

# A Survey on Bioplastics from Non-edible Tamarind Seed Starch

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**ABSTRACT:** This paper presents a plastics, which were claimed to be biodegradable, appeared on the market more than twenty years ago. Their appearance on the market did not bring immediate success, primarily due to poor evidence of their actual biodegradability, i.e. the characteristics that were presented as their greatest advantage. The tamarind seed starch plastic is one of the revolutionary idea that we present here brings the huge difference here. Our plastic incredibly outshines other plastics by degrading in 180 days. The tamarind seed starch is derived from the tamarind seed by using the gelatine process. While comparing to the other petro based plastics, the process of production is very complicated. But cheap also. The tamarind seed starch plastic is light when compare that with the same dimension of petro based plastic. Plastics are one of the most important petrochemical based products and they are used in all aspects of life. Most polymers are oil based and are made by either addition or condensation polymer techniques. Most are considered to have a detrimental effect on the environment as they do not readily biodegrade.

**KEYWORDS:** Tamarind seed starch, Gelatination, Bio degradation.

## I. INTRODUCTION

Plastic is a material consisting of any of a wide range of synthetic or semi-synthetic organic compounds that are malleable and can be molded into solid objects. Plastics are typically organic polymers of high molecular mass, but they often contain other substances. They are usually synthetic, most commonly derived from petrochemicals, but many are made from renewable materials such as polylactic acid from corn or cellulose from cotton linters. Plasticity is the general property of all materials that are able to irreversibly deform without breaking, but this occurs to such a degree with this class of moldable polymers that their name is an emphasis on this ability.

Currently, about 82 % of all polymeric materials are produced by the petrochemical industry, i.e. they are produced from fossil (non-renewable) resources. Along with the increased use of plastics the burden on the environment is also increasing. In addition to the environmental impacts caused by the mere production of polymers and plastics, there is a growing burden of waste, generated when users discard products that are no longer needed. Waste has been a pressing problem for many years; with the increasing mass consumption of products with a short life span, the amount of waste is also increasing rapidly. Dumping grounds have numerous potential negative environmental impacts (seepage of leach into the groundwater, odours, destruction of the local flora and fauna, local changes in the environment, soil pollution...) and they also require a lot of space. Waste plastics that one way or another find their way into the natural environment, of course represents an even greater danger. The re-use and recycling of products are two of the options to reduce the amount of land filled waste and related environmental burdens [1].

Commonly used types of bioplastics are based on cellulose, starch, glucose and oil. Specific techniques are then employed to convert these feed stocks into thermoplastic starch, polylactic acid, poly-3-hydroxybutyrate, polyamide 11 and biopolyethylene.

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Plastics are one of the most important petrochemical based products and they are used in all aspects of life. Most polymers are oil based and are made by either addition or condensation polymer techniques. Most are considered to have a detrimental effect on the environment as they do not readily biodegrade. The consumption of oil-based plastic in 2008 was 268 million tonnes. This is a significant issue as oil resources will dwindle rapidly over the next thirty years. Although polymer collection for recycling is widely carried only a small proportion is actually remade into materials. The majority is incinerated to reclaim energy. There are many other reasons that motivate industries and researchers to find alternatives to non-renewable resources; however, it is noted that all replacements for current plastics should meet some important conditions, they need to be low cost, renewable, sustainable and biodegradable.

Very few materials are made up of just polymeric components. Usually a variety of additives are included to achieve the required properties of the material. These can include; fillers such as carbon black to reduce cost; plasticizers such as alkyl phthalates to change mechanical properties; lubricants to aid processing; pigments to change the optical properties; stabilizers to stop the degradation of the polymer by heat; anti-wear agents; antistatic agents to spread the charge on materials introduced by friction; curing agents to increase rigidity; flame retardants and blowing agents to produce foams. Some additives fulfill many roles e.g. carbon black is a filler, stabilizer and pigment. In many cases the additives can be the major component of the material. The combination of polymer and additive is known as a plastic.

