

**SYNTHESIS AND PRODUCTION OF BIODEGRADABLE POLYMERS FROM LOW COST
PLANT RESOURCES WITH CASE STUDY OF CASSAVA STARCH**

BY

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**A RESEARCH PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF CHEMISTRY
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DECLARATION


I Magoola Morris declare that the information laid down in this project report was obtained from the different activities that I carried out in my research project held at Busitema University laboratory. Therefore, this is to certify that this research project report is my original work and has never been submitted or published for any other degree award in any higher institution of learning.

Signature.....Magoola Morris..... Date 24th /May/2023

MAGOOOLA MORRIS

APPROVAL

This is to certify that Magoola Morris, Registration Number BU/UP/2019/1595, pursuing Bachelor's Degree in Science Education did this research project and compiled this report under my supervision and it is ready for submission to the department of Chemistry.

Signature... Date... 24/May/2023

Dr. Kamoga Omar Lwako

DEDICATION

I dedicate this research project to my beloved parents Mr. Nalugoda Aggrey and Mrs. Nanangwe Doreen, my brothers Nalugoda Musa and Kakaire Aaron, sisters and all who made me what I am today.

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LIST OF ACRONYMS

DS- Degree of substitution

TGA- Thermal Gravimetric Analysis

FTIR- Fourier Transform Infrared Spectroscopy

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ABSTRACT

Cassava is one of the commonly, cheap and available food resource of interest in making the biodegradable polymers. Biodegradable polymers constitute of being less harmful to the environment compared to the non-biodegradable ones. Once these polymers are exposed to the environment they take some time in the environment then afterwards are worked upon by the microorganisms (enzyme catalytic action) hence get decomposed into soil particles and become useful to the environment.

The main interest of the biodegradable polymers is that they can even add value to the soil once decomposed that is to say soil formation, manure etc. Synthesis and production of these polymers is accompanied by different chemical reactions (esterification modification reactions) for example acetylation, gelatinization, and use of dicarboxylic acids. These modifications aim at identifying the DS of the hydroxyl groups by the different reagents used. DS is also determined using different methods for example X-ray diffraction, FTIR analysis, TGA. These provide how the starch was substituted and also testing the different properties of the polymers got. DS is important in application of the polymers got for example highly substituted polymers are used in textile industries to produce plastics compared to the less substituted ones.

Therefore, the need to reduce on the increased usage of plastics in our country Uganda there should be a suggestion on how to mitigate this, through coming up with different ideas on substituting them. Assessment of the biodegradable polymers can be discussed in broad to understand the similarities and differences between the structures, properties and their behavior before and even after application of them in the environment.

CHAPTER ONE: INTRODUCTION

1.1 Back ground of the study.

Cassava botanically known as *Manihot esculenta* is a root plant tuber that is grown at large scale by most of the people that live in Uganda for both eating and as means of earning income through selling it (Ezeoha and Ezenwanne 2013). It is predominately consumed after peeling it and then cooking it, but also it has some other importance after substantial quantities are used to extract cassava starch called tapioca, normally used as food, animal feeds and even for industrial purposes (Logeshwaran, Sabarinath et al. 2020). Cassava starch therefore refers to starch that is made and got from leaching and drying of the root of cassava plant (Mulyono, Suhartono et al. 2015).

Bio degradable polymers refer to polymers that when subjected to the environment can be decomposed chemically into metabolic products through enzymatic work of the microorganisms (bacteria and fungus) in the soil and hence have no effect on the environment (Quintana, Sanabria et al. 2021). Examples of these metabolic products are soil particles, water, biomass, carbon dioxide and methane that are friendly to the environment (Emmanuel, Agnes et al. 2012). In Uganda today almost every house hold uses plastics which after disposal of the plastic wastes have harmful effects to the environment (Oladunmoye, Aworh et al. 2014). Due to the rampant increase in the population in Uganda there is seemingly an increase in the use of these plastics in daily life hence there will be high impact on the environment for example there will be fumes from these plastics during burning them that is to say carbon dioxide, carbon monoxide and other rare gases will be emitted that will eventually lead to global warming and suffocation of the animal lives (Oladunmoye, Aworh et al. 2014). Still most of these plastics are composed of non-biodegradable polymers for example polyethenes, polyvinyl chlorides, polypropylenes and others where by once used and deposited to the environment cannot be worked upon by the microorganisms through enzymatic work (Cipurkovic, Horozic et al. 2018).

