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MANAGEMENT OF SOLID WASTE FROM EDIBLE OIL INDUSTRY

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Abstract

The current increase in oilseed production is not only due to increase in demand by the food industry but also due to the fact that oilseed crops are being widely evaluated for potential production of biodiesel to supplement fossil fuel supplies .Oil extraction from oilseeds leaves a residue rich in carbon and nitrogen , requiring considerations of soil degradation when dumped on land without any treatment .This adversely affects soil microbial ecology resulting in environmental degradation due to inhibitory effects on nonpathogenic, soil microorganisms affecting bacterial and eukaryotic community structure. Alteration of soil microbial communities may directly impact Carbon mineralization and soil quality. In the present study ,Total Kjeldahl Nitrogen (TKN) and total organic carbon in waste from mustard oil industry viz. oil seed meal was determined . They were found to be 0.58% and 9.1% , respectively. A reduction of 77% in BOD and 99.3% in COD was observed following treatment of this waste by batch fermentation using *Paenibacillus dendritiformis*,isolated from oil contaminated site .The waste material did not have any autochthonous bacterial microflora. The results, taken together,suggest that land application of oil seed meal as a means of disposal may not be a good strategy for waste disposal due to the high C and N load. Treatment of the waste using allochthonous microbial biomass may offer a novel and promising strategy for development of treatment methods prior to disposal of this solid waste generated in edible oil industry therebgy alleviating problems of land pollution.

Keywords: Solid waste management, ,Biochemical Oxygen demand, Chemical Oxygen Demand

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Introduction

The world production of oils and fats is about 2.5-3 million tons, 75% of which are derived from plants and oil seeds. India has a high capacity to generate vegetable oil and there are significant waste from industries associated with soybean, sunflower, olive, groundnut, rapeseed, safflower, sesame, coconut, palm and mustard oils refining. Mustard oil is the third largest source of oil in India. The extraction of oil from mustard seeds results in generation of large amounts of wastes and their disposal is a serious problem. Oilseeds, such as soybeans, have been cultivated for hundreds of years with much of the oilseed meal, or press-cake, remaining after oil extraction used as additives in animal feed or organic fertilizers because of their high nutrient content (Goos et al.2009, Matthiessen & Kirkegaard, 2006; Mazzola et al.,2007;Mazzola & Brown, 2010; Moore et al.,2010 .) Mustard seed meal i.e. solvent extracted oil seed cake is reported to contain 43% protein, 2.05% oil, 1.22% allylisothiocyanate (AIT) and 2.75% phytic acid (Khan, 1986) However, certain plants within the Brassicaceae family cannot be used in the same manner because of their biocidal properties. Upon enzymatic hydration by myrosinase, a number of allelochemicals are physically separated from the glucosinolates until the plant tissue is disrupted (Gimsing & Kirkegaard, 2009).When hydrolyzed, glucosinolates are converted into biocidal chemicals such as isothiocyanates, nitriles, and ionic thiocyanates (Bell et al,.1995; Katamotoet al.;2001,Wang et al., 2012). They suppress a number of soil pathogens, insects, and weeds (Mazzola et al,.2007;Chun et al. ,2002; Smolinska et al.,1997& Yu et al.,2007). Although numerous studies have documented the beneficial usage of

brassicaceous plants or green tissue (Matthiessen et al., 2006) and seed meals (Mazzola et al.,2007; Mazzola & Brown ,2010; Smolinska et al. ,1997; Yu et al., 2007) as biofumigants and biopesticides. However, the cultivation of additional oilseed varieties, at the scale necessary to meet worldwide demands including that to supplement fossil fuels, may saturate existing markets for these oilseed meal coproducts .

Therefore, a feasible and profitable means of seed meal disposal needs to be developed in order to manage environmental pollution load that such wastes carry. This study evaluates a process of pretreatment of material left after extraction of oil and removal of oil cake at high chemical oxygen demand (COD) and Biochemical Oxygen Demand (BOD) loadings from a mustard oil mill before dumping it in soil.

MATERIAL AND METHODS:-

2.1 Collection of Waste Sample

Oil seed meal from a mustard oil mill was used as waste. Samples were collected from a small-scale mustard oil mill in Neem-Ka-Thana, a village in the vicinity of Jaipur city in Rajasthan, India.

2.2 Organism and Growth Conditions

A bacterium capable of growth on the waste was isolated from oil contaminated site from the soil of a motor garage in Jaipur, Rajasthan, India. It was identified by 16S ribosomal RNA gene sequencing. Isolation was performed using dilution method on Luria Bertanii agar. Optimal pH and temperature for growth was determined by growth on pH varying between 3 and 10 and temperature varying between 4ºC to 60ºC. It was subsequently grown on Luria Bertani broth supplemented with varying concentrations of waste and at optimal pH and temperature .Growth was followed by measuring absorbance at 540nm of supernatant after centrifugation of culture at 4000 r.p.m.to remove the suspended waste material. The bacterial isolate was identified using 16S r-DNA sequencing. Isolation of bacteria was also performed using the waste samples collected .The waste was sprinked on plates of Luria Bertani agar.

