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AN INNOVATORY AND SUSTAINABLE APPROACH FOR GREEN SYNTHESIS OF BIOPLASTIC

E. R. Atshaya[1], T. R. Indumathi[2]* and G. Rubalakshmi[3]
[1]III B.Sc. Student and [2]Assistant Professor, Department of Costume Design and Fashion, Dr.N.G.P. Arts and Science College, Coimbatore
[3]Principal Scientist, GRD Bio Clinical Research, Rasipuram, Namakkal.

ABSTRACT
A plastic pollution is one of the century's key challenges affecting our planet's environmental health. Plastic has evolved into a human requirement. The threat to our ecosystem and food sources is growing rapidly as more plastic is thrown in nature and the oceans. The principal environmental issues associated with the widespread use of synthetic plastics are their biodegradability and the creation of toxins when they degrade. Bioplastics are environmentally benign and biodegradable, making them an effective alternative to traditional plastics. Some stakeholders advocate for the utilization of waste feedstock to reduce the amount of virgin land-based resources used to make bio-based polymers. This is concerning because it puts pressure on residual waste streams, incentivizing and establishing markets around them, when trash should be eliminated in the first place, in accordance with the international waste hierarchy. Toaddress these issues, the proposed work aims at the synthesis of completely biodegradable materials, by using sericin and starch synthesized from cocoon waste and curcuma angustifolia respectively with poly vinyl alcohol. The product as such can find its place as a strong replacement of packaging, holding, singleuse plastic goods and medical applications. Besides waste reduction in terms of use of cocoon waste as a source of sericin also gains significance in terms of well-being of the environment. To best of our knowledge this is the first report of biodegradable plastic film from Curcuma angustifolia starch and sericin.

Keywords: Cocoon waste, Sericin, Curcuma starch, bioplastic film, PVA.

1. INTRODUCTION

Plastic pollution is one among this century's major issues impacting the environmental health of our planet. Plastic has become a personality's necessity. With the rising amount of plastic being discarded in nature and within the oceans, the threat towards our eco system and food supplies increases rapidly. per UN Environmental Programme, UNEP, a staggering 6.5 million loads of plastic are being dumped alone in our oceans every year. the main environment concerns behind extensive synthetic plastics usage are its biodegradability, and production of poisons while its degradation. In recent years, there has been an increasing trend towards replacing conventional fossil-based plastics with bioplastics i.e., plastics derived partly or fully from biomass or that are biodegradable. The bioplastics industry uses their green- sounding credentials to position themselves as helping to hurry the reduction in fuel use and solving the ever-growing plastic pollution and marine litter issues (Jafari et al.,2020). Under this context there arises a lack must find a promising viable alternative for producing biodegradable plastics to switch existing conventional plastics (Zhao et al., 2020.

To address these issues, the proposed work aims at the synthesis of completely biodegradable materials, by using sericin synthesized from cocoon waste with starch from Curcuma angustifolia. The product as such can find its place as a strong replacement of packaging, holding and single use plastic goods. Besideswaste reduction in terms of use of cocoon wastes as a source of sericin also gains significance in terms of wellbeing of the environment (Wang et al., 2021).

2. MATERIALS AND METHODS

Demand for bioplastics is increasing since past decade because of growing awareness concerning environmental conservation, use of bio-based or natural resources for manufacturing materials and formulation of varied regulations across countries for effective use of natural resources and waste management. Products and solutions supported bioplastics/biopolymers present interesting opportunities globally. Opportunities are present across a range of business sectors that include packaging, water, beverages, insulation materials, specialty materials and more. The key factor driving the bioplastics market is that the need for more eco-friendly and fewer polluting materials. Other drivers include volatile fuel prices and therefore the need for companies to decrease their carbon footprint across their entire business value chain. The demand for bioplastics has been gradually increasing because of its renewability and availability of staple, advanced functionality and technical properties, and also the recycling options a minimum of a number of them present.

2.1 Conceptional Framework

The purpose of this methodology is to present the technical study in which raw materials, tools andequipment and processes are included. To accomplish the study objectives, the following methods were used to obtain the information. The selected and relevant literature was reviewed to obtain current information pertaining to biodegradable plastic film made of sericin.

