TABLE OF CONTENTS

Page no.

No.		0
1 Introduction		1-16
	Origin of the problem	1
	Research gaps	5
	Research questions	6
	Research objectives	6
	Plan of research	7
	Chapter arrangement of the thesis	8
	Bibliography	11
2 Revie	ew of literature	17-46
	Introduction	17
2.1.1	Vermicomposting Process - A comparison with	18
	composting	
	Process optimization of vermitechnology	20
	Physico-chemical and biochemical factors	22
	Microbial growth and enzyme activity	27
	Earthworm species, stocking density, and duration	28
	Feedstock composition and quality indices	30
	Pollutants and theirdetoxification: A focus on polycyclic	33
	aromatic hydrocarbons (PAH)	
	Innovation vermireactors and vermicomposting process	36
	Bibliography	37
3 Methodology and experiment planning		47-56
	Phase I: Studying the variations in decomposition	47
	process of lignocellulosic waste materials with species	
	reference to microbial community structure	
	Phase II: Effect of earthworm stocking density on	49
	microbial profile and end product quality in vermibeds	
	composed of kitchen vegetablewaste, banana stem, and	

	cow dung		
	Phase III: Polyaromatic hydrocarbons (PAHs)	50	
	detoxification routes by Eiseniafetida and Eudrilus		
	eugeniae		
	Phase IV: Designing innovative continuous-flow	50	
	mechanized vermireactor and performace assessment		
	Quality assurance and quality control	51	
	Sample storage and preservation	51	
	Purity of chemicals, reagents, lab wares	51	
	Calibration procedures	52	
	Initial demonstration of performance	52	
	Linear calibration range (LCR)	52	
	Method detection limit (MDL)	52	
	Operations and maintenance	53	
	Bibliography	55	
4 Microbial diversity and nutrient mobilization in		57-88	
lignocellulosic waste (spent mushroom straw) based			
lignoce	llulosic waste (spent mushroom straw) based		
C	llulosic waste (spent mushroom straw) based omposting systems		
C		57	
C	omposting systems	57 58	
C	omposting systems Introduction		
vermic	omposting systems Introduction Materials and methods	58	
vermic	omposting systems Introduction Materials and methods Experiment design, Collection ,treatments	58 58	
vermic	Introduction Materials and methods Experiment design, Collection ,treatments Chemical analysis	58 58 60	
vermic	Introduction Materials and methods Experiment design, Collection ,treatments Chemical analysis X-ray diffraction (XRD) and Fourier transforms infrared	58 58 60	
vermic	Introduction Materials and methods Experiment design, Collection ,treatments Chemical analysis X-ray diffraction (XRD) and Fourier transforms infrared spectroscopy (FTIR) analysis: Crystallinity and	58 58 60	
vermic	Introduction Materials and methods Experiment design, Collection ,treatments Chemical analysis X-ray diffraction (XRD) and Fourier transforms infrared spectroscopy (FTIR) analysis: Crystallinity and functional of the vermicomposted SMS	58 58 60 64	
vermic	Introduction Materials and methods Experiment design, Collection ,treatments Chemical analysis X-ray diffraction (XRD) and Fourier transforms infrared spectroscopy (FTIR) analysis: Crystallinity and functional of the vermicomposted SMS X-ray diffraction (XRD)	58 58 60 64	
vermic	Introduction Materials and methods Experiment design, Collection ,treatments Chemical analysis X-ray diffraction (XRD) and Fourier transforms infrared spectroscopy (FTIR) analysis: Crystallinity and functional of the vermicomposted SMS X-ray diffraction (XRD) Fourier transforms infrared spectroscopy (FTIR)	58 58 60 64	
vermic	Introduction Materials and methods Experiment design, Collection ,treatments Chemical analysis X-ray diffraction (XRD) and Fourier transforms infrared spectroscopy (FTIR) analysis: Crystallinity and functional of the vermicomposted SMS X-ray diffraction (XRD) Fourier transforms infrared spectroscopy (FTIR) analysis	58 58 60 64 64 65	
vermic	omposting systemsIntroductionMaterials and methodsExperiment design, Collection ,treatmentsChemical analysisX-ray diffraction (XRD) and Fourier transforms infraredspectroscopy (FTIR) analysis: Crystallinity andfunctional of the vermicomposted SMSX-ray diffraction (XRD)Fourier transforms infrared spectroscopy (FTIR)analysisMicrobial growth, Microbial biomass C (MBC),compost respiration (CR), microbial quotient (Mq),microbial metabolic quotient (qCO2), and Phospholipid	58 58 60 64 64 65	
vermic	Introduction Materials and methods Experiment design, Collection ,treatments Chemical analysis X-ray diffraction (XRD) and Fourier transforms infrared spectroscopy (FTIR) analysis: Crystallinity and functional of the vermicomposted SMS X-ray diffraction (XRD) Fourier transforms infrared spectroscopy (FTIR) analysis Microbial growth, Microbial biomass C (MBC), compost respiration (CR), microbial quotient (Mq),	58 58 60 64 64 65	