2.3 Preparation of Seeding Material

The isolate was grown in Luria Bertanii broth at 37°C for 24h.The culture was centrifuged at 8000rpm for 10mins.The pellet obtained was washed with sterile media before being used as seeding material.

2.4 Characterisation of Waste (mustard oil seed meal)

2.4.1 Estimation of Total Organic Carbon in Waste

Total Carbon was measured by dichromate oxidation procedures as given by Walkley-Black (1934).

2.4.2 Estimation of Total Nitrogen in Waste

0.3g sample was digested in a mixture of 10 ml sulphuric acid with a pinch of copper sulphate and potassium sulphate. This was distilled using sodium hydroxide (40%) and boric acid (4%) . This was titrated against 0.1% HCl.

2.5 Treatment Method

The waste was treated by means of batch fermentation using *Paenibacillus dendritiformis* . A dose of 0.13 g wet weight biomass/100ml was used for seeding a 10% dilution of waste without media amendment to the diluted waste . Fermentation was carried out in Batch mode for 5days ,under agitation of 180rpm .Temperature was maintained at 37C .BOD and COD of the solid waste were measured before and after treatment.

2.6 Measurement of BOD before and after treatment

13 g wet weight biomass was inoculated as seeding material in a 10 % dilution of waste (oil seed meal) without media amendment to the diluted waste. This was incubated at 37C, with agitation of 180 r.p.m. for 5 days . BOD of the untreated waste was determined as per APHA1998 by measuring dissolved oxygen on Day 1 and Day 5. BOD of waste treated for 5days was determined in the same manner using residue left after filteration.

2.7 Measurement of COD before and after treatment

COD is used to express the amount of oxygen consumed during oxidation of a sample with hot acid dichromate solution under defined conditions; the test provides an estimate of the oxidisable matter present in the sample. COD in the waste was measured as per APHA 1998 in both treated and untreated waste diluted @10% without media amendment as above for BOD.

2.8 Measurement of BOD of unseeded waste

A 10 % dilution of oil seed meal in distilled water without media amendment and without biomass as seeding material was incubated at 37C, with agitation of 180 r.p.m. for 5 days. BOD was determined as per APHA by measuring dissolved oxygen on Day 1 and Day 5.

RESULTS AND DISCUSSION:-

3.1 Organism and Growth Conditions

No colonies were observed on plates sprinkled with waste.Two colonies were found to be growing on plates containing dilutions of soil from automobile workshop.16-s r DNA analysis of both isolates revealed that both were *Paenibacillus dendritiformis.* Optimal growth conditions were 37˚C (Fig 1) , pH of 7.0 (Fig. 2) and media supplemented with 10% waste (Fig .3).

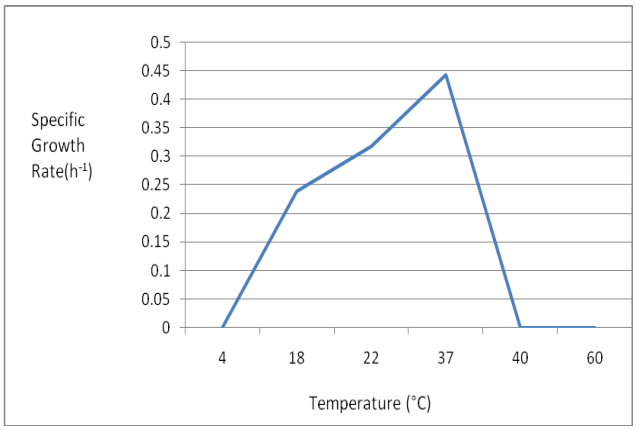

Fig. 1 Specific growth rate of *Paenibacillus dendritiformis* growing on LB broth at varying temperatures

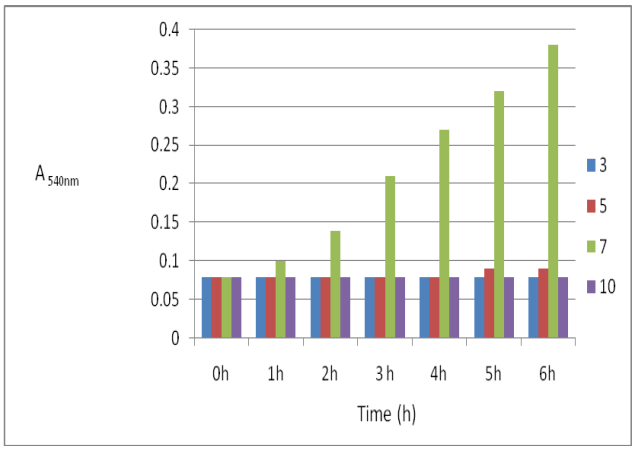

Fig. 2; Absorbance of *Paenibacillus dendritiformis* cultures growing on LB broth at varying pH.