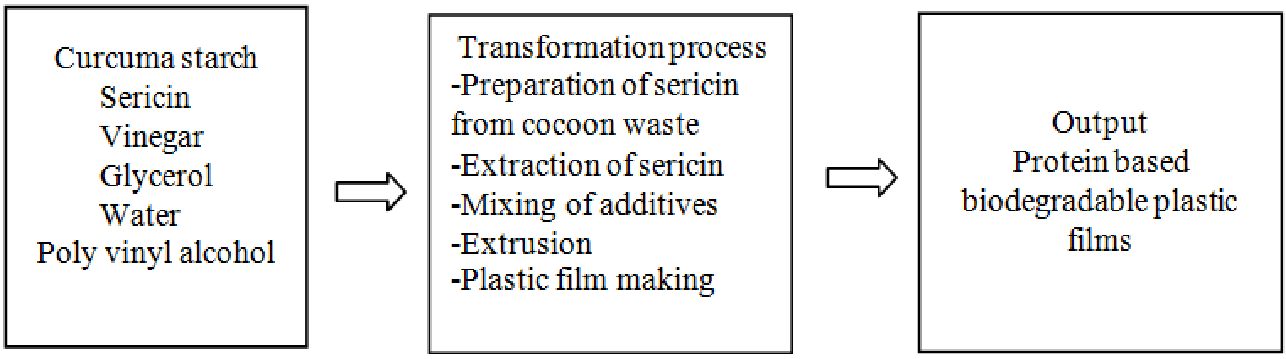

Fig: 1 Conceptional framework

2.2 Research Design

To arrive with the final product of biodegradable plastic film made of Sericin and Curcuma angustifolia a effective starch binder the process should be completed. The breakdown of information about the raw materials, tools and equipment and processes involved in making this product are to beidentifyingtogiveyouanideaonhowthefinalproductwillbecompleted.

2.3 Raw Materials Used in Biodegradable Plastic Film

Curcuma Starch

A white, tasteless and odorless powder that can be used as a thickening, stiffening or gluing agent when dissolved in warm water, giving wheat paste. It will be used as an additive for the decomposition ofthe product. In the study, the mixing of additives such as glycerol, sodium hydroxide and polyvinyl alcohol were used. This starch contains amylopectin that decreases the strength of the plastic, addition of hydrochloric acid was used to break down amylopectin. The raw materials are mixed and extrusion was done make plastic films (Ordonio, Perez & Roque, 2009).

Sericin

Sericin may be a protein created by Bombyx mori(silkworms) in the production of silk. Silk could be a fiber produced by the silkworm in production of its cocoon. It consists mainly of two proteins, fibroin and sericin. Silk consists of 70–80% fibroin and 20–30% sericin; fibroin being the structural center of the silk, and sericin being the gum coating the fibers and allowing them to stay to every other.

Glycerol

A chemical compound, also commonly called glycerin or glycerin. it's a colorless, odorless, viscous liquid that's widely employed in pharmaceutical formulations. It is sweet tasting and of low toxicity. it's used as plasticizer to enhance the flexibleness and softness of the plastic.

Vinegar

Vinegar is a solution of ethanoic acid and trace chemicals that will include flavorings. Vinegar typically contains 5–8% carboxylic acid by volume. Usually, the ethanoic acid is produced by the fermentation of ethanol or sugars by ethanoic acid bacteria. There are many varieties of vinegar, reckoning on source. Vinegar is now mainly utilized in the culinary arts: as a flavorful, acidic cooking ingredient, or in pickling.

Water

It is commonly mentioned because the alkahest1. it's wont to dilute all the raw materials to return upwith the mixture.

Color Pigment

Pigments are used for coloring paint, ink, plastic, fabric, cosmetics, food and other materials. Most pigments utilized in manufacturing and therefore the visual arts are dry colorants, usually ground into a fine powder.

Ethanol

Ethanol has widespread use as a solvent of substances intended for human contactor consumption, including scents, flavorings, colorings, and medicines. It is used to form precipitate of sericin.

The amounts of the raw materials are based on the amount of the biodegradable plastic film from Sericinand the researchers added more of the glycerol and starch so that the product will be thick.

