



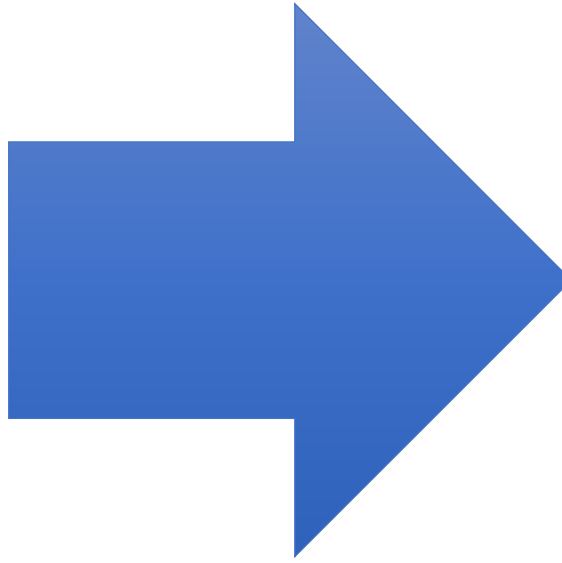
بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



WHAT OTHERS DO!



BLACK MONEY



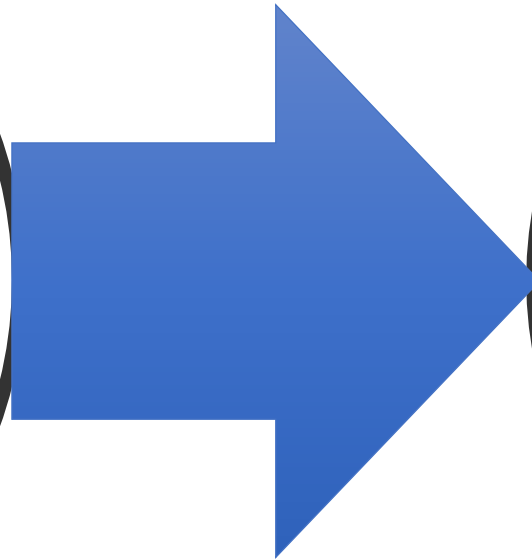
WHITE MONEY



AND WHAT WE DO!



WHITE MONEY



BLACK MONEY

Composting of Shredded Banknote Paper



Composting of Waste Banknote Paper **&** **An Experiment over Waste Ink and** **Wastewater Sludge**

PAKISTAN SECURITY PRINTING CORPORATION (PSPC)

(A Subsidiary of State Bank of Pakistan, the central bank of the country)

Project Sponsor

Mr. M. Haroon Rasheed
Managing Director PSPC

Project Advisor

Dr. Sikandar Hayyat Malik Director
Human Resources & Operations PSPC

Project Leader

Syed Faizan Haider Shah
DM – MD Secretariat



CONTENTS

- Waste and Global Warming
- What is Composting?
- Composting Over Other Waste Disposal Techniques
- Project Background & Initiation
- Composting Methods & Techniques
- Optimal Conditions for Rapid Composting
- Raw materials and Ratios
- Physiochemical Analysis of Compost
- Heavy Metals and Bacterial Analysis



Cont'd

- Application of Waste Paper Compost
- Cost of the Experiment and Utilized Area
- Wastewater Sludge and Ink to Compost
- Conclusion
- References



Waste and Global Warming

- 2019 was the second warmest year on record and Global temperatures projected to rise by up to 3.2oC by 2100
- Open landfills were found to represent 91% of all landfill methane emissions
- In Pakistan, huge amount of organic wastes, e.g., municipal solid waste, cattle manure and poultry manure etc., are available for composting



Impacts of Improper Waste Management

- Improper waste management is detrimental to human health
- Causes air pollution
- Affects water bodies when dumped into the water
- Approximately 1400 people die daily due to water and water-related problems/disease
- Depletes the ozone layer when burnt thereby increasing the impact of climate change
- These substances are toxic to human lives



What is Composting?

- Using the natural process of decay to change organic wastes into a valuable humus-like material called compost
- Organic material from decomposition of carbon (Browns) and nitrogen (Greens).





Composting Over Other Waste Disposal Techniques

Composting	Conventional
• Helps to ensure environmental sustainability • Helps to keep wastes in a controlled environment and recycled to a useful product. • Increase biodiversity in the soil • Helps to suppress diseases in plants and enrich the soil • Mitigates the production of gases like methane. • Though CO₂ releases during composting yet its lesser (less than 50% carbon content goes to CO₂ during composting) compared to other (combustion) modes of waste management. • Reduces the volume of wastes drastically	• Pollutes the soil, air, and water bodies. • In addition, they cause contamination of underground water when wastes are buried. • Hosts pest, pathogens and insects, which have a bad impact on human and animal health. • More Methane emissions are caused • Around 93% carbon content goes to CO₂ during combustion/incineration. • Increases volume of wastes



Project Background & Initiation

- The Bank of England while switching to polymer banknote £5, £10 and £20
- Data on composting paper bank notes were taken from a paper on modelling composting in LCA studies
- It was assumed that the nutrient content of compost made from paper bank notes is the same as that for green compost
- Composting feasibility and research have never been done before
- Started our research from scratch





Challenges

- It is cotton based, unlike other paper material
- It Contains specialized inks, varnishes and etc.

