, and 3rd flushes respectively. The ramification rates of *Ganoderma lucidum* grown on T1 and T2 of EFBOP had the following data 0, 0,4.3, 9.8, and 11.8 and 18.6 cm while T2 recorded 0, 0, 3.7, 8.5, 9.7 and 15.3 cm respectively. The fruiting bodies of *Ganoderma* yielded on T1 0, 0, and 5.0kg on the 2nd and 3rd flushes respectively while T2 showed the minimum fruiting body of *Ganoderma lucidum* 0,0 and 4.0kg on the 2nd and 3rd flushes respectively. The T1 with natural buffered wastes supplemented with decay banana pseudostem extract (DBPE) colonized faster regarding some days to complete mycelial growth and yielded more mushrooms than T2 of agricultural lime. *Ganoderma lucidum* had longer ramification and fruiting periods than period than *Pleurotus*. Data generated were analyzed by simple mean, standard deviation, and percentage. It is therefore recommended that natural buffers should be used for the cultivation of mushroom since it contains no artificial additives that could be harmful to health. Farmers are encouraged to use locally available substrates from agricultural by-products that are abundant and economically feasible.

Keywords: Comparative studies, Natural and artificial buffered, Wastes, *Pleurotus ostreatus*, *Ganoderma lucidum*

INTRODUCTION

Oyster mushroom (*Pleurotus* spp.) is commercially cultivated worldwide for its medicinal, nutritional properties and incredible taste (Tesfaw *et al.,* 2015). One of the most charming points of the cultivation of mushrooms is that they are grown on agricultural wastes procured at low prices or even for free and to conserve our environment by recycling wastes (Khan *et al.*, 2012).

Mushrooms are sources of easily absorbed proteins, carbohydrates, amino acids, B vitamins (thiamine, riboflavin, and niacin), vitamin D, and mineral salts (calcium, phosphorus, iron), characterized by low fat concentration (Jin *et al.*, 2018). The fruiting bodies of fungi of the *Pleurotus* genus are a rich source of micro and macro elements, such as copper, iron, zinc and sodium, potassium, magnesium, and phosphorus. Their amount depends to a large extent on the species, age, and size of the fungus, as well as the growing conditions. The mushroom pilei contain primarily potassium and phosphorus, whose content varies between 10-20 mg/100 g (Mbassi *et al.*, 2018). Straw mushrooms promote the production of body fluid rich in protein, fat, iron, zinc, various amino acids, and large amounts of Vitamin C (Singh *et al.*, 2020).

In addition, mushrooms are considered a healthy diet food due to their health benefits (Mowsurni and Chowdhury, 2013). The major medicinal properties of mushrooms have been documented (Mowsurni and Chowdhury, 2013). The medicinal properties attributed to mushrooms include antibiotic, anticancer, immune response stimulating effects, antiviral activities, and blood lipid-lowering effects (Alam *et al.*, 2007). Oyster mushroom has high medicinal value, and hence consumption can aid in ameliorating and preventing many ailments which include high blood, kidney problems, diabetes, cholesterol level, impaired immune response, hepatitis B, chronic, hypertension, heart disease, gastric cancers, fatigue syndrome and microbial infection (Mowsurni and Chowdhury, 2013).

Furthermore, mushrooms have medicinal benefits such as antioxidants that defend the body against free radicals. Mushroom extracts are inhibitory to sarcoma, and generally immunochemical from mushroom species shown anticancer (Mahendran *et al.*, 2012). Mushroom extracts also can protect DNA a lot of mushroom species possess highly potent immune enhancers against cancer for both humans and animals (Wani *et al.*, 2010).

Ganodermalucidum has been recognized as a medicinal mushroom for over 2000 years and its powerful effects have been documented in ancient scripts. Besides promoting longevity, it has unique properties of strengthening the immune system (Valverde *et al.*, 2015). It is a popular remedy to treat conditions like chronic hepatitis, hypertension, cancer, low blood pressure, high blood pressure, diabetes, rheumatism, heart problems, paralysis, ulcers, arthritis, asthma, tiredness, hepatitis A, B, and C, sterility, psoriasis, mumps, epilepsy, and alcoholism (Zang, 2009). It refreshes the body and mind, delays aging, and is also effective in reducing the blood glucose level of diabetic patients after two months of treatment. *G. lucidum* has been used in Traditional Chinese Medicine (TCM) as a remedy to treat more than 20 different illnesses which include migraine and headache, hypertension, arthritis, bronchitis, asthma, anorexia, gastritis hemorrhoids, hyper-cholesterolemia, nephritis, dysmenorrhoea, constipation, lupus erythematosus, hepatitis, leucopenia, cardiovascular problems and cancer (De Silva *et al.*, 2013). It also has a therapeutic effect on insulin resistance, reduces the risk of prostate cancer, and can help treat a variety of conditions associated with metabolic syndrome

Various important health products have been made from mushrooms, and some of these efforts are currently being translated into healthcare products. For example in Ghana, Accra Polytechnic, in collaboration with Aloha Medicinal USA, has developed a product called Immune Assist 24/7 from tropical *G. lucidum* and other mushroom species for enhancing the immunity of HIV/AIDS patients (Anchang, 2014).

