

BUSITEMA UNIVERSITY
FACULTY OF ENGINEERING AND
TECHNOLOGY
DEPARTMENT OF POLYMER TEXTILE AND INDUSTRIAL
ENGINEERING

FINAL YEAR PROJECT REPORT

DEVELOPMENT OF A SUPERABSORBENT
MATERIAL FROM A MODIFIED BLEND OF
BANANA AND SUGARCANE BAGASSE FIBERS

By

KEFFA ZIZINGA

&

NAMISI DANCAN

**This Project Report is submitted to the Faculty of Engineering and
Technology in Partial Fulfillment of the Requirement for the Award of the
Degree of Bachelor of Science in Polymer Textile and Industrial Engineering
of Busitema University.**

MAY 2025



FINAL YEAR PROJECT REPORT
DEVELOPMENT OF SUPERABSORBENT MATERIAL FOR
DIAPERS FROM A MODIFIED BLEND OF SUGARCANE
BAGASSE AND BANANA FIBERS

By

KEFFA ZIZINGA (BU/UP/2021/0353)

&

NAMISI DANCAN (BU/UP/2021/0365)

SUPERVISORS

DR. MUSINGUZI ALEX

MR. TUMISIIME GODIAS

MR. OKINYI SAMM

MAY 2025

ABSTRACT

Superabsorbent materials are used in a vast number of applications including medical, industrial, agricultural and personal care products. The rapid growth in the textile industry and improvement in technology has tasked innovators to diversify on the different textile raw materials for various applications improving on the utilization and management of resources. Banana fibers have been utilized for clothing application and bagasse fibers used for cleaning oil floors due to their reasonable absorbency. In efforts to curb plastic pollution the national environment authority (NEMA) came with a national strategy for management of plastic pollution (2023 to 2028) which involves shaping market for plastic alternatives. The fibers were blended by carding processes to obtain a thorough mixture of the fluff fiber pulp. Box Behnken Design (BBD) as the response surface methodology RSM was used considering factors acrylic acid, fibers, potassium persulfate, time, temperature for polymerization and cross-linking Graft polymerization was carried out on the carded fiber fluff pulp using acrylic acid and potassium persulfate as the initiator and crosslinked using N, N-methylene bisacrylamide (MBA).

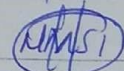
Keywords: Graf polymerization, shredding, blending, cross-linking, initiator.

DECLARATION

I KEFFA ZIZINGA with NAMISI DANCAN we declare that this research report has been compiled by us and has never been used for any academic reward at an institute of learning or level of education.

Signature 

Date 21/05/2025

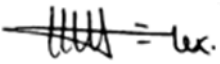
Signature 

Date 21/05/2025

APROVAL

This project report has been written under the supervision of the following supervisors.

Dr. MUSINGUZI ALEX

Signature  _____

Date _____ 16/05/2025 _____

Mr. TUMUSIIME GODIAS

Signature  _____

Date _____ 19/05/2025 _____

Mr. OKINYI SAMM

Signature _____

Date _____

ACKNOWLEDGEMENT

We are so much grateful and thankful for God's providence and guidance through our research and compilation of this research.

We also extend our sincere gratitude to our supervisors for the knowledge and guidance and to our fellow course mates who have also endlessly assisted in all times of need.

Contents

ABSTRACT	i
DECLARATION	ii
APPROVAL	iii
ACKNOWLEDGEMENT	iv
List of tables	vii
List of figures.....	viii
List of acronyms	ix
CHAPTER ONE: INTRODUCTION.....	1
Background.....	1
1.1 PROBLEM STATEMENT	3
1.2 OBJECTIVES OF STUDY	4
1.3 JUSTIFICATION.....	5
1.4 SIGNIFICANCE.....	6
1.5 SCOPE OF STUDY	7
CHAPTER TWO: LITERATURE REVIEW	8
2.1 Description of the problem	8
2.2 RAW MATERIALS	9
2.3 EXTRACTION METHODS	11
2.4 Characterization of fibers	13
2.5 Fiber modification techniques	14
CHAPTER THREE: METHODOLOGY	17
3.1 Materials and equipment.....	17
3.2 To characterize fibers from sugarcane and banana plant.....	17
3.2.1 Pre-hydrolysis and alkaline curing of banana fibers	17
3.2.2 Characterization	19
3.3 To determine the mixing ratio of banana bagasse fibers for absorbency.....	19
3.4 To develop the super absorbent material and evaluate absorbency	19
CHAPTER FOUR: RESULTS AND DISCUSSIONS	21

4.1 To characterize fibers from sugarcane and banana plant	21
4.1.1 Characterization	21
4.1.2 Scanning electron microscope results.....	23
4.2 To determine the mixing ratio of banana bagasse fibers for absorbency.....	24
4.3 To develop the super absorbent material and evaluate absorbency	26
CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS	36
5.1 CONCLUSION	36
5.2 CHALLENGES	36
5.4 RECOMENDATIONS.....	37
5.6 REFRENCES.....	38
5.5 APPENDENCIES	41