Therefore, the best alternative was to come up with better solutions on how we can combat these non-biodegradable plastic wastes is to substitute the rampant use of these uneconomical non-biodegradable plastic waste material for recycling or reuse with the biodegradable polymers

References

- Ackar, D., et al. (2015). "Starch Modification by Organic Acids and Their Derivatives." **20**: 19554-19570.
- Agboola, S. O., et al. (1990). "Processing of Cassava Starch for Adhesives Production."
- Alade., D. O. M. and M. A. C. Ogbo (2014). "A Comparative Study of Chemistry Students Learning Styles Preferences in Selected Public and Private Schools in Lagos." journal of research and method in education **4**(1 ver. 1): 45-53.
- Allem, A. C. (2002). "The Origin and Taxonomy of Cassava."
- Cipurkovic, A., et al. (2018). "Biodegradable Polymers, Production, Properties and Application in Medicine." **10**(1): 25-35.
- Dufour, D., et al. (1996). "Cassava Flour and Starch."
- Emmanuel, O., A, Clement, A, et al. (2012). "Chemical composition and cyanogenic potential of traditional and high yielding CMD resistant cassava varieties." International Food Research **19**(1): 175-181.
- Eriksson, E. (2013). "Flour from three local varieties of cassava."
- Ezeoha, S. L. and J. N. Ezenwanne (2013). "Ptroduction of Biodegradable Plastic Packaging Film from Cassava Starch." journal of engineering **3**(10): 14-20.
- Ferreira-Villadiego, J., et al. (2018). "Chemical Modification and Characterisation of Starch Derived from Plantain Peel Waste as a Source of Biodegradable Material." **65**(4).
- Ghanbarzadeh, B. and H. Almasi (2013). "Biodegradable Polymers."
- Guira, F., et al. (2016). "Origins, production and utilisation of cassava in Burkina Faso."
- Gunatillake, P. A. and R. Adhikari (2003). "Biodegradable Synthetic Polymers for Tissue Engineeri
- Hadi, N. A., et al. (2019). "Comparison of Three Methods to Determine the Degree of Substitution of quinoa and rice starch." foods **9**(83).
- Hong, J., et al. (2016). "Recent Advances in Techniques for Starch Esters and the Applications." **5**(50).
- Karlstrom, A., et al. (2016). "Biological Implications in Cassava for the Production of Amylose-Free Starch." **7**.
- Logeshwaran, V., et al. (2020). "Bioplastic from Cassava Starch." journal of modern trends in science and technology **6**(12): 286-289.

Mulyono, N., et al. (2015). "Development of Bioplastic Based on Cassava Flour and its Starch Derivatives for Packaging of Food." journal of harmonised research **3**(2): 125-132.

Odedeyi, T., et al. (2022). "Estimation of Starch content in Cassava based on coefficient of reflection measurement."

Oladunmoye, O. O., et al. (2014). "Chemical and functional properties of cassava starch, durum wheat semolina flour, and their blends." **2**(2): 132-138.

Pereira, B. L. B. and M. leonel (2014). "Resistant Starch in Cassava Products." 298-299.

Prochon, M. and O. Dzeikala (2012). "Biopolymer Composites as an Alternative to Materials for the Production of Ecological Packaging." **13**.

Quintana, D. N., et al. (2021). "Physical characterisation of biopolymers with starch from potato and cassava organic wastes polymerised in water." journal of physics **8**.

Raya, S. S., et al. (2022). "Functional and pasting properties of cassava starch in Ethiopian varieties."

Rodriguez, L. M., et al. (2018). "Preparation and Characterisation of Potato Starch Microparticles with Acrylamide by Microwave Radiation." **9**(2).

Sandoval Aldana, A. and F. Quintero (2013). "Physicochemical Characterisation of Two Cassava Starches and Flours." **1**: 19-25.

Sharmiladevi, S., et al. (2019). "Production of Bio Degradable Bags Using Cassava Starch." International Research Journal of Multidisciplinary Technonovation.

Sriroth, K., et al. "Biodegradable Plastic from Cassava Starch in Thailand."

Surtono, A., et al. "Measuring of Cassava Starch Content by Using Strain Gauge."

Tian, S., et al. (2018). "Preparation and Characterisation of Starch Ester and Its Effects on Dough Physicochemical Properties." of food quality **2018**: 7.

Watcharakitti, J., et al. (2022). "Modified Starch-Based Adhesives:." **14**.

Widowati, S. and K. Hartojo "Production and use of cassava flour ": 578.

Zdybel, E., et al. (2020). "Effect of the Esterification of starch with a Mixture of Carboxylic Acids from *Yarrowia lipolytica* Fermentation Broth on its Selected Properties." polymers **12**(1383).