Biodegradable polymers represent food to microorganisms. Biological degradation thus takes place under the influence of various microorganisms, which due to enzymes they have, can decompose polymers. During the metabolic processes, biodegradable polymers in the final stage, under aerobic conditions are converted into water, carbon dioxide and biomass; under anaerobic conditions into methane, water and biomass. The characteristic of those final products of degradation is that they are non-toxic, and thus normally present in nature, as well as in living organisms [2].

The concept bioplastic plays a major role in that, were the plastic what we manufactured will not produce any harmful effect on human health and also it is biodegradable. In case of petro plastics it takes nearly 1000years to decompose. The recent development in technology provides a wide scope on this plot. Many companies are employing new methods to manufacture bioplastic to use them for the commercial purpose. By no means do we dispose of biodegradable plastics in the natural environment; likewise, we do not dispose of compostable plastics there. It is true that both biodegradable plastics and compostable plastics will decompose in nature, but quite some time is needed for that. In the meantime, they represent a pollutant in nature, which just like all the other waste, poses a danger to animals and spoils the environment. One of the key factors of industrial composting is high temperature, therefore degradation in the natural environment (land or water) takes much longer time.

After the use of biodegradable plastic product, place it among organic waste (brown containers). Proper waste management of biodegradable plastics is either aerobic (composting) or anaerobic (biogas) decomposition. We should not place biodegradable plastics into the normal waste bins packaging (yellow container), since due to its different processing characteristics it can create problems when recycling all the other, non-biodegradable types of plastics. Biodegradable plastics decomposition optimally takes place under conditions of industrial processing of organic waste. This process is slower in nature which is why we do not dispose of biodegradable plastics into the natural environment. Every consumer's worry, that a product made of biodegradable plastics are of lower quality than those of artificial plastic mass, is superfluous. Biodegradable plastic bag has the same characteristics as anon-biodegradable one; its degradation will occur after a longer period of time and under the right conditions, and not before the product would have served its purpose [21].

In such a case, the consumer has a lot of power. The markets are based on the principle of supply and demand. With increasing demands, the supply also grows, followed by growing production and fall in prices. The more people wanting to buy products made of bio plastics, the greater the need for the production, therefore their prices will eventually fall. Unfortunately this does not happen overnight, so it's necessary to inform consumers about their choices, teach them about the aspects of new possibilities and remind them of other people that will live on Earth after them and

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also – as them – needing drinking water, clear air and unpolluted soil for food production under the influence of microorganisms; conditions for decomposition and how long decomposition will last are not defined.

From a practical point of view, a more appropriate word is 'compostability', it is important to be aware that biodegradability refers to the degradation of the material referring to biodegradability under specified conditions and within a limited timeframe. All compostable plastics are therefore biodegradable; but not all biodegradable plastics are also compostable, since biodegradation can take longer than the composting cycle (does not meet standard requirements for compostability). Compostable plastics are therefore a subgroup of biodegradable plastics [3].

## II. DESIGN

Polymers (Greek: poly-many, meros-particle) are compounds with high molecular mass, constructed of interlinking, perennial basic building blocks, called monomers. Simplified they can be compared to a pearl necklace - each pearl represents one monomer unit; a few tens of pearls are strung on the necklace, and so the necklace is a polymer. Also, a paper clip can also represent a monomer, and a polymer is represented by a chain of these clips, obtained when we attach them to one another [5].

Many examples of polymers are extremely important to our lives: e.g. DNA - of which the monomeric unit is a nucleotide, proteins that produce enzymes and our muscles are composed of amino acids. Polymers are also: cellulose - an essential component of wood, and starch – an energy reserve of plants that can be found for example in potatoes and corn; their monomeric unit is glucose.

Plastics are a material formulated and prepared for use. The main components of plastics are the polymers with additives as fillers (inorganic or organic), pigments, lubricants, inhibitors of oxidation, etc. There are many different types of plastic materials. The choice of polymers on which they are based is the key. PET (polyethylene terephthalate), from which almost all the bottles for water and other beverages are made, is well known to all; also often encountered is polypropylene (PP), from which automobile parts, the casing for household appliances and pipes for hot water are made; and polystyrene (PS), which is used for packaging in the cosmetic and pharmaceutical industries and for cutlery; polyethylene (PE) - bags, toys, cables, lids/caps. Therefore, mentioned types of plastics are the most widespread, representing about 75 % of all produced plastics. We can see that all of the names include the poly-prefix, which indicates that it is a polymeric material, consisting of monomeric units [9].