Is it
Compostable?





Composting Methods & Techniques

Aerobic Composting

- In an oxygenated atmosphere
- Lesser Methane
- Higher temperature increase
- Kills pathogens effectively
- Hummus is found in the final product
- More Efficient
- Composting rate is 42%

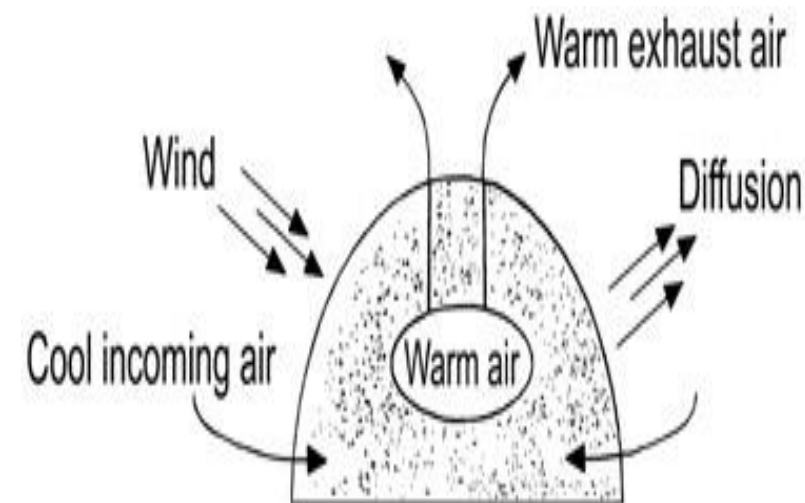
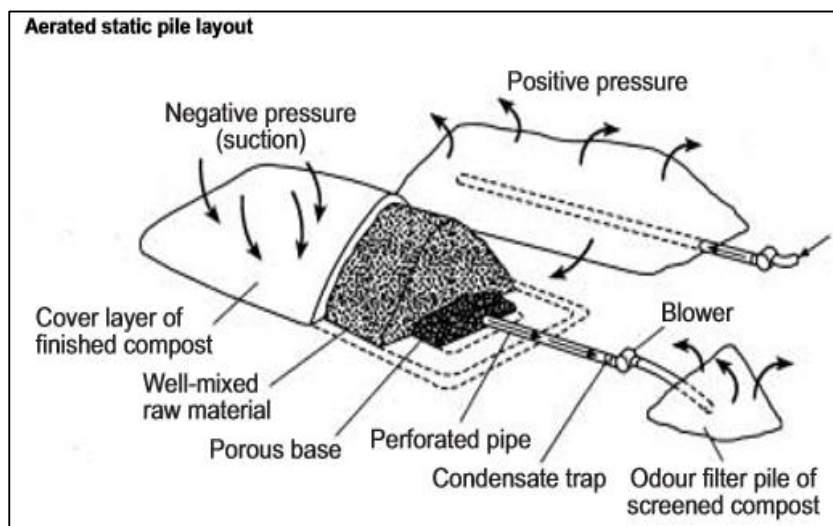
Anaerobic composting

- In the absence of oxygen
- More Methane, carbon dioxide etc.
- Smaller temperature increase
- Not effective in killing pathogens
- Final product is in the form of mud
- Less Efficient
- Composting rate is 33%



Aerobic Composting

- Composting In Passive Stack
- **Composting In Transitional Stack/Windrow**
- Composting In A Ventilated Static Stack/Windrow
 - Passive Ventilation System
 - Compressed Ventilation System





Small windrows (up to 2 m high, 2.5 m wide)

