

**PRODUCTION OF CELLULOSE-BASED SUPERABSORBENT
POLYMER FROM WATER HYACINTH**
(Eichhornia crassipes)

MENOR, KENNY LOUIE M.

An Undergraduate Thesis Submitted to the Faculty of the Department of Agricultural and
Biosystems Engineering, College of Engineering, Central Luzon State University,
Science City of Munoz, Nueva Ecija, Philippines
in Partial Fulfillment of the Requirements
for the Degree of

**BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS
ENGINEERING**
Major in Process Engineering

JUNE 2023

TABLE OF CONTENTS

	Page
LIST OF FIGURES	viii
LIST OF TABLES	ix
LIST OF APPENDIX TABLES	x
LIST OF APPENDIX FIGURES.....	xi
ABSTRACT.....	xii
INTRODUCTION	1
Background of the Study	1
Statement of the Problem	3
Objective of the Study	3
Significance of the Study.....	4
Scope and Limitations of the Study.....	4
Time and Place of the Study.....	5
REVIEW OF RELATED LITERATURE.....	6
Superabsorbent Polymer.....	6
Water Absorption Mechanism of SAPs.....	9
Roles of Cellulose in SAP	10
Feasibility of Water Hyacinth as Superabsorbent Polymer.....	11
Effects of SAP to Polluted Lands	11
Effects of SAP to Soil.....	12
Effects of SAP to Various Crop	13
Crosslinking in SAP	14
Instruments and Equipment	17
Super absorbency Test of the SAP	18
Isolation of Cellulose from Water Hyacinth.....	19
Synthesis of SAP	20
METHODOLOGY	21
Conceptual Framework.....	21
Research Design	22
Isolation of Cellulose from Water Hyacinth.....	23
Synthesis of SAP	23

Data Gathering	24
Super Absorbency Test of the SAP	24
Salient Properties of Powdered SAP	24
Data Analysis	25
Cost Analysis	25
RESULTS AND DISCUSSIONS	27
Superabsorbent Polymer from Water Hyacinth	27
Production Protocol for SAP From Water Hyacinth	28
Isolation of Cellulose	30
Physical Properties of SAP	31
Water Absorbency Test of SAP	32
Cellulose-based SAP vs Fossil-based SAP	33
Cost Plan of Production	33
SUMMARY	36
CONCLUSION	38
RECOMMENDATION	39
LITERATURE CITED	40
APPENDICES	42
Appendix Table	42
Appendix Figures	49

LIST OF TABLES

TABLE		Page
1	Experimental Layout of the Study	22
2	Cellulose Obtained from Water Hyacinth	30
3	Cost Production per 500g Cellulose	34
4	Cost Production per 500g SAP	35

LIST OF FIGURES

FIGURE		Page
1	Water Absorption Mechanism	9
2	Process flow diagram of cellulose isolation from water hyacinth	19
3	Process flow diagram of SAP synthesis	20
4	Conceptual framework of the study	21
5	Synthesized SAP from Water Hyacinth	27
6	Production Protocol of SAP	29
7	Cellulose applied vs Water Absorbed (%) Graph	32

LIST OF APPENDIX TABLES

TABLE		Page
1	Calendar of Activities for the Duration of Experiment	42
2	Raw Data Collected for SAP Test	43
3	Raw Data for Properties of SAP	44
4	Table of Analyzed Data	45
5	ANOVA Table	46
6	Summary Statistics	47
7	Standard Errors	47
8	Pairwise Mean Comparison of Treatments	47
9	Summary of Results	48

LIST OF APPENDIX FIGURES

Figure		Page
1	Collection of Water Hyacinth (1 st site)	49
2	Drying of Water Hyacinth (1 st batch)	49
3	Isolation and Bleaching of Cellulose (1 st batch)	50
4	Air drying and grinding of cellulose (1 st batch)	50
5	Collection of Water Hyacinth (2 nd site)	50
6	Drying of Water Hyacinth (2 nd batch)	51
7	Isolation and Bleaching of Cellulose (2 nd batch)	51
8	Air drying and grinding of cellulose (2 nd batch)	51
9	Collection of Water Hyacinth (3 rd site)	52
10	Drying of Water Hyacinth (3 rd batch)	52
11	Isolation and Bleaching of Cellulose (3 rd batch)	52
12	Air drying and grinding of cellulose (3 rd batch)	53
13	Synthesis of SAP	53
14	Testing for Water Absorbency	53

ABSTRACT

MENOR, KENNY LOUIE M., Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University, Science City of Munoz, Nueva Ecija Philippines, March 2023, **PRODUCTION OF CELLULOSE-BASED SUPERABSORBENT POLYMER FROM WATER HYACINTH (*Eichhornia Crassipes*)**

Adviser: **THEODY B. SAYCO**, Ph.D.