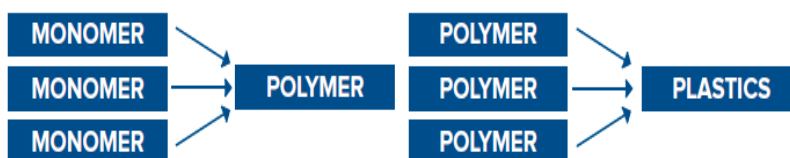


Fig. 1 : Detail diagram of polymer and plastics

In detail, the chemical reactions which are necessary for the formation of polymers. By combining several Amino-Acids (AA), a protein (polymer) is formed. It is condensation, whereby water is separated during the reaction. The reaction is also carried out in the opposite direction; with the hydrolysis (binding with water) of a protein, amino acids are obtained [10].

**INGREDIENTS:** The main components of the plastic are the plasticizer, initiator, water and starch.

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Vol. 7, Issue 12, December 2018

Here, in the tamarind seed starch plastic the components are,

**Glycerin-** It acts as a plasticizer on physical reaction involved with starch (tamarind seed starch) and produces a plastic. Glycerol is generally obtained from plant and animal sources where it occurs as triglycerides. Triglycerides are esters of glycerol with long-chain carboxylic acids. The hydrolysis, saponification, or trans-esterification of these triglycerides produces glycerol as well as the fatty acid derivative [12].

**Ammonium acetate-** It contains Ammonium and acetate ion which readily react with starch and dissolves it. So the polymer molecules will be disordered more easily and results in formation of linear chain.

**Water-** It is used as solvent used in biopolymer to disorder the polymer chains become entangled and neat film is formed this process is known as film casting [6].

**Tamarind seed starch-** Tamarind trees are there in most parts of the country. Northern states of Uttar Pradesh, Madhya Pradesh, and other states like Orissa, Karnataka, and Tamil Nadu are major cultivators. The tamarind fruit is used for edible purpose and seeds are generally discarded. The seeds have value and with little effort it can be processed to produce other value-added products such as starch. This starch is used for sizing in textile industry. This is one of the cheapest available non-edible starches. The process of manufacture is simple. The yield is about 63%.

The process of manufacturing basically comprises roasting and pulverizing. The tamarind seeds are roasted in oil fired roaster and decorticated to remove skin. Seeds are then broken into small pieces in a grinder. These pieces are then pulverized to make starch. The product is packed in polythene lined gunny bags. The yield is around 63% is available with Central Government research Laboratories. The machinery is all indigenously available. The production capacity envisaged is 950 tonnes per year [11].

### III. MANUFACTURING PROCESS

The present invention provides a biodegradable plastic prepared from non-edible starch (tamarind seeds) which contains w/w tamarind seed powder, gelatin, Micro-crystalline cellulose and v/v of Vinegar and glycerol in a fixed proportion. The product has a Gas Transmission rate of 168.48 cc/m<sup>2</sup> day; water vapor transmission rate of 0.068 g/m<sup>2</sup>/day and tensile breaking force of 34.41 N. The product of the present invention has widespread industrial application e.g. in manufacture of biodegradable art objects/household objects, carry bags, packaging material etc. and also biomedical field e.g. bandages, dressings, sutures. Other potential uses include biodegradable diaper parts, biodegradable sanitary napkins etc [15].