Other biological properties of the mushrooms are antidiabetic, antioxidant, and antitumor (Meng *et al.*, 2016). Due to the benefits derived from mushroom production, many indigenous and commercial cultivation methods have been developed and put in place to domesticate mushrooms (Kortei *et al.*, 2018).

Mushroom cultivation has gained interest among entrepreneurs, farmers as well scientists around the world over the past few decades. Several studies reported various methods to make mushroom cultivation more profitable and popular while at the same time focusing on evaluating the source of nutrition for mushroom mycelium (Fasehah and Shah, 2017).

Alternatives for mushroom cultivation have been reported with varying success including empty fruit bunch of oil palm, wheat straw, cottonseed straw, cereal straw, corncob, sugar cane straw, and sawdust. (Masevhe *et al.*, 2016). According to Nithyatharani *et al.* (2018), a substrate is any material containing lignin, hemicellulose, and cellulose and where the mycelium can grow until it forms a fruiting body (mushroom). Suitable substrates for mushroom cultivation are important because substrates can influence nutritional content, yield, quality, efficiency, and economic costs as well influence cultivation time (Masevhe *et al.*, 2016).

Mushroom multiplication and survival are related to several factors such as chemical composition, the ratio of carbon (C) to nitrogen (N), sources of nitrogen, surfactant, minerals, pH, water activity, moisture, particle size, and amount of inoculum, antimicrobial agents, and the existence of interactions between microorganisms are considered as chemical, physical, and biological aspects that are linked to mushroom production (Bellettini *et al.*, 2019). The key environmental variables encompass luminosity, humidity, temperature, and air composition of the surrounding substrate, such as the concentration of carbon dioxide and oxygen, which affect the yield and quality of oyster mushrooms. (Mutema *et al.*, 2019).

The different artificial buffer agents used in mushroom cultivation are BisTris-HCL, BisTris-Citric acid, calcium carbonate, and MES-KOH. Nagahashi *et al.* (2006) reported some effects on hyphae growth and branching caused by different buffering systems. Child *et al.* (2013) tested MES and EMTA on 16 different fungal strains finding significant differences in the response to the buffering agent among the strains). Natural buffering agents often used are extracts of banana or plantain pseudo stem and biochar of plants and animals which have shown incredible success in mushroom farming.

Aim and Objectives of the Study

This research work aimed at comparative studies of the effects of natural and artificial buffers on *Pleurotus* and *Ganoderma* performances and the objectives are:

(i) To cultivate *Pleurotus ostreatus* on empty fruit bunch of oil palm with natural buffer (decay pseudostem of banana) and artificial buffer (agricultural lime).

(ii) To cultivate *Pleurotus* ostreatus on an empty fruit bunch of oil palm with an artificial buffer (agricultural lime).

(iii) To cultivate *Ganoderma* on empty fruit bunch of oil palm with natural buffer (decay pseudostem of banana)

(iv) To cultivate *Ganoderma* on empty fruit bunch of oil palm with artificial buffer

(v) (agricultural lime).

(vi) To compare the effects of natural and artificial buffers on *Pleurotus* and *Ganoderma* growth.

(vii) To make recommendations based on the results obtained.

MATERIALS AND METHODS

Materials

Pleurotus and *Ganoderma* cultivation required the following: spawn, potato dextrose agar, weighing balance, spawn polythene bag, rubber band, cotton wool, methylated spirit, guinea corn, pieces of foam, ½ inch pipes, bunsen burner, forceps, razor, extract of banana pseudostem, agricultural lime dissecting pins carried out at the National Cereal Research Institute at OwotUta, IbesikpoAsutan Local Government Area. The *Pleurotus* and *Ganoderma* were grown on empty fruit bunch of oil palm (an agricultural waste).

Mushrooms cultivation on Substrate/ Preparation

Collection and composting of substrate

Empty fruit bunch of oil palm (EFBOP) was obtained from a local oil palm processor and was packed to the research location. The EFBOP was macerated and ground using a fabricated grinder. It was then heaped and allowed to decay for one (1) month with the biweekly turning of the heap for aeration.

Bagging

A kilogram of the substrate was weighed into the mushroom heat-resistant polythene EFBOP to water ratio of 1kg: 10 ml. Using the ½ inch pipe, the polythene was closed and tight with rubber bands and stocked with pieces of foam.

Sterilization

The EFBOP stocked bags were packed into the autoclave and sterilized for 1 hour. It was then removed and allowed to cool for 24 hours.

Inoculation

The sterilized cooled substrate bags were inoculated with about 20g of spawn, tight, and stocked back aseptically for mycelial formation.