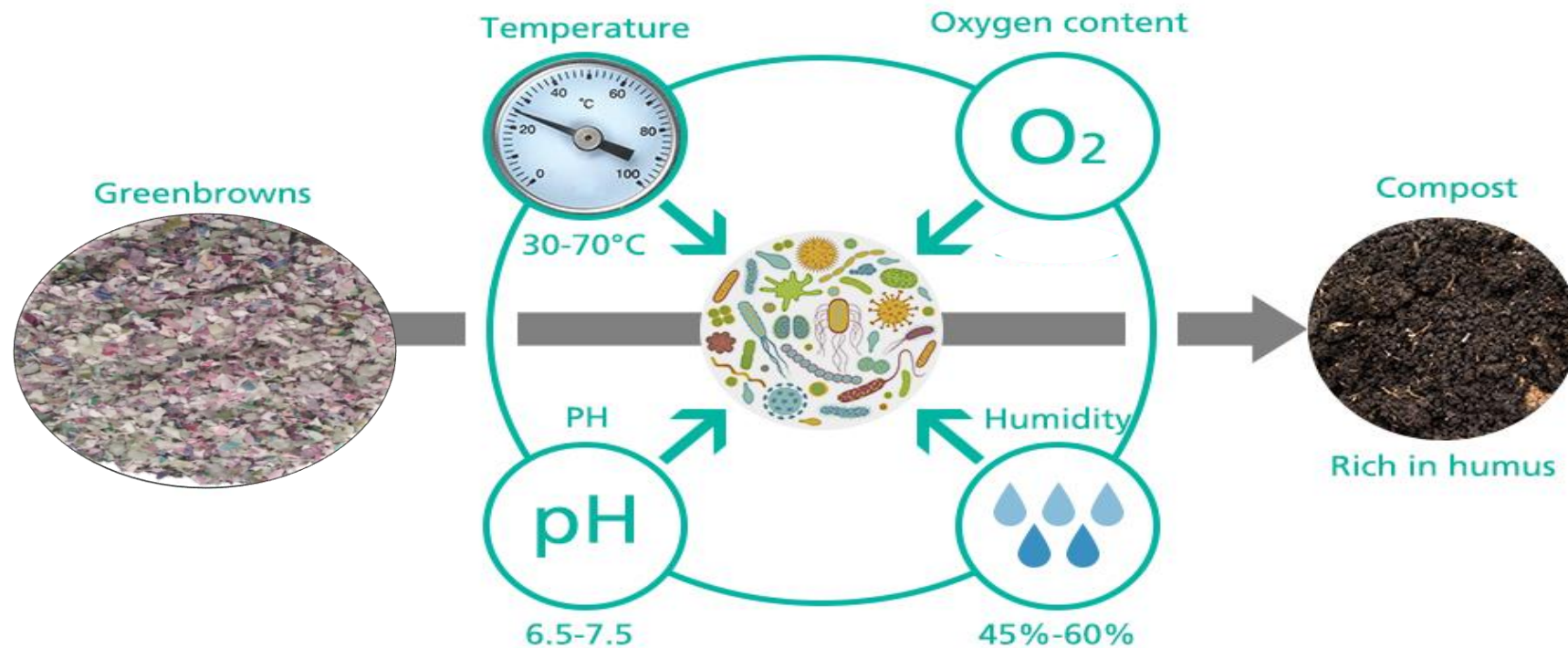
- Appropriate to treat volumes up to 5,000-6,000 tons per year
- Individual management of piles to produce different composts for different applications
- Medium investment costs
- Relatively labour intensive
- High surface area requirement