List of tables

Table 1. Mechanical properties of banana and bagasse fibers.....	12
Table 2. Chemical composition of banana and sugarcane bagasse fibers	13
Table 3. FTIR band origins and their positions	13
Table 4. BBD factors optimization	20
Table 5. Representing high absorbency fiber ratio	25
Table 6-BBD Experimental results	26
Table 7. Analysis of variance	27

List of figures

Figure 0-1. banana plant	10
Figure 0-2. Sugarcane bagasse	11
Figure 0-1. Banana fiber FTIR characterization	21
Figure 0-2. sugarcane bagasse fiber FTIR characterization.....	22
Figure 0-3. treated banana fibers	23
Figure 0-4 Untreated banana fibers	23
Figure 0-5. treated sugarcane bagasse fibers	24
Figure 0-6. untreated sugarcane bagasse fibers	24
Figure 0-7. Mean perturbation graphs for absorption percentage	29
Figure 0-8. Optimal plots	30
Figure 0-9. Surface plots	33
Figure 0-10. Contour plots	33
Figure 0-11. FTIR characterization of the absorbent material	33

Figure 0-1. banana plant	10
Figure 0-2. Sugarcane bagasse	11
Figure 0-1. Banana fiber FTIR characterization	21
Figure 0-2. sugarcane bagasse fiber FTIR characterization.....	22
Figure 0-3. treated banana fibers	23
Figure 0-4 Untreated banana fibers	23
Figure 0-5. treated sugarcane bagasse fibers	24
Figure 0-6. untreated sugarcane bagasse fibers	24
Figure 0-7. Mean perturbation graphs for absorption percentage	29
Figure 0-8. Optimal plots	30
Figure 0-9. Surface plots	33
Figure 0-10. Contour plots	33
Figure 0-11. FTIR characterization of the absorbent material	33

List of acronyms

NaOH	Sodium hydroxide
CH ₃ COOH	Acetic acid
H ₂ O ₂	Hydrogen peroxide
NPD	National Development Plan
SDG	Sustainable Development Goals
UBOS	Uganda Bureau of Statistics
FTIR	Fourier Transform Infrared

5.6 REFERENCES

- Azcarate, S. M., Teglia, C. M., Chiappini, F. A., & Goicoechea, H. C. (2023). Fundamentals of design of experiments and optimization: Experimental designs in response surface methodology. In *Introduction to Quality by Design in Pharmaceutical Manufacturing and Analytical Development* (pp. 47-66). Springer.
- Badanayak, P., Jose, S., & Bose, G. (2023). Banana pseudostem fiber: A critical review on fiber extraction, characterization, and surface modification. *Journal of Natural Fibers*, 20(1), 2168821.
- Balda, S., Sharma, A., Capalash, N., & Sharma, P. (2021). Banana fibre: a natural and sustainable bioresource for eco-friendly applications. *Clean Technologies and Environmental Policy*, 23, 1389-1401.
- Beg, S., & Akhter, S. (2021). Box–Behnken designs and their applications in pharmaceutical product development. *Design of experiments for pharmaceutical product development: volume I: basics and fundamental principles*, 77-85.
- Begum, H. A., Tanni, T. R., & Shahid, M. A. (2021). Analysis of water absorption of different natural fibers. *Journal of Textile Science and Technology*, 7(4), 152-160.
- Bhanu Rekha, V., Prakash, C., & Gowri, K. (2022). Synthesis and characterization of superabsorbent natural polymers from agro-waste fibres. *Indian Journal of Fibre & Textile Research (IJFTR)*, 47(4), 395-402.
- Daghaghele, S., Kiasat, A. R., Safieddin Ardebili, S. M., & Mirzajani, R. (2021). Intensification of extraction of antioxidant compounds from Moringa oleifera leaves using ultrasoundassisted approach: BBD-RSM design. *International journal of fruit science*, 21(1), 693705.
- Damiri, F., Salave, S., Vitore, J., Bachra, Y., Jadhav, R., Kommineni, N., Karouach, F., PaivaSantos, A. C., Varma, R. S., & Berrada, M. (2024). Properties and valuable applications of superabsorbent polymers: A comprehensive review. *Polymer Bulletin*, 81(8), 6671-6701.
- Devadiga, D. G., Bhat, K. S., & Mahesha, G. (2020). Sugarcane bagasse fiber reinforced composites: Recent advances and applications. *Cogent Engineering*, 7(1), 1823159.
- Farirai, F., Shonhiwa, C., Mupa, M., & Daramola, M. (2020). Compositional analysis of Zimbabwean sugarcane bagasse ash towards production of nano silicon for solar cell application. *Valorization of Biomass to Value-Added Commodities: Current Trends, Challenges, and Future Prospects*, 47-57.
- Ferede, E., & Atalie, D. (2022). Mechanical and water absorption characteristics of sisal fiber reinforced polypropylene composite. *Journal of Natural Fibers*, 19(16), 14825-14838.
- Gond, R., Gupta, M., & Jawaid, M. (2021). Extraction of nanocellulose from sugarcane bagasse and its characterization for potential applications. *Polymer Composites*, 42(10), 54005412.
- Gronborg, K. C., Giles, S. M., & Garrett-Roe, S. (2022). Rotationally-resolved two-dimensional infrared spectroscopy of CO₂ (g): Rotational wavepackets and angular momentum transfer. *The Journal of Physical Chemistry Letters*, 13(34), 8185-8191.
- Guimaraes, J. L., Frollini, E., Da Silva, C., Wypych, F., & Satyanarayana, K. (2009). Characterization of banana, sugarcane bagasse and sponge gourd fibers of Brazil. *Industrial Crops and Products*, 30(3), 407-415.

