AN INTEGRATED APPROACH FOR MAHUA SEED CAKE UTILIZATION

by

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DEDICATED

to

MY PARENTS

CERTIFICATE

*This is to certify that the thesis entitled '**An Integrated Approach for Mahua Seed Cake Utilization'** submitted by **Ms. Aditi Gupta** has been prepared under my guidance with the rules and regulations of Indian Institute of Technology Delhi, India. The research report and results presented in the thesis have not been submitted for any degree or diploma in any other institute or university.*

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(Aditi Gupta)

ABSTRACT

In the present scenario of rising populations and energy crisis, bio-diesel from non-edible oil seeds offers a promising alternative amongst various renewable sources being scrutinized. Jatropha and karanja oils have been successfully used for the production of bio-diesel. Recently, mahua oil methyl esters have also been prepared with their fuel properties closely related to diesel along with reduced emissions of carbon monoxide, hydrocarbons and oxides of nitrogen. After the extraction of oil from their respective seed kernels, a large part of the seed material is left as seed cake. Owing to the presence of toxins in them, these seed cakes find limited use. The production of bio-diesel can be made more sustainable if this large amount of biomass generated can be managed properly and safely disposed. Seed cakes of jatropha, neem, karanja, etc have already been used as fertilizers, biopesticides and substrates for the production of biogas and other value added products. However, not much work has been done on mahua seed cake. The present study attempted to design an integrated approach for effective utilization of mahua cake through biopesticidal evaluation of its active components, biogas production, mushroom cultivation and subsequent vermi-culturing.

Mahua cake used in the present study was identified as *Madhuca indica* J.F. Gmel syn. *Madhuca longifolia* (L.) J.F. Macbr. It was rich in sugars, proteins and contained 12-16% saponins as its major active component. Crude saponins were found to be a mixture of three compounds, out of which Mi-saponin *A* and Mi-saponin *B* were identified. The mixture was hydrolyzed and subsequently, purified prosapogenin (3-O-*β*-D-glucopyranosyl protobassic acid) and sapogenin (bassic acid) were isolated and structurally characterized using various spectroscopic techniques. Saponins and purified prosapogenin, sapogenin were effective against *Odontotermes obesus* termites, *Meloidogyne incognita* nematodes and certain phytopathogenic fungi. 100% termite mortality was achieved with 10% prosapogenin in 18 h and 10% saponins in 24 h. Sapogenin, on the other hand, gave a relatively poor performance. Similar results were obtained for the nematicidal activity with 1% proapogenin showing 100% J2 juvenile immobility in 48 h. It was observed that monodesmodic saponins (saponin with one sugar chain, i.e., prosapogenin) were found to be more effective against

termites and nematodes as compared to bidesmodic saponins. Saponins were also able to completely inhibit the growth of *C. dematium, F. solani* and *F. oxysporum* at test concentrations of 5, 7 and 10%, respectively. On the other hand, mahua cake did not inhibit the growth of *A. niger* and *R. oryzae* fungi. Preliminary experiments on protease production from these two fungi were also carried out using cake as the substrate for solid state fermentation. When mixed with cow dung in appropriate amounts, mahua cake (especially when detoxified by water treatments) was found to yield significant production of biogas. Maximum biogas volume of 442 ± 5.5 L/kg total solids, along with 55-57% methane content, was obtained from the treatment containing 50% cow dung and 50% hot water treated detoxified mahua seed cake (approximately 75% saponin removal). This gave an increase of 125% in the biogas volume produced over cow dung (control). Significant decrease in celluloses and hemicelluloses and an increase in the nutrient content (N, P, K) of the digested slurries was obtained. Mahua cake, especially when freed of saponins, was also found to significantly increase the yield and nutrient content of *P. sajor-caju* mushrooms on wheat straw. Highest biological efficiency of 115.5% was achieved from supplementation of wheat straw with 20% biogas slurry of the combination containing 50% hot water treated detoxified mahua seed cake and 50% cow dung. Mushroom fruit bodies were found to be rich in proteins, amino acids and minerals (N, P, K, Fe, Zn, Mn) but low in fat and sugar content. HPLC studies confirmed the absence of any saponin residues in both mushroom fruit bodies and spent. Significant degradation of celluloses, hemicelluloses and lignin (qualitatively monitored *via* FTIR and quantitatively estimated) was found in spent which also possessed good manurial values. Biogas slurries and mushroom spents obtained above very well supported the growth and reproduction of *Eisenia fetida* earthworms, giving rise to quality vermi-manure. Biomanure and biopesticides thus obtained from our work could be utilized for the growth of mahua/other plants. An integrated approach for resourceful utilization of mahua cake is thus presented here.

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