Composting of Shredded Banknote Paper



Optimal Conditions for Rapid Composting





Raw Materials And Ratios

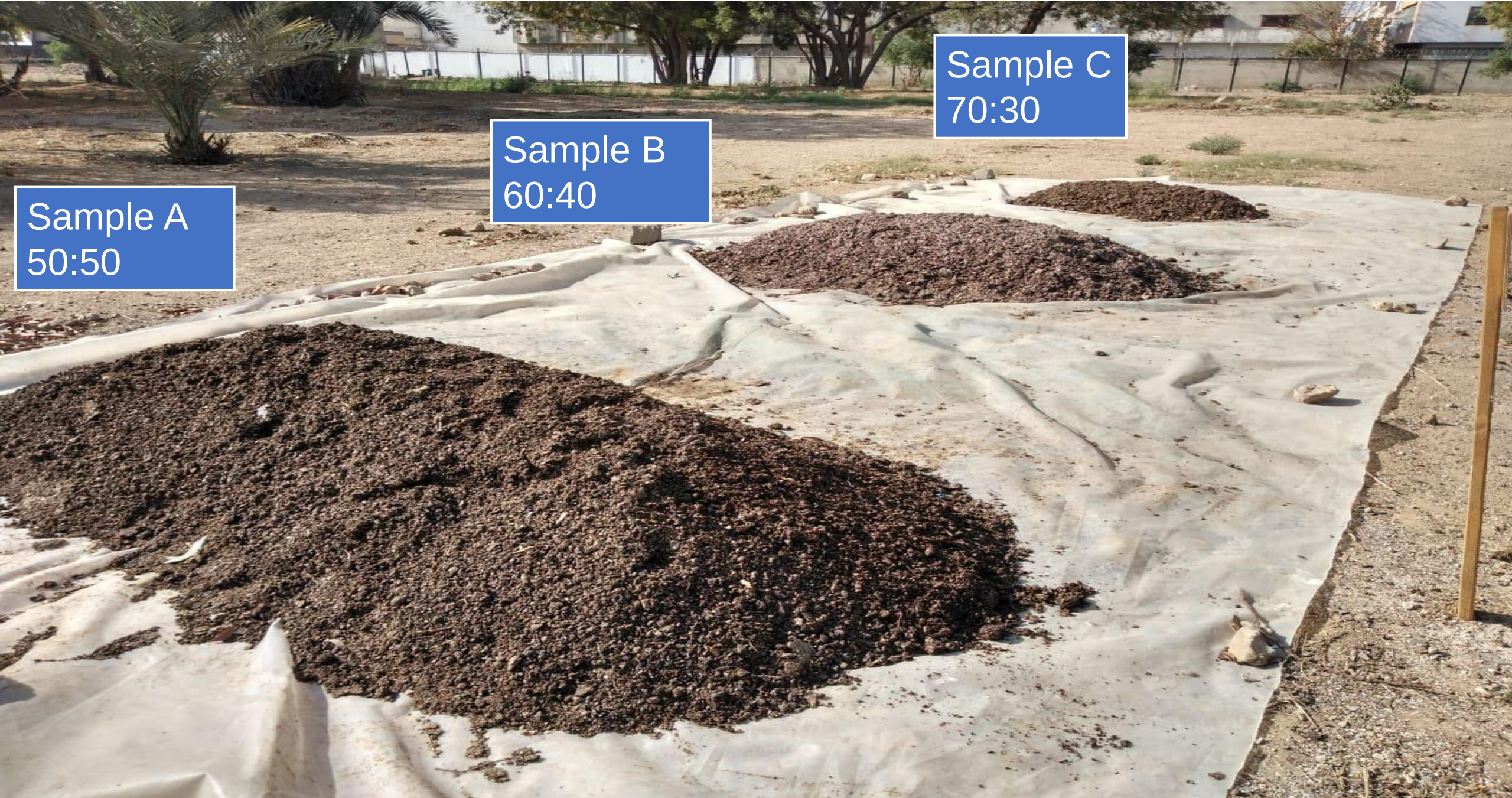
- Currently PSPC is producing 1-1.5 Tonnes of Shredded Paper Per Day
- A lab Test from M/S SGS shows 39.84% of Carbon
- We mixed our carbon rich waste with cow manure (Nitrogen Rich) in a ratio to maintain an ideal C:N Ratio.
- We prepared 3 samples with different ratios, named as A, B and C.



