iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** VII **Month of publication:** July 2020

DOI: http://doi.org/10.22214/ijraset.2020.7038

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VII July 2020- Available at www.ijraset.com

Review on Bioplastic from Cassava Starch

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Abstract: The plastics are polluting the environment and affect the humans. 94% of the plastics are thermoplastics or recyclable materials such as PET (polyethylene terephthalate) and PVC (Polyvinyl Chloride). The purpose of bioplastic production is an alternative for synthetic plastic. The starch is a natural biopolymer. Cassava starch is used for bioplastic production in many ways.
Keywords: Bioplastic, Cassava, Plastic, Starch

I. INTRODUCTION

Plastics are used for packaging material because of their inexpensive, flexible, strong and corrosion-resistant material. Plastic is not degraded in the environment by microorganisms in the long term. In-vitro degradation of synthetic plastic is a time-consuming process (Schink *et al*. 1992) but these plastics are polluted environment. So, we need an alternative. Bioplastic is alternative for the synthetic plastic.

The natural polymers are derived from animal, marine, and agricultural sources, which include the polysaccharides, such as starch, cellulose, and chitin. Plant and animal extracted proteins (casein, collagen, gelatin) and lipids including cross linked triglycerides. By nature most of these polymers are hydrophilic and crystalline in nature, which create several problems while processing in moist food packaging. However, they have excellent gas barrier so that it used in food packaging (Averous and Pollet *et al.*2012). Biopolymer-based films are sensitive to moisture and low mechanical properties (Pelissari F.M., *et al*. 2012)

The advantage of bioplastics is they are easily degraded by the decomposing microorganisms. The bioplastic is designed to facilitate towards enzymatic microorganism degradation process (Avella *et al*. 2009). These bioplastics are non-toxic, produce visible and distinguishable residues following the degradation process (Mooney BP *et al*. 2009). India is major producer of cassava so that we can produce bioplastic from cassava starch.

II. STARCH AS ALTERNATIVE FOR PLASTIC

Major source of starch-based bioplastics though starches from potato, wheat, rice, barley, oat and soy sources are also used nowadays (Guilbert, Cuq, & Gontard,1997) Starch-based biofilms are odorless, tasteless, colorless, non-toxic, and biodegradable. They have low permeability to oxygen at a low relative humidity (Debeaufort *et al*. 1997). Bioplastics can also be made using micro-organisms and sometimes various nanometre-sized particles especially carbohydrate chains like polysaccharides (Petersen *et al*. 1999).

Starch is completely biodegradable in environment as it is hydrolyzed into glucose by microorganism and enzymes, and then it was metabolized into carbon dioxide and water (Choi E-J *et al*. 1999). Production of biodegradable plastics using different formulations and various materials increases their strength. During the production of biodegradable plastics, various plasticizers are used. It improved their processability, flexibility, and stretch ability, by reducing intramolecular forces in them. (Stevens *et al*. 2002)

The main function of packaging is to preserve, protect and prevent contamination of food products and raw materials. (Tharanathan *et al*. 2003). Many researchers have so far developed several starch-based biopolymers for conserving petroleum resources and reducing environmental impact (Park JS *et al*. 2004; Schwach E *et al*. 2004). The starch industry is currently growing, and about 180 million tons of starch and starch derivatives are expected to be produced worldwide by 2022 (Marques *et al*., 2018).

Starch is usually used as a thermoplastic and constitutes a substitute for Polystyrene (PS). It is plasticized through destructuration in presence of specific amounts of water or plasticizers like glycerol orsorbitol used. Starch is an attractive material for packaging applications because of its relatively low cost, availability, and biodegradability.

Starch having poor resistance to moisture and their poor mechanical property restricts their use. Therefore, to improve these properties starch is blended with various biopolymers and certain additives (Yadav *et al*. 2018). In production of starch-based film is sensitivity to humidity and to obtain a flexible starch-based bioplastic, sorbitol, glycerol, andxylitolare often added as plasticizers (Yang J H *et al*. 2006).

III. SIGNIFICANCE OF CASSAVA STARCH

Tapioca starch, a common name for starch extracted from cassava, gelatinization temperatures quite low, only about 52-64°C.In the Cassava starch is made up of two polymers; where amylose contributes only 20-30% but amylopectin contributes about 70 - 80% of the total amount. Amylose is a long straight chain of polymer of anhydroglucose units. Amylopectinis a branch of chain compound, also of anyhydroglucose units. (Nigel *et al*. 2004). A high amylopectin level gives better binding power to gel because of its branched chains. One report says that high amylose content in starch signifies lower gel strength and Stickiness. (Chaplin *et al.* 2005).

