Calocybe indica is an ideal candidate for the management of Municipal solid waste

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Abstract - **Municipal solid waste management (MSWM) is one of the most problematic and neglected aspect of world cities. Solid waste management through proper waste collection, segregation, transportation, treatment , disposal. The extensive use of different trees and plant materials in various functions results in a large organic content in the MSW. Fungi has gained wide acceptance as a key component of integrated solid waste management. It has been promoted as an eco-friendly and sustainable solution to urban waste management. Any agricultural waste which is in lignocellulosic nature can be fermented which lignocelluotic fungi. Therefore, it is time to concentrate more on development and innovate technological or identify technologies or solid state fermentation methods which are suitable for MSW management, is the need of the hour an attempt was also made to study the possibility of using Calocybe indica to ferment MSWOM along with paddy straw. We have used six substrate namely C1, C2, T1, T2,T3, and T4 respectively. Which were MSW harvested on 32nd day. In total, the fungal fruit body has yielded 20.2% of biological efficiency.**

keywords - **Municipal solid waste management, solid state fermentation, biological efficiency,**

I INTRODUCTION

Solid waste has emerged as one of the most serious problem being faced by urban countries all over the world. Due to population growth, industrialization, urbanization and economic growth, a trend of significant increase in municipal solid waste (MSW) generation has been recorded worldwide. India, being world second highest populated country and one of the fastest urbanizing countries is facing the problem of solid waste management. Solid waste generated in India is 1,27 486 TPD or 47 million tons per year 2012 status (CPCB) and is expected to increase to 300 million tons per year by 2047 [1]. The estimated land requirement for disposal of such huge quantum of waste would be km^2. Out of the total waste generated in the country 89,334 tones (70%) is collected 15,881 tones (12.50%) is being treated while 22,271 tones (17.5%) is not being collected (CPCB) . A successful solid waste management system utilize many functional elements associated with generation on site storage, collection, transfer, transport, characterization, and processing, resource recovery and final disposal [2]. MSW contains compostable organic matter (Fruit and vegetable peels, food waste) recyclable paper, plastic, glass, metals and etc., [3]. MSW composition at generation source and collection points determined on a wet weight basis, consists mainly of a large organic fraction (40- 60%) and fine inert material (30 - 40%) [4]. South India extensive use of banana leaves and stem in various in a large organic content in the MSW [5] . The organic fraction of municipal solid waste (OFMSW) has by far the highest moisture content of any constituent in MSW [6]. To make sure a produce disposed the MSW it is desirable to decrease its pollution potential and Nemours processing systems are planned for this purpose. Decomposition of stuff by micro organism in warm moist aerobic environment. Decomposition is as a result the most simple and economical technology for operating the organic fraction of MSW [7]. Solid state fermentation (SSF) has proved to be excellent technology for solid waste treatment. It can be successes that agro industry solid waste can be utilize for the production of various added value products[8]. The issue of solid waste being thrown onto the land and the subsequent environmental problems could be overcome [9]. Agro-industrial waste can be improved through microbial SSF technology and thus, SSF can be an ideal platform for biomass biochemical conversion for bio-based products [10]. Improvements in the quality of food and agro-industrial waste can be associated with the improved value of food and agro-industrial waste [11]. the microbial bioconversion technology involved may allow novel alteration of nutritional quality [12]. Solid state fermentation offers greatest possibilities when fungi are used. In SSF, the moisture necessary for microbial growth exists in an absorbed. The aim of SSF is to bring cultivated fungi, bacteria and other micro organisms.

II MATERIALS AND METHODS

The municipal solid waste collected from garbage dumping site of Madurai corporation vellaikkal, Avaniyapuram, Madurai, Tamil Nadu. Paddy straw was collected from Madurai, perungui agriculture land. The samples were transported to our laboratory by bicycle and where it was subjected to manual segregation in to organic matter (MSWOM). MSWOM either alone or in combination with paddy straw. Four different substrates were prepared by mixing various level of MSWOM with known amount of paddy straw and were designated in T_1,T_2,T_3,T_4. The T_1 substrate contains 4 part of MSWOM with one part of paddy straw likewise, T_2 contains three part of MSWOM with one part of paddy straw, T_3 contains two part of MSWOM with one part of paddy straw, and T_4 contains equal part of both MSWOM and paddy straw 100% MSWOM and 100% paddy straw were reference as control substrates and were designated as C_1 and C_2 respectively.

