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Influence of Microorganisms in the conversion of Cocoa shell and Jack fruit peel waste as Biocompost

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Abstract

Different microorganism plays an important role in the bioconversion of agro-industrial waste. Biocompostedagroindustrial waste contains more micro and macronutrients than other wastes producing healthy food crops and livestock without damaging the environment. Cocoa shell and Jack fruit peel waste was generally considered as agro-industrial waste have almost no economic value. Improper disposal of this waste also creates problems to the environment. These wastes do not degrade quickly due to large amounts of chemical constituents like lignin, cellulose, hemicellulose, pectin and calcium. The present study was aimed to analyse the changes in microbial population at regular intervals of biocomposting units 0-30, 30-60 and 60-90 days. The eight kinds of biocomposting units were prepared by combining different microorganisms like *Pleurotus eous, Pleurotus florida* and earthworm species *Eudrilus eugeniae.* The biocomposting units are named as C_1, C_2, C_3, C_4, C_5, C_6, C_7 and C_8. This investigation concluded that combined application of microorganism treated biocomposting units C_8 -Raw jackfruit peel + 10 g *Pleurotus eous* + 10 g *Pleurotus florida* + *Eudrilus eugeniae* & C_4- Raw cocoa shell+ 10 g *Pleurotus eous* + 10 g *Pleurotus florida*+ *Eudrilus eugeniae* is microbiologically more active than other composting units.

Composting of organic waste is a natural process that stems through microbial succession, degradation and stabilization of organic matter present in waste. The use of microbial additives during composting is considered highly efficient and likely to enhance the production of different enzymes resulting in better rate of waste degradation. In lesser developed countries, composting has emerged as a vital technology for recycling biodegradable waste while generating a useful product[4]. Microbes carry out the decomposition

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of organic waste by utilizing carbon and nitrogen as the energy sources along with oxygen and water, ensuring the production of water, carbon dioxide, heat, and soil-enriching compost. The derived compost possesses a significant concentration of biologically stable humic substances, acting as excellent soil amendment[1]. A spontaneous rise in temperature helps eliminate the pathogens and makes the compost safer during the process. The lignocellulolytic microorganisms are easier to manage and recycle the lignocellulosic waste with high economic efficiency. Microorganisms enhance the rate of lignocellulose degradation due to their synergistic activity through intermediate degradation products. During composting, the mesophilic population builds up initially by the utilization of simple nutrients, which raises the temperature of the piles and thermophilic microbes to proliferate in the second phase[9].

Improper disposal of cocoa shell and jack fruit peel waste in open dumps, inactive landfill or active landfills will increase the risk of health in humans, damage ecosystems, and accelerate the destruction of the environment. This work aims to determine the changes by assessing microbial colony-forming units of bacteria,fungi and actinomycetes in cocoa shell and jack fruit peel waste during biocomposting. Soil microorganisms can be classified as bacteria, actinomycetes, fungi, algae, protozoa and viruses. Each of these groups has different characteristics that define the organisms and different functions in the soil. These organisms do not exist in isolation and influence soil fertility as much or more than the organism's activities. Bacteria are organisms that have only one cell and are microscopic. There are 100 million to one billion bacteria in just a teaspoon of moist, fertile soil. They are decomposers eating dead plant material and organic waste. The bacteria release nutrients that other organisms could not access and the process is essential in the nitrogen cycle. Actinomycetes are soil microorganisms like bacteria and fungi, and have characteristics linking them to both groups. They are often believed to be the missing evolutionary link between bacteria and fungi, but they have many more characteristics in common with bacteria than they do fungi. Actinomycetes give soil its characteristic smell. They are helpful but could also be harmful, to soil organisms. Fungi are helpful because they have the ability to break down nutrients that other organisms cannot[2]. These beneficial microbes can help the easy composting of cocoa shell & jack fruit peel. This waste decomposes very slowly due to the presence of high amount of lignin, cellulose, hemicellulose, pectin and calcium like components which do not degrade quickly but can be decomposed by *Pleurotus eous, Pleurotus florida* and *Eudrilus eugeniae* is generally considered to be an safe and effective method. *Pleurotus eous* and *Pleurotus florida* are essential as it recycles starch through lignin degradation. *Eudrilus eugeniae* (earthworm) breaks down the organic waste and decompose large quantities of organic materials into usable vermicompost.Vermicomposts are rich in microbial populations and diversity, particularly fungi, bacteria and actinomycetes. The presence of a high level of biologically active soil microorganisms is vermicompost's main characteristics, which makes it effective fertilizer[11]. At the end of this bioconversion period cocoa shell and jack fruit peel waste is changed into a well decomposed black mass.