Renewable resources from natural polymer such as cellulose from water hyacinth was used to synthesize and produce super absorbent polymer. The isolation of cellulose from water hyacinth was done through refluxation and bleaching process which was then use for the creation of superabsorbent polymer. The characterization of the synthesized SAP was done through observation and calculation method was done in getting its water absorption. An experiment was conducted to see the difference in terms of water absorption between the cellulose-based SAP from water hyacinth and petroleum-based SAP from feminine pad and diaper. The extracted cellulose from water hyacinth was mixed with sodium carboxymethyl cellulose and aluminum sulfate to produce superabsorbent polymer. The physical properties of the shredded SAP were observed to be light yellow to white and color, odorless, hard and brittle texture, lightweight, and flake to sugar-like structure. The SAP was tested for its water absorbency by immersing it on water for 5 mins. Results of this study revealed that increasing amount of isolated cellulose applied for the synthesis and production of SAP increases the water absorbency by a rate of 600-900% more than its initial weight. The water absorbency of SAP from water hyacinth was also compared against petroleum-based SAPs like feminine pads and diapers. The results showed that

SAPs from feminine pads and diapers has water absorbency of 2462% and 6343.33%, respectively, which is expected due to their chemical stability. The produced SAP from water hyacinth costs 1680.21 which is cheaper than commercially available synthetic SAP. With their far below expected absorption capacity, cellulose-based SAPs are environmentally compatible with soil and plants and does not have any adverse effects when applied and does not release harmful by-products unlike petroleum-based SAPs. The depleting and toxic nature petroleum-based polymeric materials gives rise to the use of renewable resources like biopolymers as polymeric material in water irrigation, tissue engineering, and bio-ethanol production.

Keywords: cellulose, petroleum, SAP

LITERATURE CITED

- D'Odorico, P., Davis, K., Rosa, L., Carr, J., Chiarelli, D., & Dell'Angelo, J. et al. (2018). The Global Food-Energy-Water Nexus. *Reviews of Geophysics*, 56(3), 456-531. Retrieved from <https://doi.org/10.1029/2017rg000591>
- Rosa, L., Rulli, M., Davis, K., Chiarelli, D., Passera, C., & D'Odorico, P. (2018). Closing the yield gap while ensuring water sustainability. *Environmental Research Letters*. Retrieved from <http://dx.doi.org/10.1088/1748-9326/aadeef>
- Rejesus, R., Palis, F., Rodriguez, D., Lampayan, R., & Bouman, B. (2022). *Impact of the alternate wetting and drying (AWD) water-saving irrigation technique: Evidence from rice producers in the Philippines*. *Food Policy*, 36, 280-288. Retrieved from <http://dx.doi.org/10.1016/j.foodpol.2010.11.026>
- Chen, X., Mao, X., Lu, Q., Liao, Z., & He, Z. (2016). Characteristics and mechanisms of acrylate polymer damage to maize seedlings. *Ecotoxicology And Environmental Safety*, 129, 228-234. Retrieved from <https://doi.org/10.1016/j.ecoenv.2016.03.018>
- Abrisham, E., Jafari, M., Tavili, A., Rabii, A., Zare Chahoki, M., & Zare, S. et al. (2018). Effects of a super absorbent polymer on soil properties and plant growth for use in land reclamation. *Arid Land Research and Management*, 32(4), 407-420. Retrieved from <https://doi.org/10.1080/15324982.2018.1506526>
- Esposito, F., Del Nobile, M., Mensitieri, G., & Nicolais, L. (1996). Water sorption in cellulose-based hydrogels. *Journal of Applied Polymer Science*, 60(13), 2403-2407. Retrieved from [https://doi.org/10.1002/\(sici\)1097-4628\(19960627\)60:13<2403:aid_app12>3.0.co;2-5](https://doi.org/10.1002/(sici)1097-4628(19960627)60:13<2403:aid_app12>3.0.co;2-5)
- Chang, L., Xu, L., Liu, Y., & Qiu, D. (2020). *Superabsorbent polymers used for agricultural water retention*. *Polymer Testing*, 94, 107021. Retrieved from <http://dx.doi.org/10.1016/j.polymertesting.2020.107021>
- Modelli, A., Rondinelli, G., Scandola, M., Mergaert, J., & Cnockaert, M. (2004). *Biodegradation of Chemically Modified Flax Fibers in Soil and in Vitro with Selected Bacteria*. *Biomacromolecules*, 5, 596-602. Retrieved from <http://dx.doi.org/10.1021/bm0344203>
- L. Chang, L. Xu, Y. Liu, D. Qiu. (2021). Superabsorbent polymers used for agricultural water retention, *Polymer Testing*. Retrieved from <https://doi.org/10.1016/j.polymertesting.2020.107021>.

- Zhang, M., Zhang, S., Chen, Z., Wang, M., Cao, J., & Wang, R. (2019). Preparation and Characterization of Superabsorbent Polymers Based on Sawdust. *Polymers*, *11*(11), 1891. MDPI AG. Retrieved from <http://dx.doi.org/10.3390/polym11111891>
- Ramirez, A. & Maria, R. (2022). Production of cellulose-based superabsorbent polymers for soil water retention. Electronic Thesis and Dissertation Repository.9093. Retrieved from <https://ir.lib.uwo.ca/etd/9093>
- Cuadri AA, Romero A, Bengoechea C, Guerrero A. (2017). Natural superabsorbent plastic materials based on a functionalized soy protein. *Polym Test*. doi: 10.1016/j.polymertesting.2016.12.024.
- Czarnecka, E., & Nowaczyk, J. (2020). Semi-Natural Superabsorbents Based on Starch-g-poly(acrylic acid): Modification, Synthesis and Application. *Polymers*, *12*(8), 1794–. doi:10.3390/polym12081794