Selection of candidate fungus:

Calocybe Indica mother spawn and culture spawn of the fungal were raised the laboratory on our own and were used for experiments. Four different substrate and control substrates soaked in water for 10 – 12 hrs. Each substrate was air dried for short while, and was inoculated with *Calocybe indica* (150g/ kg of substrate) spawn and each spawn and substrate was filled in three poly bag fermenters one kilogram in each. The fermenter were transferred and kept in fungal growth chamber for solid state fermentation, sufficient relative humidity (RH), temperature and ventilation inside the chamber throughout the study period from the day one onwards the fermenters were monitored to observe fungal colonization, mycelia growth, time taken to complete mycelia coverage on substrate.

Casing treatment:

The casing material were covered with newspaper and streamed in an autoclave at 110^0 C for 60 min. After 24 hrs when the soil was cool. This soil was uniformly spread over the half spawn run beds. Regular spraying on the surface of the casing soil was done to maintain approximately 60 percent moisture on the bed surface. After casing period the incubator inside temperature range was 30^0 to 40^0 and the relative humidity was more than 85 %. Light should be provided in long time. The changes thus made in environment. Finally resulted in the initiation of fruit bodies within 5 – 8 days in the form of needle shape which mature about a week.

Biological efficiency:

The amount of fruit body production in each substrate is measured in terms of percentage of biological efficiency (BE). The BE can be calculated by the following formula

$$\% \text{ of BE} = \frac{\text{Amount of fresh fungal fruit body}}{\text{Total amount of Before SSF dry substrate used}}$$

III RESULT AND OBSERVATION

We could observe that the spawn of the candidate fungus germinates and produce mycelia which proliferate and cover the substrate completely on all the substrates. *Calocybe indica* fungus successfully initiated its fruit body on 24th , 23rd, 23rd and 22nd day on T4, T3, T2 and T1 substrates. Whereas it was noticed on 32nd and 22nd day on C1 and C2 substrates. The total number of primordial formed is 4, 15, 22, 20, 26 and 30 on C1, T4, T3, T2, T1 and C2 substrates(**Table: 1**)

Growth performance of *Calocybe indica* on pulverized municipal solid waste co- fermented with paddy straw

S. No	Composition of substrate PMSW: PS	Amount of substrate in each bed (kg)	Day in which no. of primordial appeared						Total No. of primordial
			Flush I		Flush II		Flush III		
			day	no.	day	no.	day	no.	
1.	5:0	1	32	3	42	1	60	1	4
2.	4: 1	1	24	2	35	4	55	9	15
3.	3:1	1	23	3	33	9	52	10	22
4.	2:1	1	24	4	35	3	55	13	20
5.	1:1	1	24	15	35	5	53	6	26
6.	0:5	1	22	3	35	8	50	19	30

It was recorded that the *Calocybe indica* fungus fruit bodies in all their flushes successfully in all substrates. The % of biological efficiency on T1, T2,T3, T4and substrate were 35. 8 %, 40.6%, 44.6%, and 66.9% respectively . recording the fruit body yielded lowest biological efficiency 20.6%. Whereas, C2 substrate yielded of 89.5 % which was maximum (**Table:2)**

Biological efficiency of *Calocybe indica* on pulverized municipal solid waste co-fermented with paddy straw

			Amount of fresh and dry fungal fruit body (g)	Total weight		

S. No	Composition of substrate PMSW: PS	Amount of substrate in each bed (kg)	Flush I		Flush II		Flush II		of fresh and dry fruit body (g)		% of dry fungal fruit body	Biological efficiency (%)
			Fresh Wt.	Dry Wt.	Fresh Wt.	Dry Wt.	Fresh Wt.	Dry Wt.	Fresh Wt.	Dry Wt.		
1.	5:0	1	57	8	48	8	57	6	162	21	12.9	20.6
2.	4: 1	1	93	9	91	11	78	9	262	29	11.5	35.8
3.	3:1	1	73	9	103	13	88	10	264	32	12.1	40.6
4.	2:1	1	104	10	100	12	86	13	290	35	12.0	44.6
5.	1:1	1	147	17.4	110	13	102	11.4	359	41.8	11.6	66.9
6.	0:5	1	154	15	115	13	143	19	412	47	10.8	89.5

Solid state fermentation efficiency of the ***Calocybe indica*** was assessed in terms of dry biomass reduction of the substrates during fermentation. The result revealed that the candidate fungus could reduce 12.36% dry biomass from C1 substrates over period of 60 days. Whereas, it was 34.35%, 38.88%, 44.07, 42.85 and 46.52 from T1, T2, T3, T4 and C2 substrate respectively (**Table -3**)

Efficiency of *Calocybe indica* on solid state fermentation of PMSW co- fermented with paddstraw.