This biocompost offers several benefits such as enhanced soil fertility and soil health, leading to increased agricultural productivity, improved soil biodiversity, reduced ecological risks, and a healthier environment.

Collection of Agro-industrial wastes :

The agro-industrial wastes of cocoa shell and jack fruit peel waste were collected from Calicut and Wayanad district of Kerala. The collected wastes were smashed into small pieces. It was sun-dried and stored in gunny bags.

Collection of Microorganisms :

Pleurotu seous, Pleurotus florida were collected from Tamil Nadu Agricultural University, Coimbatore. The earthworm species of *Eudrilus eugeniae* were obtained from KisanVigyan Kendra, Coimbatore.

Preparation of biocomposting units :

The process of biocomposting consists of eight pits (1.6 ft. dimension and 5 sq.ft area). They were named as biocompost 1 (C_1), biocompost 2 (C_2), biocompost 3 (C_3), biocompost 4 (C_4), biocompost 5 (C_5) and biocompost 6 (C_6), biocompost 7 (C_7) and biocompost 8 (C_8). The sundried cocoa shell waste was transferred to C_1 pit. This process was repeated till the heap reaches a height above 1.5 meter and after 30 days vermicomposting *(Eudrilus eugeniae)* method is adopted. C_2 pit was filled with cocoa shell waste and added 20 g of *Pleurotus eous*. It was allowed for decomposition for 30 days. Vermicomposting (*Eudrilus eugeniae)* process adopted. C_3 pit was filled by cocoa shell. It was predigested using 20 g of *Pleurotus florida* spawn and then *Eudrilus eugeniae* process was adopted. C_4 pit was filled with cocoa shell & added 10 g of *Pleurotus eous* + 10 g of *Pleurotus florida* spawn. After 30 days transferred into the vermicomposting tray. The above same procedure was repeated in jack fruit peel biocomposting units (C_5, C_6, C_7 & C_8).

Table-1. Biocomposting treatments

Biocomposting units	Combinations
C	Absolute control
C_1	Raw cocoa shell + *Eudrilus eugeniae*5 t/ha^{-1}
C_2	Raw cocoa shell + 20 g *Pleurotus eous* + *Eudrilus eugeniae*5 t/ha^{-1}
C_3	Raw cocoa shell+ 20 g *Pleurotus florida* + *Eudrilus eugeniae*5 t/ha^{-1}
C_4	Raw cocoa shell+ 10 g *Pleurotus eous* + 10 g *Pleurotus florida* +*Eudrilus eugeniae*5 t/ha^{-1}
C_5	Raw jackfruit peel+ *Eudrilus eugeniae* 5 t/ha^{-1}
C_6	Raw jackfruit peel+ 20 g *Pleurotus eous* + *Eudrilus eugeniae*5 t/ha^{-1}
C_7	Raw jackfruit peel + 20 g *Pleurotus florida*+ *Eudrilus eugeniae*5 t/ha^{-1}
C_8	Raw jackfruit peel+10 g *Pleurotus eous* + 10 g *Pleurotus florida*+ *Eudrilus eugeniae* 5 t/ha^{-1}

Tray preparation with Eudrilus eugeniae :

After pre-decomposition, pre-digested cocoa shell and jack fruit peel was transferred to the eight plastic trays (40×20×20). Added around fifteen exotic earthworms (*Eudrilus eugeniae)* into above mentioned each biocomposting units. Water was sprinkled at regular intervals to maintain the moisture content of each tray. These experimental trays were kept in the room temperature undisturbed for 60 days. On the 90th day of composting, the samples were taken and sieved.