Table 1: Amount of the Additives in the mixture

S.No	Rawmaterials	Amount
1	Sericin	500 g
2	Glycerol	0.07ml
3	Vinegar	0.5ml
4	Curcuma Starch	0.5 g
5	Water	0.07ml
6	Sodium hydroxide	0.10ml
7	Color pigment	0.05 g

2.4 Sample Collection

Silk cocoons were collected from the silk industry waste in and around Salem district. This material was washed thrice with distilled water to remove all dirt and then drained. After drying it completely in an oven, it was used as raw material for further studies.

2.5 Extraction of Silk Sericin from Cocoon Waste

Sericin was extracted from silk cocoons using the protocol described by Yang et al. (2013) with a slight adaptation. In brief, the well-dehydrated silk cocoon peduncles were finely cut into pieces, weighed, and soaked in an extraction solution containing urea (8 M), Sodium dodecyl-sulfate (SDS) (1%) and β- mercaptoethanol (2%) for 30 min at room temperature and moved to the oven at 80 °C for 5 min. After removing the remaining fiber, the supernatant was vortexed to obtain the sericin solution. The sericin- containing fluid was mixed with 70% ethanol at a 1:3 ratio and stored at -20 °C for 1 h, obtaining sericin as a precipitate. This sericin residue was dissolved by adding the required volume of Tris–HCl (20 mM).

2.6 Biuret Test

1% copper sulphate solution and 1% potassium hydroxide solution are prepared. The 5ml of the solution collected is mixed with potassium hydroxide solution with 1:1ratio. Three drops of copper sulphate solution are added to the mixture solution. Changesin the solution observed and recorded. The solution is analyzed under uv-vis to obtain its absorbance.

2.7 Analysis of the Sample

The solution collected after purification is analyzed in FTIR and its wavelength graph obtained andcompared with the standard graph. The solution fully precipitated using ammonium sulfate, the solids are separated weighed and its weight recorded.

2.8 Method of Extraction of Starch from Curcuma Angustifolia

The method of extraction of starch from the Curcuma angustifolia powder is reported in literature (Kokate C.K.,1994), but in order to improve the quality of starch the method was modified as follows: i) Fresh Curcuma angustifolia bulbs were collected and washed it thoroughly with water and scrapped of theouter layer and kept in sufficient amount of water overnight, followed by milling to get smooth paste. ii) Purification: This paste was transferred into a beaker, stirred well and allowed to settle. The supernatant liquid was decanted and washed the residue. iii) The residue is washed repeatedly until the colour of the residue becomes pure white. The residual water was filtered of completely using a vacuum filter. iv) Drying: The pure white starch (residue) was dried at 80°C till it was completely dry. v) Pulverizing and screening: The dried powder (starch) was pulverized and passed through a 100 mesh sieve and stored in an airtight container.

2.9 Preparation of Bioplastic Film

The precipitated sericin are isolated by filtration and dried under vacuum. The sericin is ground into a fine powder using a mortar and pestle. The sericin from cocoons is mixed with the additives which are poly vinyl alcohol, glycerol, wood glue, starch, color pigment and water in the mixer machine. The additives that are added to the mixture increase the chemical properties of the biodegradable plastic bag. The starch is used to increase the degrading effects of light, heat or bacteria. The mixture is fed in a hopperthen fed into an extruder, which is a long heated chamber. The mixture is moved by the action of a Continuously revolving screw. The rotating screw continues to act as a pump and forces the molten plasticthrough a die.

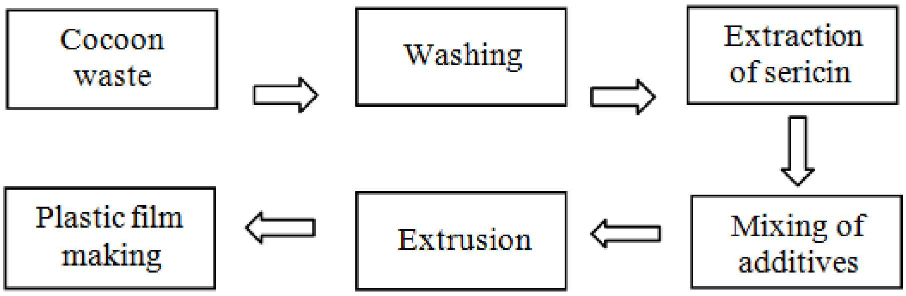

Fig: 2 Preparation of bioplastic film

3. RESULT AND DISCUSSION

Research interest has especially been intensified in exploring biopolymers from waste resources or industrial byproducts. Sericin from cocoon wastes are the abundant, hidden biopolymers to be exploited. Sericins, being the foremost component of cocoons respectively, are the nonfood protein featuring excellent biocompatible and biodegradable properties.

