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RESEARCH ARTICLE

PILOT STUDY ON MICROBIAL PERFORMANCE AND ECONOMIC VIABILITY OF AGRO-WASTE-BASED SUBSTRATES FOR LOW-COST PRODUCTION OF *TRICHODERMA SPP.* AS COMPOST FUNGUS ACTIVATOR

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ABSTRACT

Trichoderma spp. is extensively utilized in sustainable agriculture due to their abilities to suppress pathogens, stimulate plant growth, and accelerate organic matter decomposition. However, commercial mass production often depends on costly media such as oatmeal agar, limiting broader adoption. Meanwhile, agro-industrial by-products like rice hull, coconut coir, and sawdust are abundant yet underutilized in many tropical regions. To evaluate the microbial performance of *Trichoderma spp.* grown on locally available agro-waste substrates as alternatives to oatmeal agar, and to determine the economic feasibility of producing compost fungus activators (CFAs) using these low-cost materials. Conducted at DA-RFO 02 Ilagan Soil Laboratory, three sterilized agro-waste substrates—rice hull, coconut coir, and sawdust—were tested for their capacity to support *Trichoderma spp.* colonization. Each substrate was inoculated and incubated under laboratory conditions for seven days. Fungal growth was documented visually and a comparative cost analysis performed. Rice hull demonstrated the most extensive colonization, coconut coir showed rapid but patchy sporulation, while sawdust exhibited sparse growth. Switching to agro-waste reduced production costs by over 99%, lowering expenses from ₱5,625 to ₱15 for 1,500 CFA packets. Rice hull and coconut coir are effective, highly economical substrates for mass-producing *Trichoderma spp.* intended for CFA use, supporting circular agriculture and low-cost bioinput systems.

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INTRODUCTION

The intensive use of chemical fertilizers and pesticides in agriculture has led to significant environmental and health issues, including soil degradation, biodiversity loss, water pollution, and ecosystem disruption[1,2,3]. While these practices have increased food production, they have also resulted in negative outcomes such as greenhouse gas emissions, erosion, and persistent hunger alongside rising obesity rates[3]. The transition towards more sustainable farming systems is crucial but challenging, requiring a balance between agronomic, economic, and ecological constraints[4].Agroecological approaches that reduce external inputs, preserve soil fertility, and enhance biodiversity are proposed as alternatives to industrial agriculture[1,3]. However, the shift towards sustainable practices may be costly for farmers, necessitating collaborative efforts between stakeholders and potential policy interventions to support this transition[2,4]. *Trichoderma* species are versatile biocontrol agents and plant growth promoters that offer sustainable alternatives to chemical inputs in agriculture[5,6].They employ multiple mechanisms to suppress plant pathogens, including mycoparasitism, competition, antibiosis, and induced systemic resistance[6]. *Trichoderma* strains enhance plant growth by solubilizing nutrients, producing phytohormones, and improving nutrient uptake[5,7]. These fungi colonize root systems, affecting plant metabolic activities and enhancing defense mechanisms against biotic and abiotic stresses[7]. *Trichoderma* species produce various metabolites and enzymes that exhibit antipathogenic properties and promote soil health[7]. Their ecological flexibility and multifaceted benefits make *Trichoderma* an essential component in sustainable agriculture, addressing environmental concerns and food production challenges[5,6]. The valorization of agro-industrial wastes through fungal bioconversion presents a circular economy solution with multiple benefits. Macrofungi can transform lignocellulosic residues into valuable compounds for various applications, including functional foods and pharmaceuticals[8]. This approach aligns with Sustainable Development Goals, promoting environmental sustainability and diversifying labor supply[9]. Agricultural residues like coffee husks serve as excellent substrates for producing fungal biocontrol agents, offering an eco-friendly alternative to chemical pesticides[10]. Furthermore, the bioconversion of agri-residues by fungal cultures can yield biocatalysts like lipase, which has numerous industrial applications[11]. Despite these advantages, challenges remain, including ensuring continuous substrate supply and overcoming cultural barriers in non-fungiphilic societies[9]. Nonetheless, this circular approach holds promise for sustainable waste management, economic growth, and environmental protection. This study explored the feasibility of using rice hull, coconut coir, and sawdust as alternative media for propagating *Trichoderma spp.* specifically assessing their ability to support fungal growth and their comparative costs against oatmeal agar. This work sought to generate actionable data to guide LGUs, farmer cooperatives, and small-scale laboratories in adopting more sustainable, affordable CFA production systems.