The preparation of biodegradable plastic of present invention comprises the following steps :

- i. **Roasting of seeds:** Tamarind seeds were roasted by heating on hot sand to remove moisture.
- ii. **Grinding and sieving:** The roasted seeds were then ground to produce powder, which was sieved to produce fine powder
- iii. **Addition of polymers:** To the fine powder, gelatin, cellulose, vinegar, glycerol and water were added.
- iv. **Stirring:** The resultant mixture was then stirred to produce an even composition avoiding clump formation
- v. **Centrifugation and heating:** The mixture was then centrifuged at 6000 rpm for 10 minutes followed by heating at Bunsen burner for 4 minutes with continuous stirring to prepare a very fine and even paste, which was then spread on an even glass surface.
- vi. **Drying:** The layer was air-dried at Room temperature and room humidity for 49 hours to produce a thin sheet of biodegradable plastic.

After the production of starch from the tamarind seed, it is mixed with water, glycerin, ammonium acetate together with the help of the centrifugal tensioner and heated for 4-5 hours with continuous stirring process which makes the water molecules to evaporate. After this process, the sample is placed inside the furnace for the uniform heat distribution with the minimum time of 4 hours, which makes the mixture to form a stiff and flexible plastics [20].

The next step is heat treatment process, the sample is taken from the furnace and kept in room temperature for minimum of 5 days. In these days, pungent smell caused by the ammonium acetate is removed partially, to the pungent smell completely 'ester' is added to remove the pungent smell. Since Ester is aromatic compound, it is used as the fragrance producing agent which cause no effects in stiffness and flexibility of the bioplastics.

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## IV. EXPERIMENT RESULTS

The testing sample is prepared according to the ASTM D 882. The standard specimen is having the dimensions as follows, length = 50 mm, width = 20 mm, thickness = 0.25 mm. The same specimen is used for both elongation and tensile strength tests. The ASTM D 882 is compatible for both [19].

**ELONGATION:** It is the property of the material that shows the response of the material to the longitudinal force. If the strength between the molecules of the material is stronger than the longitudinal force the material will not change its length (i.e. no elongation).

MAXIMUM LOAD (N)	ELONGATION (%)
135.16	49.16646
135.26	48.41657
159.58	45.83985
95.98	35.08358
82.42	68.41630
120.66	86.66666
109.20	79.16477
128.76	40.83356
159.58	86.66666
121.00	57.07585
124.71	38.79560
82.42	48.08479

**Table 1. Elongation of the specimen at max. load**

The maximum load column indicates the maximum amount of longitudinal force that the material specimen withstands before breaking. The elongation denotes the increase in length of the specimen before breaking in percentage.

MAXIMUM LOAD (N)	TENSILE STRESS(MPa)
135.16	5.40678
135.26	5.45255
159.58	6.38789
95.98	4.26235
82.42	3.70574
120.66	5.36383
109.20	4.90658
128.76	5.15357
159.58	6.38452
121.00	5.07437
124.71	5.25695
82.42	3.70468

**Table 2. Tensile stress at maximum load**

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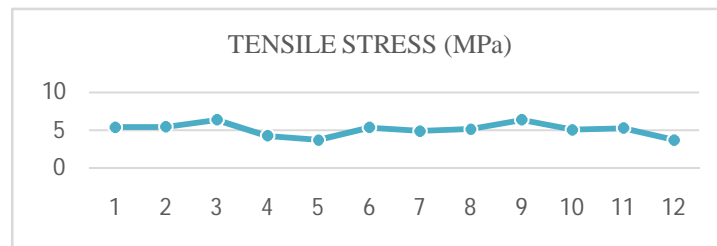


Fig. 2. Graph of specimen and their tensile strength

The tensile strength test shows the tensile stress that the specimen can withstand without breaking. Here the peak stress of 6.3 Mpa is recorded which is higher than most petrobased plastics [22].

**YOUNG'S MODULUS:** The young's modulus is determined using the tensile stress and other parameters. It is used to denote the strength of the material. The young's modulus is standard across the world, so it is used to compare the material strength with others.

### V. CONCLUSION

In this paper, design the availability of petro based plastics will not last long forever. The recent study says that the presence of crude petroleum under the earth has almost reached its dead end with in few decades the presence of petroleum may be exhausted due to our innumerable usage. So in order to prevent us from that exploitation we need to identify the better way to enhance our resources. There are lot of non-edible things are available in nature.

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