It is been a protracted time ago since artificial polymers happens to interchange natural materials in mostly everyday appliance and nowadays plastics became an important a part of our life. because the time goes by, the soundness and sturdiness of plastics are improved constantly, and hence this group of materials is now considered as a synonym for materials being proof against many environmental influences. The plastics uses today are made up of inorganic and organic raw materials, like carbon, silicon, hydrogen, nitrogen, oxygen and chloride. the fundamental materials used for creating plastics are extracted from oil, coal and gas.

Recently, the event of bio composites from biodegradable polymers and natural fibers has attracted great interests among researcher within the worldwide. this is often because, bio composite may have complete degradation in soil or by composting process similarly as don't emit any toxic substance during production and disposal process. By successfully producing bio composite, we is also able to substitute the traditional petro-based plastic in various applications. This finding will contribute plenty in environmental concern furthermore as in industry. The conceptual paradigm of the method in making a biodegradable bag made by sericin from silk industry waste.

Extraction, Purification, Isolation and Characterization of Sericin from Silk Waste Cocoons

The sericin was isolated from cocoons by the method described by Takasu et al.2002 with a slightmodification. In brief, the finely cut peduncle pieces were weighed and soaked in a solution containing 8M urea, 1% SDS and 2% β-mercaptoethanol for 30 min at room temperature and then kept at 80 $^{\circ C}$ for 5 min. After the removal of residual fiber, the supernatant was centrifuged to get sericin solution. The sericin

Was collected as precipitate by adding three volumes of ethanol followed by storing at $-20^{\circ C}$ for an hour.20mM Tris–HCl was added to dissolve the precipitate. The protein concentration was determined by Lowry protein assay method, 8% SDS-PAGE was performed under reducing -condition.

Fig: 3 Diagrammatic representation of extraction, purification, isolation and characterization ofSericin from silk waste cocoons

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Fig: 4 Final yield of starch from Curcuma angustifolia