MATERIALS AND METHODS

Study location: The research was performed at the DA-RFO 02 Ilagan Soil Laboratory in Isabela, Philippines—a facility actively engaged in developing and innovating local biofertilizer products. This regional context provided immediate access to fresh agro-waste materials critical for the study.

Substrate collection and preparation: Rice hull was sourced from nearby rice mills, coconut coir from local coconut vendors, and sawdust from local carpentry shops. Each was air-dried for 48 hours to reduce moisture content, then sieved to obtain relatively uniform particle sizes. Thirty grams of each substrate were placed into autoclavable containers, moistened with 20 mL distilled water adjusted to pH ~5 using dilute sulfuric acid, and sterilized at 121°C and 15 psi for 1 hour to eliminate background contaminants.

Fungal inoculum preparation and inoculation: Pure cultures of *Trichoderma spp*. were maintained on PDA. Fresh, actively growing 5 mm mycelial plugs were aseptically transferred into the center of each sterilized substrate sample to ensure uniform starting points for colonization. Containers were loosely capped to allow gas exchange and incubated at 20–22°C.

Assessment of fungal growth: Substrates were visually examined daily for signs of mycelial expansion and sporulation. By day 7, observations focused on extent of white hyphal spread and development of green conidial masses, documented through consistent photographic records.

Economic analysis: A cost comparison was conducted for producing 1,500 CFA packets (30 g each), contrasting expenses between traditional oatmeal agar and agro-waste substrates. Local market rates for oatmeal (₱625/kg) and agar (₱1,000/kg) were used, while agro-waste was priced nominally at ₱2/kg.

RESULTS

Fungal growth on agro-waste substrates

Rice hull supported vigorous mycelial growth[12], with uniform coverage and dense green sporulating clusters by day 7. Coconut coir facilitated rapid initial colonization, though with somewhat patchy sporulation patterns, suggesting localized moisture or chemical variability[12]. Sawdust yielded scattered, small green colonies interspersed with large uncolonized regions, indicating less favorable conditions for fungal proliferation[13].

Comparative production costs: The cost analysis revealed a stark contrast: using oatmeal agar incurred a raw material expense of ₱5,625 for 1,500 CFA packets, whereas substituting agro-waste substrates reduced this to just ₱15—representing direct savings exceeding 99%.

Raw Material Analysis of 1,500 Packets of CFA 30g per Packet

Parameters (₱)	Oatmeal-Agar	Agro-Waste
Oatmeal (kg)	5.00	
Agar (kg)	2.50	
Agro-Waste (kg)	0.00	7.50
Total Cost of Oatmeal (₱)	3,125.00	
Total Cost of Agar (₱)	2,500.00	
Total Cost of Agro-Waste (₱)		15.00
Total Cost of Raw Material (₱)	5,625.00	15.00
Savings in Compare to Oatmeal-Agar	-	5,610.00

DISCUSSION

Research indicates that rice hull and coconut coir are effective substrates for cultivating *Trichoderma spp*. supporting findings of their favorable porosity and nutrient content[14,15]. Coconut coir, in particular, has been shown to promote sporulation significantly, outperforming other substrates like sawdust, which may require pre-conditioning due to lignin constraints[15,16]. The uneven growth observed on coconut coir suggests potential inhibitory factors, such as phenolics or moisture gradients, that could affect sporulation uniformity[15]. Additionally, another the study highlights that various organic substrates, including rice husk, can enhance the biomass production and efficacy of *Trichoderma spp*. indicating the importance of substrate selection in biocontrol applications[17]. Overall, these findings underscore the need for careful substrate evaluation to optimize fungal proliferation and biocontrol effectiveness. Economically, the dramatic cost reduction underscores the transformative potential of integrating agro-waste valorization into decentralized CFA production systems. By empowering LGUs and farmer cooperatives to adopt low-cost, locally sourced substrates, this approach directly addresses affordability barriers while simultaneously diverting agricultural residues from waste streams into productive use—key pillars of climate-smart and circular agriculture.

CONCLUSION

Rice hull and coconut coir are effective, highly economical substrates for mass-producing *Trichoderma spp*. as CFA. Their use not only slashes production costs by over 99% compared to oatmeal agar, but also contributes to sustainable waste management and climate-resilient farming systems. Future research should explore optimized blends, moisture and pH adjustments, and multi-cycle reuse to further enhance their practical deployment in community-scale biofertilizer initiatives.

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Glossary of Abbreviations

CFA – Compost Fungus Activator
DA – Department of Agriculture
ILD – Integrated Laboratory Division
LGU – Local Government Unit
PDA – Potato Dextrose Agar
RFO – Regional Field Office

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