- Hiranobe, C. T., Gomes, A. S., Paiva, F. F., Tolosa, G. R., Paim, L. L., Dognani, G., Cardim, G. P., Cardim, H. P., dos Santos, R. J., & Cabrera, F. C. (2024). Sugarcane bagasse: challenges and opportunities for waste recycling. *Clean technologies*, 6(2), 662-699. <IJNRD2304016.pdf>.
- Kaur, A., Varghese, L. M., Battan, B., Patra, A. K., Mandhan, R. P., & Mahajan, R. (2020). Biodegumming of banana fibers using eco-friendly crude xylano-pectinolytic enzymes. *Preparative Biochemistry & Biotechnology*, 50(5), 521-528.
- Kim, D., Seo, K., & Park, K. (2004). Polymer composition and acidification effects on the swelling and mechanical properties of poly (acrylamide-co-acrylic acid) superporous hydrogels. *Journal of Biomaterials Science, Polymer Edition*, 15(2), 189-199.
- Ma, X., & Wen, G. (2020). Development history and synthesis of super-absorbent polymers: a review. *Journal of Polymer Research*, 27(6), 136.
- Mehraz, L., & Nouri, M. (2020). Modification of silk fibers via β -cyclodextrin—empirical modeling and process optimization using response surface methodology. *Journal of Natural Fibers*, 17(8), 1225-1237.
- Michel, D., Bachelier, B., Drean, J.-Y., & Harzallah, O. (2013). Preparation of cellulosic fibers from sugarcane for textile use. Conference Papers in Science,
- Prem Chand, R., Ravitej, Y., & Shiva Mani Kanta, J. (2020). Characterization of banana and bagasse fiber-reinforced hybrid epoxy composites. *Advances in Fluid Mechanics and Solid Mechanics: Proceedings of the 63rd Congress of ISTAM 2018*,
- Ramesh, M., Palanikumar, K., & Reddy, K. H. (2017). Plant fibre based bio-composites: Sustainable and renewable green materials. *Renewable and Sustainable Energy Reviews*, 79, 558-584.
- Rosa, F., & Casquilho, M. (2012). Effect of synthesis parameters and of temperature of swelling on water absorption by a superabsorbent polymer. *Fuel Processing Technology*, 103, 174177.
- Schramm, C. (2020). High temperature ATR-FTIR characterization of the interaction of polycarboxylic acids and organotrialkoxysilanes with cellulosic material. *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, 243, 118815.
- Shanmugasundaram, O., & Gowda, R. (2010). Development and characterization of bamboo and organic cotton fibre blended baby diapers.
- Twebaze, C., Zhang, M., Zhuang, X., Kimani, M., Zheng, G., & Wang, Z. (2022). Banana fiber degumming by alkali treatment and ultrasonic methods. *Journal of Natural Fibers*, 19(16), 12911-12923.
- Wuttisela, K., Panijpan, B., Triampo, W., & Triampo, D. (2008). Optimization of the water absorption by crosslinked agar-g-poly (acrylic acid). *Polymer (Korea)*, 32(6), 537-543.
- Yew, B. S., Muhamad, M., Mohamed, S. B., & Wee, F. H. (2019). Effect of alkaline treatment on structural characterisation, thermal degradation and water absorption ability of coir fibre polymer composites. *Sains Malays*, 48(3), 653-659.

- Yiga, V. A., Lubwama, M., Opio, J., Menya, E., Nono, D., & Nalubega Lubwama, H. (2023). Production and characterization of paper from banana stem fiber: optimization using BoxBehnken Design (BBD). *Journal of Natural Fibers*, 20(1), 2192019.
- Yussni, M. (2012). Mercerization parameters effect on natural fiber reinforced polymer matrix composite: A review. *Journal of Advanced Manufacturing Technology (JAMT)*, 6(1).
- Zhang, M., Li, M., Ye, J., Zheng, G., Wang, Z., Zhuang, X., Yang, Y., Liu, Q., Su, H., & Shao, J. (2025). Optimization of banana fibers degumming by high temperature alkaline method and spinning. *The Journal of The Textile Institute*, 116(3), 427-435.