4.5.2	Microbial biomass C (MBC)	65
4.5.3	Compost respiration (CR), microbial quotient (Mq),	65
	microbial metabolic quotient (qCO ₂)	
4.6	Seed germination assay	67
4.7	Statistical analysis	68
4.7.	Results and Discussion	68
4.8	Conclusions	82
	Bibliography	83
5.Effec	ts of earthworm stocking density on end product	89-116
quality	and microbial community structure during	
vermic	omposting	
	Introduction	89
	Material and methods	91
	Collection of raw materials and feedstock formation	91
	Experimental setup, maintenance condition, and sample	91
	collection	
	Growth and development of earthworm	93
	Physicochemical analyses of compost and	93
	vermicompost samples	
	Microbial activity and community structure:	95
	phospholipid fatty acid analysis-based profiling	
	Extraction and analyses of metals (Cd, Pb, Mn, Zn, and	95
	Cu)	
	Statistical analyses	96
	Results and Discussion	96
	Temporal dynamics of earthworm population and body	96
	weight	
	Impact of earthworm stocking density on waste	97
	valorization	
	Microbial metabolism and community structure: PLFA-	102
	based assessment	
	Bioavailability patterns of potentially toxic elements	107
	(Mn, Zn, Cu, Pb, and Cd) in feedstocks	

	Microbial profiles, community structure, C-dynamics,	108		
	and metal bioavailability: Finding linkages using			
	correlation statistics			
5.8	Conclusions	111		
	Bibliography	112		
6 Asses	sment of polyaromatic hydrocarbons (PAHs) removal	117-164		
kinetics and budget during vermicomposting				
	Introduction	117		
	Materials and methods	117		
	Experimental setup and PAH spiking	117		
	Chemical and microbial analyses	120		
	Working standards, calibration, extraction, and	121		
	estimation of PAHs in compost, vermicompost, and			
	earthworms			
	PAH removal efficiency and budget equations	125		
	Statistical analyses	126		
	Results and discussion	126		
	Changes in PAH concentration and removal efficiency	126		
	(RE)			
	Earthworm fecundity and PAH accumulation pattern in	138		
	two earthworm species			
	Temporal budget of 13 PAHs: Insights on reduction	143		
	mechanism			
	Temporal dynamics in chemical and microbial	153		
	attributes: Finding the linkages to PAH remediation			
	through correlation statistics			
	Conclusions	158		
	Bibliography	159		
7 Vermireactor improvisation towards technical fortification		165-193		
	Introduction	165		
	Materials and methods	167		
7.2.1	Designing and proto-type development of mechanized	167		
	and modified vermireactors			

Mechanized shredder-fitted perforated vermireactor	167
(MSVR)	
Clay and paper paste made perforated-walled truncated	169
cone shaped vermireactor (CPVR) and simple earthen	
truncated cone shaped reactor (EVR)	
Feedstock preparation, earthworm selection,	171
maintenance of vermicomposting systems, and sample	
collection	
Earthworm fecundity	173
Chemical analyses	173
Microbial analyses	174
Seed vigor assay	175
Statistical analysis	175
Results and discussion	175
Impact of vermireactors on earthworm fecundity	175
Changes in chemical composition of the feedstock	176
under vermicomposting	
Impact of vermireactors on microbial enrichment	179
Impact of vermireactors on metal bioavailability	186
Impacts of vermireactor-mediated vermicomposts on	188
seed vigor	
Conclusions	189
Bibliography	190
8 Summary	
List of Publications	197