Incubation

The already inoculated bags were transported to a dark cool room with a regulated temperature of less than 250C maintained throughout incubation. This takes about 4 weeks to complete mycelial formation. During the period of incubation, bags are checked for contamination, and subsequent removal was done if contaminated.

Fruiting

The appearance of white pin heads signifies readiness for the fruition of *Pleurotus* and *Ganoderma*. The bags are perforated to allow the sprouting of the matured mushroom. Daily watering of the bags was necessary to enhance the growth of mushrooms and maintain the moisture content of the baglogs checking of peat is done at this stage.

Harvesting

Harvesting of mushrooms was done manually by handpicking. Harvesting of mushrooms could last 2-3 months if maintained.

RESULTS AND DISCUSSION

Results

Comparative studies on the effects of natural and artificial buffers on *Pleurotus* and *Ganoderma* performances was carried out observing all microbiological standards. Data generated from the cultivation of *Pleurotus* and *Ganoderma* were studied and the following deductions were made. The results are presented in the Tables below;

Colonization rates of *Pleurotusostreatus* grown on natural and artificial buffered EFBOP

Comparative studies on the effects of natural and artificial buffers on *Pleurotus* and *Ganoderma* performances was carried out observing all microbiological standards. Data generated from the cultivation of *Pleurotus* and *Ganoderma* were studied and the following deductions were made. The results are presented in the Tables below;

Table 1: shows the colonization rates of *Pleurotusostreatus* grown on natural and artificial buffered EFBOP. The data revealed that natural buffered waste colonized faster than artificial buffered waste.

Table 1: Colonization rate of *Pleurotus* cultivated on natural and artificial buffered wastes of empty fruit bunch of oil palm (EFBOP)

	7	14	21	28	35	42
VTreatments(Days)						

T1 + PE(cm)	11.5	13.9	15.6	16.9	17.8	19.1
T2 + Al (cm)	7.2	9.9	12.1	14.8	15.4	17.1

T1 = 1kg EFBOP + spawn of *Pleurotus* + 100ml of DBPE
T2 = 1kg EFBOP + spawn of *Pleurotus* + 2% agric lime (Al)

Comparison of fruiting bodies of *Pleurotus* grown on natural and artificial buffered wastes of EFBOP

Table 2 shows the comparison of fruiting bodies of *Pleurotus* grown on natural and artificial buffered wastes of EFBOP. It was observed that *Pleurotus* grown on artificial buffered waste was better than the natural buffered waste.

Table 2: Comparison of fruiting bodies of *Pleurotus* grown on natural and artificial buffered wastes of empty fruit bunch of oil palm (EFBOP)

Treatments(weeks)	1st Flush	2nd Flush	3rd Flush	Total
T1 + PE (kg)	184	307	500	991
T2 + Al (kg)	127	170	230	527

T1 = 1kg EFBOP + spawn of *Pleurotus* + 100ml of DBPE
T2 = 1kg EFBOP + spawn of *Pleurotus* + 2% agric lime (Al)

Colonization rate of *Ganoderma* on natural and artificial buffered wastes of EFBOP

Table 3 shows the colonization rate of *Ganoderma* on natural and artificial buffered wastes of EFBOP. It was observed that *Ganoderma* grew better in artificial buffered wastes than the natural buffered wastes of EFBOP.

Table 3: Colonization rate of *Ganoderma* grown on natural and artificial buffers on empty fruit bunch of oil palm (EFBOP) (cm)

Treatments(Days)	0	7	14	28	35	42
T1 + PE (cm)	0	0	4.3	9.8	11.8	18.6

T2 + Al (cm)	0	0	3.7	8.5	9.7	15.3

T1 = 1kg EFBOP + spawn of *Ganoderma* + 100ml of DBPE

T2 = 1kg EFBOP + spawn of *Ganoderma* + 2% of agric lime

Comparison of fruiting bodies of *Ganoderma* grown from natural and artificial buffered wastes of EFBOP

Table 4 shows the comparison of fruiting bodies of *Ganoderma* grown from natural and artificial buffered wastes of EFBOP. It was observed that *Ganoderma* had a slow growth rate and production rates.

Table 4: Comparison of fruiting body of *Ganoderma* grown on natural and artificial buffered wastes of EFBOP

Treatments(week)	1st flush	2nd flush	3rd flush	Total
T1 + PE(kg)	0	3.0	5.0	8.0
T2 + Al (kg)	0	1.0	2.0	3.0

T1 = EFBOP + spawn of *Ganoderma* + 100ml of DBPE

T2 = EFBOP + spawn of *Ganoderma* + 2% agric lime

Recommendations

Based on the findings, the researcher wishes to recommend that;

Parents and other persons should prevent children from been labored as such do influence students academic performance in Biology .

Conclusion

Based on the findings, it was concluded that agricultural, hawking and domestic Comparative studies of the effects of natural and artificial buffers on *Pleurotus* and *Ganoderma* performances.

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