Enumeration of Bacteria, Fungi and Actinomycetes :

One g of each sample was taken in sterile conical flasks containing 9 ml of distilled water, shaken for 30 min in vortox mixer and used as stock from which various dilutions were prepared ranging from 10^1 to 10^7 with sterile distilled water. 1 ml each of the dilutions of bacteria (10^7), fungi (10^4) and actinomycetes (10^5) from each sample was transferred to sterile Petri plates containing nutrient agar medium (Bacteria), rose bengal agar medium (Fungi) and Ken-Knights agar medium (Actinomycetes) incubated for one day, three days and seven days respectively. Microbial colonies were counted during the decomposition of cocoa shell and jack fruit peel agro-industrial waste at regular interval of 0-30, 30-60 and 60-90 days. Viable colony count was done with the help of colony counter.

Statistical Analysis :

The experimental data obtained on 0-30, 30-60 and 60-90 days were analyzed statistically using two way anova and inference was drawn based on results.

The experimental result of microbial population changes during biocomposting units of cocoa shell and jack fruit peel waste was recorded periodically and presented in tables.

a) Bacterial population :

The total changes in bacterial population was observed on the 30, 60 and 90 days.On the 0-30th day, total bacterial count was increased in C_8 (4.84×10 x10^7 cfu/g) followed by C_4 (3.83×10^7) compared to control (1.12×10^7 cfu/g). On the 30-60th day, remarkable bacterial count was obtained in C_8 (6.33×10^7 cfu/g), followed by C_4(5.76×10^7 cfu/g) compared to control (1.41×10^7 cfu/g). During 60-90th day experiment, bacterial population was slightly decreased. Maximum bacterial population was observed in C_8(4.77×10^7 cfu/g) followed by C_4 (2.95×10^7 cfu/g) over control (1.10×10^7 cfu/g) as shown in table 2(a).

b) Fungal population :

On the 30th day, the total fungal count was significantly increased in C_8 (0.92×10^4 cfu/g), followed by C_4 (0.79×10^4) compared to control (0.21×10^4 cfu/g). On the 60th day a remarkable increase was noted in C_8 (1.38×10^4) and C_4 (1.12×10^4) over the control (0.31×10^4 cfu/g). The fungal population on 90th day experiment, was slightly decreased in C_8 (0.78×10^4 cfu/g) and C_4 (0.66×10^4 cfu/g) over the control (0.18×10^4 cfu/g) as shown in table 3(b).

c) Actinomycetes population :

On the 0-30th day the actinomycetes

population was observed maximum on the C_8 (0.50 $\times 10^5$ cfu/g) followed by C_4 (0.45 $\times 10^5$ cfu/g) compared to control (0.14 $\times 10^5$cfu/g). On the 30-60th day remarkable actinomycetes was obtained in C_8 (0.61 $\times 10^5$ cfu/g), followed by C_4 (0.57 $\times$ 10^5 cfu/g) compared to control (0.18 $\times 10^5$ cfu/g). During 90th day actinomycetes population was slightly decreased. Maximum actinomycetes population was observed in C_8 (0.42 $\times$105 cfu/g) followed by C_4 (0.38 $\times 10^5$ cfu/g) over control (0.13 $\times 10^5$cfu/g) as shown in table 4(c).

The bacteria, fungi and actinomycetes count was significantly increased from 0-30 to 30-60 days and decreased from 60-90 days. The C_8 and C_4 biocompost have more micronutrients than other biocomposting units and control. The present finding coincides with the result on 30, 60 and 90 days in the composting periods of coir pith and corncob. They found maximum bacterial & fungal count in C_6 (94.01×10^6, 8.02×10^6 & 7.09×10^6) and C_3 (3.78×10^6, 84×10^6 & 6.90×10^6) [6]. The composting of rural and urban wastes shows high bacterial count in 60th days (54.0×10^7 cfu/g & 66.0×10^7 cfu/g), fungal count in 90th days (51.3×10^4 cfu/g & 53.3×10^4 cfu/g) and actinomycetes population was found in 120 days (53.3×10^5 cfu/g & 64.6×10^5 cfu/g)[7]. The combined application of vermicomposting of coir pith + cow dung + panchagavya (5%) increased actinomycetes count (10.96×10^5 cfu/g), highest bacteria (28×10^7 cfu/g) and fungi population (12×10^4 cfu/g) were recorded in T_8 - Coir pith (1 kg)+*Pseudomonas* sp. (5 ml) + panchagavya (5%) [8].