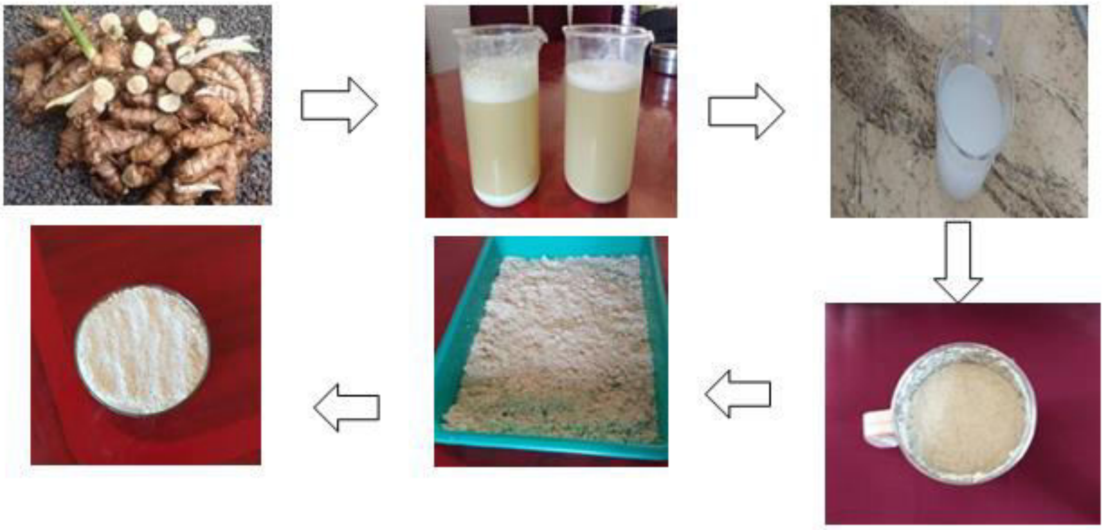

Fig: 5 Transparency of bioplastic film

Fig-6 Lab level preliminary output – biodegradable bag- product development

Knowledge of biochemical properties improves the knowledge that is needed to discover theircost. Applications of sericin is a growing fashion which traverses commercial biotechnology, with packages in bioenergy, nano-biotechnology, waste recycling and control, bioremediation, leather, and fabric industries, food and feed era, personal care merchandise, scientific and pharmaceutical applications, agriculture, bio-catalysis amongst others. Extraction of sericin from waste biomass and its production into novel biosynthesis has boosted up the biopolymer plastics as well as the cosmeticindustry.

Fabrication of Bioplastics

The bio composite film material is successfully facilitated by the optimal quantities of additives such as glycerol, vinegar, starch, sodium hydroxide, color pigment, and sericin and gelatin.The produced bio composite mix under the heated chamber of an extruder's hopper yielded fine bio composite bioplastic film material under this ideal combination. At room temperature, the bio composite material was molded into the desired shape and thickness. It can connect to form a triple helix structure in response to environmental circumstances, particularly temperature (Rglová et al., 2017). The starch in this bio composite material for bioplastic manufacturing could give sericin strength and aid in its quick decomposition by soil bacteria (Verma et al., 2020). Apart from evaluating the physical, chemical, and mechanical properties of sericin the additives used in the bio composite production process also influence the thickness of the bio composite as well as its transparency, tensile strength, and biodegradable properties (Kwak et al., 2020).

Characterization of Fabricated Bioplastic Material

Investigating the physicochemical features of manufactured bioplastic materials, such as thickness, transparency, tensile strength, and biodegradability, is crucial in determining the quality of the synthesized bioplastic and its environmental friendliness (Zhao et al., 2020).

Biofilm Thickness

One of the physical criteria that may influence the quality of bioplastic character features is the thickness of the biofilm (Shen et al., 2020). The consistency of the packaged things should be modified. Thick coatings boost strength while decreasing elastic modulus (Liuet al.,2019). The test was used to confirm the thickness of bioplastics containing sericin and gelatin. The thicknesses of four biofilms were determined based on the thickness testing findings of bioplastics in each treatment: 0.068 mm, 0.183 mm, 0.210 mm, and 0.305 mm, respectively.

BIODEGRADABILITY

Biodegradation is the process of organic matter broken down by microorganisms such as bacteria and fungi that are live in the soil. Tests for degradation of bioplastic packaging were carried out using a soil burial test method. The higher concentration of sericin and Starch, the longer bioplastic will be degraded bioplastics. The results of the biodegradability percentage of this researchafter 1 day burial ranged from 6.90-14.58%. These results are greater than the results of Ratri (2018) which have a percentage of biodegradability on the first day ranging from 5-6%. The results of the biodegradability percentage of this research after 120 days burial ranged from 98.31%-99.02%. Hydrophilic properties make it easier for microorganisms to absorb nutrients from bioplastics so thatbioplastics can be degraded. Overall, bioplastics in this research tend to be rapidly degraded by soil.

CONCLUSION

India is the third largest plastic consumer in the world, with a total consumption of plastics ofabout four million tons and a resulting waste production of about two million tons. Bioplastics are those plastic materials that are manufactured by using natural resources. There are two categories of these plastics available in the market- biodegradable bioplastics and non-biodegradable bioplastics. In Conclusion the present study of sericin were supported by the presence of the above-mentioned Isolation of sericin from silk waste and bioinformatics activities. Recently, research interest has especially been intensified in exploring biopolymers from waste resources or industrialbyproducts. Sericin a promising natural protein that could be extracted from cocoon wastes is an abundant, hidden biopolymer to be exploited. This protein is an abundant nonfood protein featuring excellent biocompatible and biodegradable properties. Under this context, the proposed project addresses the wealth from waste technology aiming towards the production of ecofriendly bioplastics. The produced bio material is expected to revolutionize the bioplastic market with its versatile biodegradable plastic properties. Preliminary synthesis of the biomaterials showed promising resultsthat it can also be further adopted to scale up process towards large scale production.

“The Beginning of the end for Plastic Bags/ Zero Waste”

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