Sample A
50:50

Sample B
60:40

Sample C
70:30





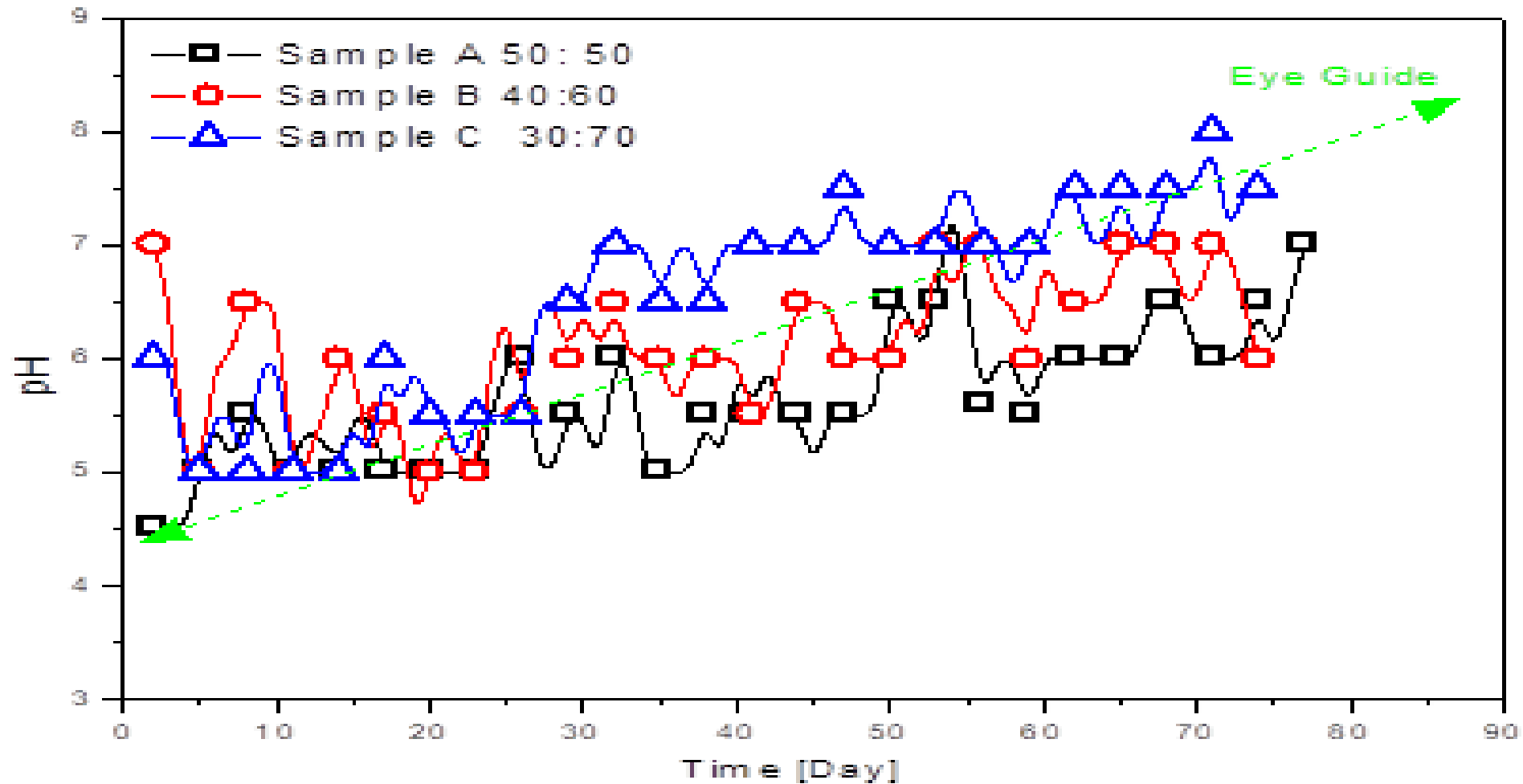
Physical Indicators of a Mature Compost

- It will have a dark brown color
- It will be crumbly, loose, and humus-like
- The pile will have shrunk in size from its original volume
- Minor/No Temperature Change
- pH Normalization
- Bag Test
- Germination Test