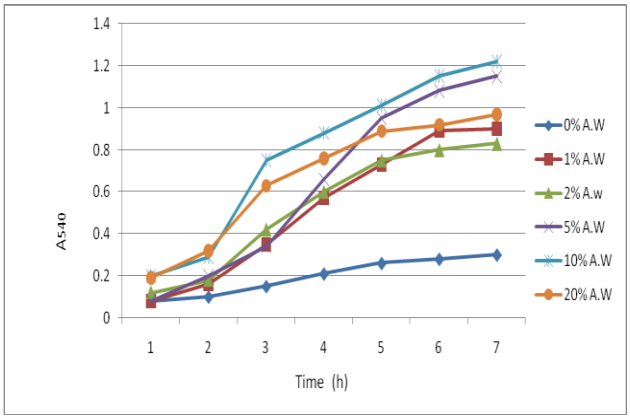

Fig. 3.Growth of *Paenibacillus dendritiformis* cultures in LB media supplemented with varying concentrations of oil seed meal (w/v)(Agro-industrial Waste –AW)

3.2 Characterisation of Waste.

Characteristics of Waste were found to be as given in table 3.

Table 3: Characteristics of the waste (mustard oil seed meal)

Total Organic Carbon (%)	**9.1**
Kjeldahl Nitrogen (%)	**0.58**

3.3 Effect of treatment on BOD and COD of waste

A reduction of 77% in BOD and 99.3% in COD was observed following treatment of waste by batch fermentation using *Paenibacillus dendritiformis* as shown in Table 2.

Table 2: BOD and COD values of the solid waste showing a decrease after batch fermentation with *Paenibacillus dendritiformis* for 5days

	Before Treatment	**After Treatment**
Biochemical Oxygen Demand (mg/L)	**960**	**220**
Chemical Oxygen Demand(mg/L)	**64000**	**440**

4. Discussion

Increasing land application of oilseed meals at rates increasing with demand for oil both from the Food and Energy sector, raises concerns about land application of the accompanying waste generated. Oilseed meals are different from traditional soil additives such as crop residues in that they contain greater

amounts of N and easily decomposable C. Three aspects require special attention when considering land application of mustard oilseed meals. First, a large proportion of C in oilseed meals will be respired and released into the atmosphere as CO_2. Carbon dynamics in subsequent months and years following application will determine how much C is eventually incorporated into soil organic matter and more information regarding these long-term effects is needed in order to develop a more complete picture of C cycling with seed meals. Increasing organic carbon amount in soil leads to decrease.in redox potential. This is because oxidation processes in soils rich in readily decomposed organic matter consume big amounts of oxygen which may lead to formation of a lot of organic compounds with reducing properties thereby increasing the BOD. This phenomenon lowers the quality of soil (Nomeda et al.,2010). Also, mustard oil seed meals have shown delayed C mineralization due to presence of biocidal compounds such as glucosinolate (Chew, 1988; Brown & Morra ,1997;Wang et al., 2012). Oilseed meals contain high amounts of easily decomposable C and N. Increasing organic carbon and nitrogen amounts in soil has been shown to decrease redox potential lowering the quality of soil (Nomeda et al,.2010) , delay C mineralization due to presence of biocidal compounds in mustard oilseed meal (Chew ,1988; Brown & Morra, 199;,Wang et al., 2012) and inhibit the effect of nitrogen-fixing bacteria. (Laane et al. ,1980). Many oilseed meals from dedicated biofuel crops, such as mustard, may release allelochemicals which can affect soil microorganisms (Wang, et al., 2012) . Increasing land application of oilseed meals at rates increasing with demand for oil both from the Food and Energy sector, has therefore raised concerns about land application of the accompanying waste generated. (Wang et al.,2012).

A need therefore arises to develop best management practices for disposal of such wastes.Organic C and N content of , mustard oil seed meal, the waste being used in the current work was found to be 9.1% and 0.58% ,respectively (Table 1) contributing heavily to the C and N loadings when dumped untreated in soil. This waste used in this study, was also found to be having a Biochemical Oxygen Demand (BOD) of 760 mg/L and a Chemical Oxygen Demand (COD)of 64000 mg/L. It was subjected to batch fermentation using *Paenibacillus dendritiformis* at a dose of 0.13g/100ml for seeding a 10 % dilution of oil seed meal without media amendment to the diluted waste . This was effective in reducing BOD from 760mg/L to 220mg/L and COD from 64000 mg/L to 440 mg/L in 5 days.(Table 1).

BOD values of unseeded waste was found to be negligible (0.004mg/L).This indicated that the waste material does not have any autochthonous microflora that could degrade it. This was also corroborated by the finding that no bacterial isolate was obtained from the waste used in this study. The results taken together show that land application of oil seed meal as a means of disposal may not be a good strategy for waste disposal and that treatment using exogenous microbial biomass may offer a promising strategy for development of treatment methods prior to disposal of this solid waste.

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