A. Cassava starch with CMC films

In the preparation of biofilms, increasing concentration of Carboxymethyl cellulose (CMC) increases tensile strength and decreased water solubility. FTIR spectra indicated intermolecular interactions between cassava starch and CMC in blended films by shifting of a carboxyl group. DSC thermograms and SEM micrographs confirmed the homogeneity of cassava starch-CMC based films. Cassava starch-CMC based films have the potential to replace synthetic packaging materials. These films are suitable for low moisture food and pharmaceutical products (Sriburi Pensiri *et al*. 2011).

B. Cassava starch with Ionizing Rays

Synthetic packages have generated serious ecological problems, contributing to environmental contamination by Solid wastes of low degradability; natural biopolymer is the only best possible alternative (Villada Castillo *et al*. 2014). Bioplastics are sensitive to moisture and have low mechanical properties. To overcome these problems by composites amplified with different biopolymers were prepared. using nanotechnology and ionizing rays e.g. ultraviolet (UV) irradiation and γ-irradiation (Shahabi-Ghahfarrokhi., I *et al*. 2015).

C. Cassava Starch with Modified Clay

Cassava starch films with improved mechanical properties for packaging using cassava starch, glycerol, and modified clay contents can be used. Glycerol was is plasticizer used to plastify cassava starch. The analysis suggested predicting the optimal mechanical property of the cassava starch film from the maximization of the tensile strength. The modified clay was contributed most to the improvement of the mechanical property of the starch film. The experiments showed that the interaction of glycerol with both modified clay and cassava starch was significant for the reduction of biofilm ductility (Monteiro *et al.* 2017)

D. Cassava Starch with Glycerol

Cassava starch film was prepared and casted in different percentage of glycerol (0%, 0.5%, 1.0%, 1.5%, 2.0% and 2.5%) as plasticizer. The effect of glycerol content in the starch film on mechanical and water absorption properties was analyzed. Increasing glycerol content in cassava starch film decreases the tensile strength and Increases the water absorbency in the biofilm. The incorporation of glycerol in cassava starch-based film increases the water absorption ability due to the increase of hydroxyl content (Walster, R *et. al* 2017)

E. Cassava Starch with Zinc Oxide nano Filter

Production of bioplastic from cassava starch films using zinc oxide Nano filter increases the mechanical properties. The content of zinc oxide in the bioplastic films was varied from 0.2%, 0.4%, 0.6%, 0.8% and 1.0% (w/w) by weight of starch. Surface morphologies of the composite's bioplastic films were examined by SEM. The result showed that the Tensile Strength (TS) was improved by using zinc oxide. The maximum tensile strength obtained was 22.30 kgf / mm on the additional of zinc oxide by 0.6% and plastilizer by 25%. Based on the FTIR analysis produced film did not change the group function and it only produced by a physical interaction. Biodegradable plastic film based on cassava starch-zinc oxide and plasticizer glycerol showed that increases in the mechanical properties, transparent, clear, homogeneous, and flexible of the film (Harunsyah *et al*. 2017).

F. Cassava Starch with Cinnamon

Biodegradable packaging in food industries is a green technology to replace the synthetic and conventional packaging systems. Biodegradable cassava starch-based films were also incorporated with cinnamon essential oil and sodium bentonite clay nanoparticles. These films were characterized for their application as a packaging material.

The cassava starch films incorporated with sodium bentonite and cinnamon oil showed significant antibacterial potential against all test bacteria like *Escherichia coli*, *Salmonella typhimurium and Staphylococcus aureus.*

Antibacterial effect of films increased significantly when the concentration of cinnamon oil was increased. The cassava starch film incorporated with 0.75% (w/w) sodium bentonite, 2% (w/w) glycerol and 2.5% (w/w) cinnamon oil was selected based on physical, mechanical and antibacterial potential to evaluate shelf life of meatballs. The meatballs stored at room temperature in cassava starch film incorporated with cinnamon oil and nanoclay, significantly inhibited the microbial growth till 96Â h below the FDA limits. Production of cassava starch-based film incorporated with essential oils and clay nanoparticles can be an alternative packaging material for food industries to prolong the shelf life of products (Iamareerat *et al.* 2018)

IV. CONCLUSION

Plastics are polluted environment. Bioplastics are the alternative for the synthetic plastic. Cassava starch is easily available raw material and bioplastic produced from cassava starch has good results. Cassava starch have high amylopectin content it increases bioplastic strength and cassava starch is very good alternative for synthetic plastic.