S. no	Composition of substrate PMSW: PS	Amount of substrate in each bed (kg)	Total fresh weight of substrate (g)		Total dry weight of substrate (g)		Duration of SSF days	Reduction in dry weight during SSF (g)	% of dry weight of during SSF
			Before SSF	After SSF	Before SSF	After SSF			
1.	5 : 0	1	1150	827	783	686.2	60	96.8	12.36
2.	4 : 1	1	1150	714	730	476.2	55	253.8	34.35
3.	3 : 1	1	1150	662	650	437.7	52	278.0	38.88
4.	2 : 1	1	1150	634	565	316.0	55	249.0	44.07
5.	1 : 1	1	1150	560	536	306.7	53	229.7	42.85
6.	0 : 5	1	1150	518	460	246.0	50	214.0	46.52

IV DISCUSSION

The present studies have stated the accepting waste treatment technologies like composting with effective source separation for organic fraction. Waste recovery of recycling would help for achieving economic, social and environment benefits [13]. The fact means card boards, textiles, wood, metal, and plastic are removed from MSW. So that, at the end of this recycling process the organic material content of MSW is over 85% [14]. Solid State Fermentation processes for produce some products with industrial interest valorising unexploited biomass [15]. Important advantage of production by SSF is the feasibility and efficient extraction of from fermented matter [16]. Agro residues that can beused as substrates for SSF include sugarcane bagasse, cas-sava bagasse, cereal brans such as wheat bran, rice bran, oatbran and soybean bran, coffee pulp and husks, fruit peelsand pulps, corn cobs, straws and husks of different origins. These materials are basically composed by cellulose, hemi-cellulose, lignin, starch, pectin and other fibers [17]. Any biodegradable waste can be used as substrata for growing fungi [18]. Fungi, are ubiquitous in the soil, and contributes to degradation of toxic materials in the soil [19]. ***Calocybe indica*** is one of the most important steps towards diversification of agriculture, microbial technology can help in large scale recycling of agro waste in India [20]. SSF as a sequential batch using agroindustrial wastes led to a sustained cellulase production for nearly 15 days [21]. ***Calocybe indica*** was largely determined by availability and utilization of cheap materials of which of which agricultural. In this present study ***Calocybe indica*** was used to ferment MSWOM and co fermented paddy straw. The revealed that the fungus, which feeds by secreting enzymes and digests food externally and absorb the nutrients in net like chain called hypha. The net like chain (hypha) is exposed to stimuli in their ecological niche and act as a conscious intellect and respond to stimuli. Dense and regular branching of hypha endows fungi with potentials to pervade any substrate thoroughly . [22] reported a sequential batch operation using bio waste digestate as the substrate with no positive poor quality of the substrate. Fungal mycelium easily colonize over the substrate, extent their coverage in short period. The time required to complete mycelial growth was observed in the sugarcane bagasse substrate (27.75 days), maize straw (29.50 days) ,sugarcane leaf (29.75 days) ,and (40.25 days) required to complete mycelia growth was waste cotton substrate [23]. Therefore, time required to mycelia growth T4 (4:1) 24 days, T3 (3:1) days 22 days, T2 (2:1) 23 days, T1 (1:1) 22 days, C1 (Raw MSWOM) 33 days, and C2 (Raw paddy straw) 22days. Fruiting bodies of C. indica were formed in six different substrates. The highest (91.75%) and lowest (51.86%) biological efficiencies were observed in the rice straw and sugarcane bagasse substrates . However, The fungal fruit body yielded was about 20.6% , 66.97% and 89.5% of biological efficiency C1 and T4 (1:1) and C2, highest biological efficiency were observed raw paddy straw (89.5), During the solid state fermentation period reduction was about 12.36% and 42.58 % of MSWOM and 50% MSWOM mixing with 50 % paddy straw. That days mycelium hypha transfer to reproductive phase and produce fungal fruit body . The all substrates tested to duration of period from 65. 75 to 91. 75 days [24]. Therefore, all substrates duration of period 50 – 60 days. The longest duration period observed in C1substrate.

V CONCLUSION

Calocybe indica was a direct utilization of their ecological role in the bioconversion of Municipal solid waste management , edible fungal fruit body biomass, which could also be regarded as a functional food. ***Calocybe indica*** fungus was one of the most economically-viable. Fungi communities and their response to the natural environment and pollutants, expanding the knowledge of the genetics of the microbes to increase capabilities to degrade pollutants, conducting field trials of new mycoremediation techniques which are cost effective, and dedicating sites which are set aside for long term research purpose, these opportunities offer potential for significant advances.

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