Table-2 (a): Bacterial population during biocomposting of Cocoa shell and Jack fruit peel waste

Biocomposting Units	Bacterial population		
	30 Days	60 Days	90 Days
C	1.12	1.41	1.10
C_1	1.50	1.95	1.26
C_2	1.91	2.72	1.42
C_3	2.22	2.38	1.16
C_4	3.83	5.76	2.95
C_5	2.49	2.88	1.75
C_6	2.67	2.96	1.56
C_7	2.75	3.12	2.27
C_8	4.84	6.33	4.77
SEd		0.00829	
CD(0.05)		0.01661	
CD(0.01)		0.02214	

** Significant at 1% (P<0.01)

Table-3 (b): Fungal population during biocomposting of Cocoa shell and Jack fruit peel waste

Biocomposting Units	Fungal population		
	30 Days	60 Days	90 Days
C	0.21	0.31	0.18
C_1	0.29	0.42	0.25
C_2	0.41	0.49	0.36
C_3	0.46	0.54	0.42
C_4	0.79	1.12	0.66
C_5	0.56	0.66	0.49
C_6	0.62	0.68	0.53
C_7	0.69	0.91	0.56
C_8	0.92	1.38	0.78
SEd	0.00899		
CD(0.05)	0.01803		
CD(0.01)	0.02402		

** Significant at 1% (P<0.01)

Table-4(c) :Actinomycetes population during biocomposting of Cocoa shell and Jack fruit peel waste

Biocomposting Units	Actinomycetespopulation		
	30 Days	60 Days	90 Days
C	0.14	0.18	0.13
C_1	0.22	0.29	0.18
C_2	0.32	0.34	0.23
C_3	0.35	0.40	0.29
C_4	0.45	0.57	0.38
C_5	0.37	0.42	0.31
C_6	0.34	0.46	0.32
C_7	0.39	0.53	0.34
C_8	0.50	0.61	0.42
SEd	0.00794		
CD(0.05)	0.01591		
CD(0.01)	0.02121		

** Significant at 1% (P<0.01)

The predominant microorganisms in banana leaf and lawn clipping composts were bacteria with respective populations of 4.5×10^8 and 1.3×10^8 CFU g dw^{-1}. Fungal populations were less than the square root of the corresponding bacterial populations, with values of 5.2×10^3 CFU g dw^{-1} in BLC and 4.6×10^3 CFU g dw^{-1} in LCC [5]. The combinations of fresh and dry cocoa pod husk composting-showed microbial load of bacteria varied between $7x10^6$ cfu and $12x10^6$ cfu and $2x10^3$ cfu and $5x10^3$ cfu for fungi isolates. The associated isolates were highest (20 isolates) at 2 weeks of composting and the population decrease with maturity of the compost[6]. The mixed organic garbage with vermicompost has a bacterial count 634 $X10^5$, fungi count 73 $X10^3$ and count of actinomycetes is 699 $x10^4$ respectively[11]. Composting municipal solid waste in the rainy season was reported that the maximum bacterial population was 7.2×10^9 CFU[8].

The present research investigates the influence of microorganisms in the conversion of cocoa shell and jack fruit peel waste as biocompost. The results concluded that biocompost 8 (C_8-Raw jackfruit peel+10 g *Pleurotus eous* + 10 g *Pleurotus florida* +*Eudrilus eugeniae* 5 t/ha-1) & biocompost 4 (C_4-Raw cocoa shell+ 10 g *Pleurotus eous* +10 g *Pleurotus florida* +*Eudrilus eugeniae* 5 t/ha-1) is microbiologically more active than the other biocomposting units and control. The microorganisms used for composting of waste material is more advanced, efficient, eco-friendly and low cost technology for fast degradation and timely composting. The processing of cocoa shell and jack fruit peel waste compost can be used as organic manure for better plant growth and yield activity.

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