V. ACKNOWLEDGEMENT

The authors express their gratitude towards the host Institution Dr. N.G.P. Arts and Science college and DST-FIST Scheme, DBT-Star Scheme, Management, Principal, Deans, Head of the Department, guide and other all other staffs of Department of Biotechnology for rendering all the facilities and support. Communication no: DrNGPASC 2020-21 BS013.

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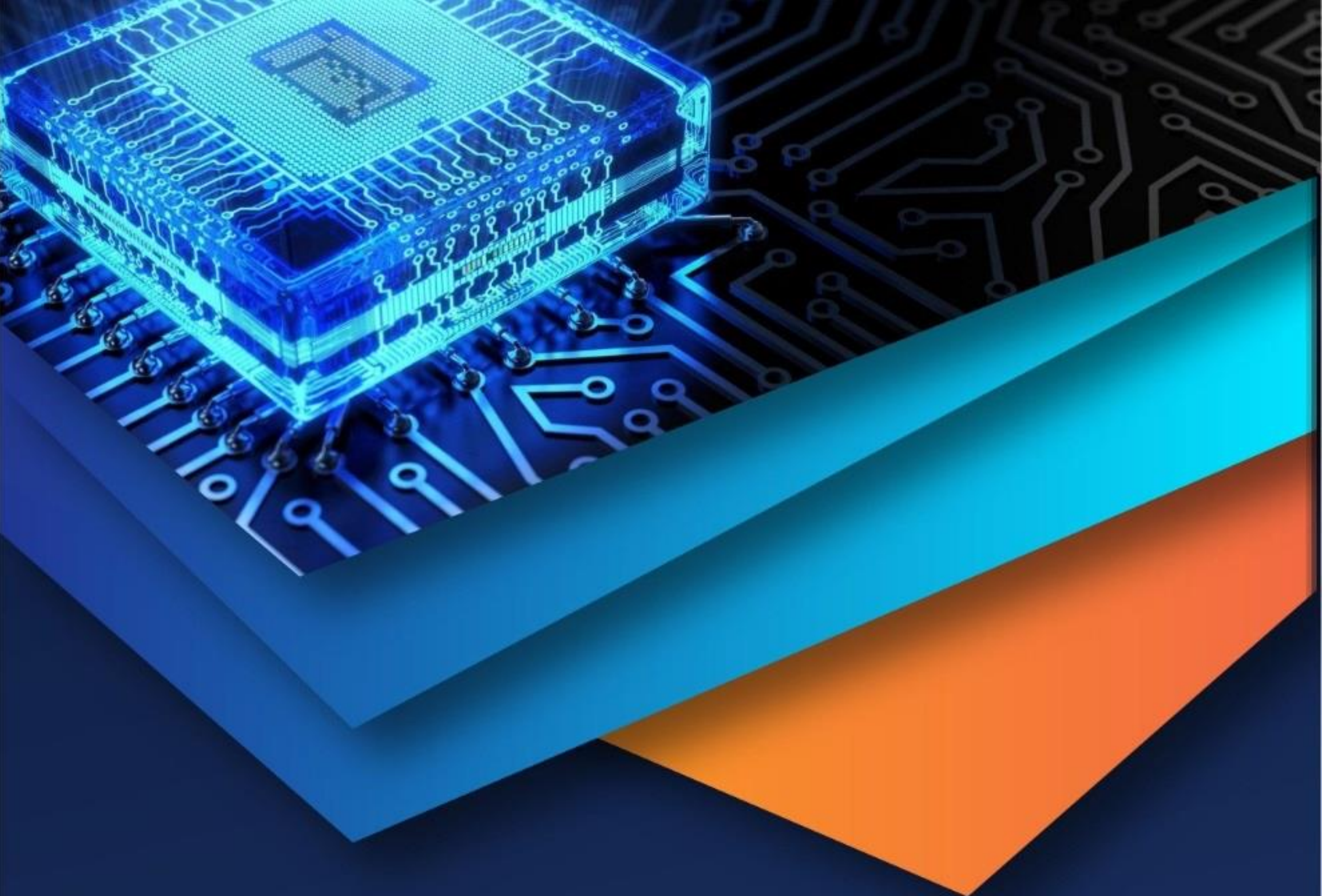

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