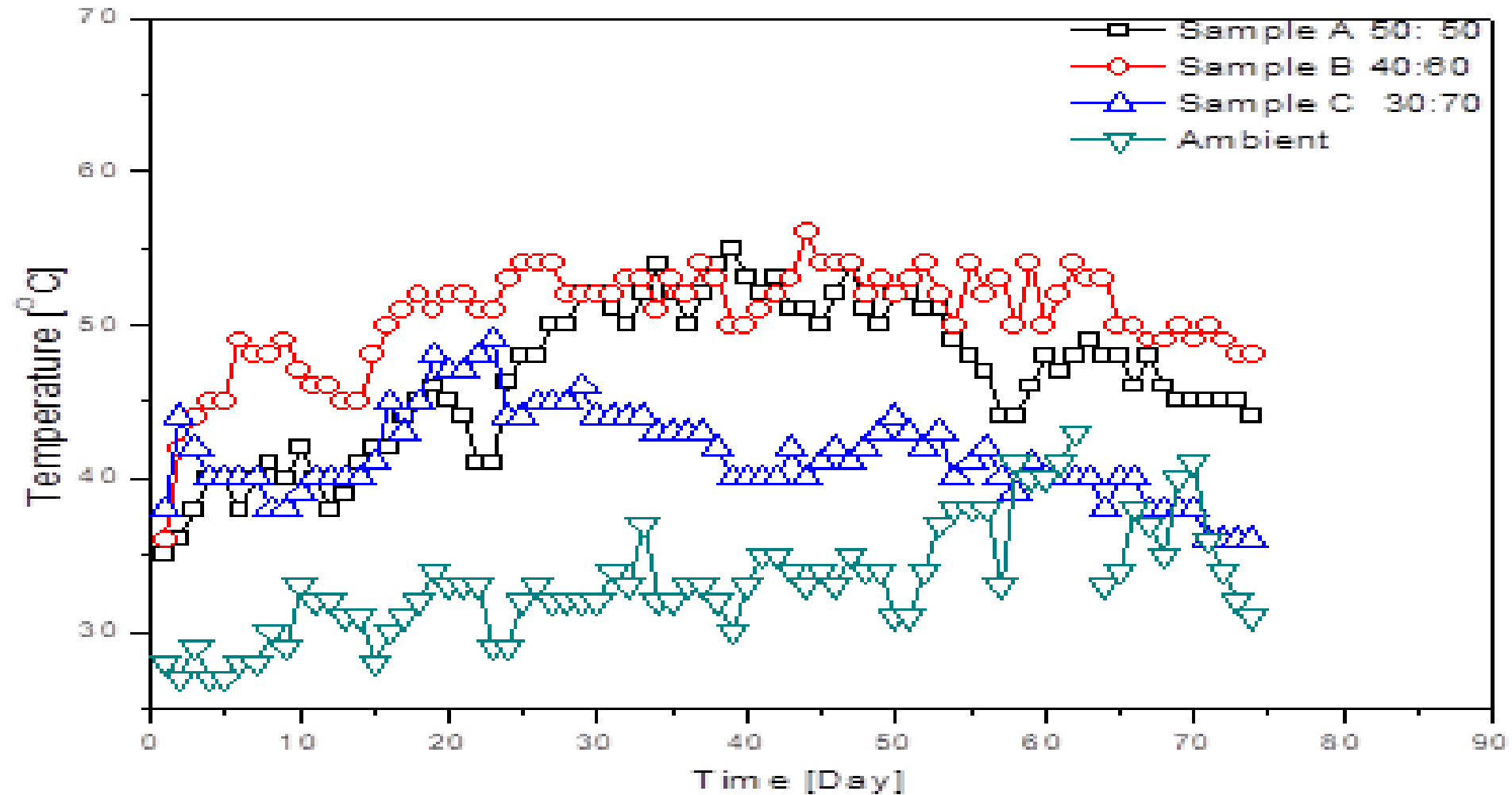


Variation in pH





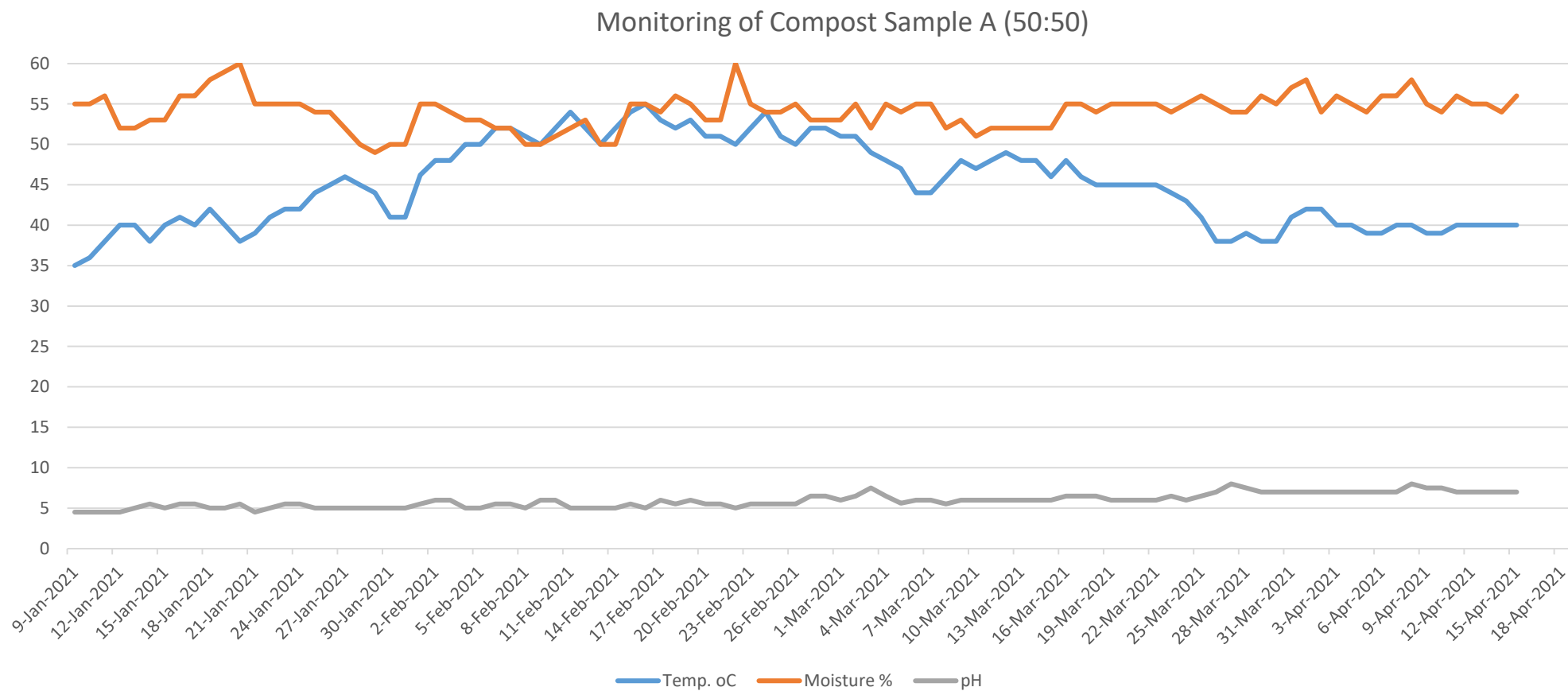
Variation in Temperature



Composting of Shredded Banknote Paper



Compost Sample A





Chemical Analysis

Comparison of General Parameters						
S. No.	Parameter	Method	Unit*	Sample A (50:50)	Sample B (60:40)	Sample C (70:30)
1	Total Nitrogen	APHA 4500-N C	g/Kg	15.98	17.35	8.20
2	Nitrogen Org N	APHA 4500-Norg B	g/Kg	15.74	16.98	13.47
3	Phosphorus (P ₂ O ₅)	APHA 4500-P	g/Kg	54.21	60.71	8.6
4	Phosphorus (P)	APHA 4500-P	g/Kg	11.83	13.25	0.75
5	Potassium	ASTM D-4192	g/Kg	47.14	40.25	1.88
6	Potassium as K ₂ O	ASTM D-4192	g/Kg	113.57	96.97	16.2
7	Organic Matter	APHA 2540	%	30.15	35.50	31.29
8	Organic Carbon	USEPA 9060A	%	16.22	18.81	16.89



Heavy Metals and Bacterial Analysis

Comparison of Heavy Metals & Other Parameters						
S. No.	Parameter	Method	Standard Value	Sample A (50:50)	Sample B (60:40)	Sample C (70:30)
1	Cadmium (mg/kg)	ASTM D-3557	1.5-3	1.63	1.3	0.8
2	Copper (mg/kg)	APHA 3500-Cu-B	150	70.23	55.26	0.04
3	Chromium (mg/kg)	ASTM D-1687	100	65.28	60.25	0.2
4	Lead (mg/kg)	ASTM D-3559	150-200	58.28	45.58	15.2
5	Mercury (mg/kg)	ASTM D-3223	1	0.56	0.45	0.15
6	Nickel (mg/kg)	ASTM D-3866	50-60	30.35	28.25	25
7	Zinc (mg/kg)	ASTM D-1691	300-700	215.24	180.28	69
8	Fecal Coliform (MPN/g)	USEPA 1681	1000	550	350.00	690
9	Salmonella (MPN/4g)	USEPA 1682	3	1.68	1.20	1.5
10	pH	ASTM-1239	7	6.493	6	6.5
11	Bulk Density (g/cm ³)	ASTM-06683	0.6-0.7	0.65	0.7	0.48



Results and Discussion

- A high quality compost with Total Nitrogen 15.98 g/kg and 30.15 % of Organic matter
- 11.83 g/kg and 47.14 g/kg of Phosphorus (P) and Potassium (K)
- Heavy Metals such as Cadmium, Nickel, Chromium, Lead and Mercury are within permissible limits as per International standards for good quality compost
- Fecal Coliform and Salmonella values are also far below the permissible limits i.e. 550 MPN*/g and 1.68 MPN*/4g.

*MPN : Most Probable Number



Application of Waste Paper Compost

- Seeds of Sunflower (*Helianthus annuus*) were collected from Karachi, Pakistan
- The experiment was carried out in a netted green house under control condition in Department of Botany, University of Karachi
- Seeds were germinated in plastic mugs (12 × 13 cm) that consist of sandy gravel soil with three different treatment: i) 1% compost (C1), ii) 2% compost (C2) and iii) control without compost (C).
- Within 10 days of sowing, emergence of radicals was observed from the seeds.
- Result of the present study shows that treatment with 1% compost increase plant height, number of leaves and root length significantly as compared with 0% (control) and 2% compost treatment



Cont'd



Composting of Shredded Banknote Paper



Cont'd



Composting of Shredded Banknote Paper



2 Months Old Urban Forest Plants



Composting of Shredded Banknote Paper



Cost of the Experiment and Utilized Area

- We utilized an Area of 20'X15' to prepare 3 samples of compost with a total weight around 700 kg
- The total project cost was around \$2500 USD including instruments, raw material and sample testing costs
- The project was completed by utilizing the remaining budget of PSPC Polyculture Forest



CONCLUSION

- Printed banknote paper waste resulted into high-quality compost with natural nutrients that are required to replenish the soil, e.g. NPK (Nitrogen, Phosphorus and Potassium) .
- Treatment of sunflower seeds with 1% compost (produced from Banknote) increased plant height, number of leaves and root length significantly
- The Physiochemical Analysis shows that the compost has no adverse effects onto the environment as the amount of heavy metals, Salmonella and Fecal Coliform are within the permissible limits as per international standards for a good quality compost.



Cont'd

- Composting process generates 0.59 ton lesser CO₂ per ton of banknote waste paper than the burning process.
- Only 0.87 Ton of CO₂/Ton of printed waste as compared to combustion/burning that produces 1.46 tons of CO₂/ton of printed waste paper.
- 320 tons of CO₂ emissions/annum through this technique
- Net profit of \$50-\$70/ton of compost. For PSPC, annual profit would be ranging from \$50k-\$70k.



Wastewater Sludge and Ink to Compost

- We performed an experiment with 12 different compositions of ETP Sludge, Decanter waste Sludge and Waste Ink from Intaglio
- Physiochemical analysis shows that these samples are unable to compost under aerobic conditions
- An experiment for Biogas production from wastewater sludge and conversion of digested waste into organic compost under anaerobic conditions may be performed (Mehran University of Engineering and Technology (MUET) has already done a similar project for textile wastewater)



Ink Composting Experiment Site







References

- [1] “(PDF) An Overview of Organic Waste in Composting.”
https://www.researchgate.net/publication/299574947_An_Overview_of_Organic_Waste_in_Composting
(accessed Nov. 05, 2021).
- [2] H. Abdel-Shafy and M. Mansour, “Solid waste issue: Sources, composition, disposal, recycling, and valorization,” Egypt. J. Pet., vol. 27, pp. 1275–1290, Dec. 2018, doi: 10.1016/j.ejpe.2018.07.003.
- [3] “WI_KComposting1.pdf.” Accessed: Nov. 05, 2021. [Online]. Available:
http://www.gov.pe.ca/photos/original/WI_KComposting1.pdf
- [4] “(PDF) Design and Study for Composting Process Site.”
https://www.researchgate.net/publication/329000060_Design_and_Study_for_Composting_Process_Site
(accessed Nov. 05, 2021).
- [5] “9060a.pdf.” Accessed: Nov. 05, 2021. [Online]. Available: <https://www.epa.gov/sites/default/files/2015-12/documents/9060a.pdf>
- [6] M. S. Ayilara, O. S. Olanrewaju, O. O. Babalola, and O. Odeyemi, “Waste Management through Composting: Challenges and Potentials,” Sustainability, vol. 12, no. 11, Art. no. 11, Jan. 2020, doi: 10.3390/su12114456.
- [7] Z. Li, H. Lu, L. Ren, and L. He, “Experimental and modeling approaches for food waste composting: A review,” Chemosphere, vol. 93, no. 7, pp. 1247–1257, Oct. 2013, doi: 10.1016/j.chemosphere.2013.06.064.



- [8] J. Schleppenbach, "The Art and Science of Composting FINAL PDF", Accessed: Nov. 05, 2021. [Online]. Available: https://www.academia.edu/6189229/The_Art_and_Science_of_Composting_FINAL_PDF
- [9] "ResearchGate Link." Accessed: Nov. 05, 2021. [Online]. Available: https://www.researchgate.net/publication/341847585_Waste_Management_through_Composting_Challenges_and_Potentials
- [10] "Full Text PDF." Accessed: Nov. 05, 2021. [Online]. Available: <https://www.mdpi.com/2071-1050/12/11/4456/pdf>
- [11] H. Zhu and X. Shang, "A Rare Cause of Late-Onset Epilepsy: Linear Scleroderma en Coup de Sabre," Case Rep. Clin. Med., vol. 05, no. 04, pp. 150–153, 2016, doi: 10.4236/crcm.2016.54028.
- [12] "Springer Full Text PDF." Accessed: Nov. 05, 2021. [Online]. Available: <https://link.springer.com/content/pdf/10.1007%2Fs13165-017-0180-z.pdf>
- [13] M. Kumar, Y.-L. Ou, and J. Lin, "Co-composting of green waste and food waste at low C/N ratio," Waste Manag., vol. 30, pp. 602–9, Apr. 2010, doi: 10.1016/j.wasman.2009.11.023.



- [14]S. Tripetchkul, K. Pundee, S. Koonsrisuk, and S. Akeprathumchai, "Co-composting of coir pith and cow manure: initial C/N ratio vs physico-chemical changes," *Int. J. Recycl. Org. Waste Agric.*, vol. 1, Dec. 2012, doi: 10.1186/2251-7715-1-15.
- [15]S. M. Tiquia and N. F. Y. Tam, "Elimination of phytotoxicity during co-composting of spent pig- manure sawdust litter and pig sludge," *Bioresour. Technol.*, vol. 65, no. 1, pp. 43–49, Jul. 1998, doi: 10.1016/S0960-8524(98)00024-8.
- [16]M. P. Bernal, J. A. Alburquerque, and R. Moral, "Composting of animal manures and chemical criteria for compost maturity assessment. A review," *Bioresour. Technol.*, vol. 100, no. 22, pp. 5444– 5453, Nov. 2009, doi: 10.1016/j.biortech.2008.11.027.
- [17]A. Makan, O. Assobhei, and M. mohammed Mountadar, "Effect of initial moisture content on the in- vessel composting under air pressure of organic fraction of municipal solid waste in Morocco," *Iran. J. Environ. Health Sci. Eng.*, vol. 10, p. 3, Jan. 2013, doi: 10.1186/1735-2746-10-3.
- [18]"Municipal Solid Waste Composting Fact Sheet Series - Key Aspects of Compost Quality Assurance." Accessed: Nov. 05, 2021. [Online]. Available: <http://compost.css.cornell.edu/MSWFactSheets/msw.fs7.html>