PRODUCTION OF STARCH BASED BIOPLASTICS AND THEIR APPLICATIONS IN FOOD PACKAGING.

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1.INTRODUCTION

Plastic is material consisting of any of a wide range of synthetic or semi-synthetic organic compounds that are malleable and so can be molded into solid objects. Most plastics are durable and degrade slowly, as their chemical structure renders them resistant to many natural processes of degradation. Plastic and polymers have become a part of our life today. The annual consumption of plastics in India is 2kg/person/year. In India, plastic wastes accounts for 1-4% by weight of the total of 80,000 metric tonnes of Municipal solid waste generated daily. Only 10% of the disposed plastic are recycled. The remaining non-recovered and unused waste takes a very long time to degrade and be reduced to dust. The plastic wastes pose a serious problem to landscape, wildlife, marine animals and become an environmental eyesore.

In last decades there has been an increasing interest in the development of renewable material with biodegradable properties in attempt to contribute to the sustainable development and to reduce the environmental impact of non-degradable petroleum based plastics. Bioplastics that are made from renewable resources which are easily broken down by microorganisms represent a new generation of plastics that can reduce the dependence on fossil fuels also at the same way can reduces the impact to the environment. In order to solve the problem, several studies have been reported the use of biodegradable starches from different sources to prepare films and coating with different properties.

The aim of the present research was to obtain bioplastics from different sources that have antimicrobial ability to restrain or inhibit the growth of spoilage and or pathogenic microorganisms and to assess the degradation of those bioplastics using microorganisms and amylase enzyme isolated from bacteria and fungi. For determining the effectiveness of the bioplastics, several testing method can be used, most of them are based on the commercial antibiotic tests used generally in the microbiological practice for many years. The evaluation methods of sensitivity of particular microorganisms against the bioplastic is the disk diffusion method. The antimicrobial effect was tested on *Staphylococcus aureus* (gram positive bacteria), *Escherichia coli* and *Pseudomonas aeruginosa* (gram negative bacteria) using zone of inhibition test on solid media. The major application of starch based bioplastic in the work is to apply in food packaging.

Starch based bioplastic:

Starch is the most important polysaccharide polymer used to develop biodegradable films, as it has potential to form a continuous matrix. Starch is made up mostly of amylose and amylopectin. The linking oxygen atom is in the axial position which helps all monomer glucose units to be oriented as each other, indicating that polysaccharide starch is connected by alpha (1 – 4) glycosidic linkage, consequently the starch chains interacts in a helix. Amylopectin is a branched version of amylose, where alpha (1 - 6) glycosidic linkage form a branch. The glycosidic linkages begin to breakdown at 150 degree C while its granules start to decompose above 250 degree C. The ratio and distribution of amylose and amylopectin vary in each starch depending on its source. Both amylase and amylopectin structures can be broken down by a specific enzyme which degrades the polymer. Some organisms digest starch using amylase enzyme to convert it into glucose, for energy. Bio-based polymers have been shown to be a viable alternative to replace these fossil sources while also having environmental advantages, such as decreasing toxic emissions . Most traditional plastics are inert to microbial attack, and the development of biodegradable packaging, these derived from renewable natural resources, has gained increasing interest. Target markets for biodegradable polymers include packaging materials like trash bags, loose-fill foam, food containers, film wrapping, laminated paper, hygiene products like diaper back sheets and cotton swabs, consumer goods like fast-food tableware and containers, egg cartons, and toys, and agricultural tools like mulch films and planters etc.

Modifiers:

Many modifiers have been used to plasticise starch including: glycerol, sorbitol, water, urea, ethanolamine and formamide. All these plasticisers have hydroxyl groups allowing compatibility with starch granules and they plasticise starch by breaking the internal hydrogen bonding between the glucose rings of starch.

The macromolecules chains of amylose and amylopectin in native starch are linked by strong intermolecular and intramolecular hydrogen bonding. The plasticiser at high temperature (90 C – 180 C) converts starch granules to thermoplastic starch, enabling it to be extruded, pressed or injection moulded, dissolving starch granules and lowering its melting temperatures. Breaking up the starch granules results an increase of macromolecular chain mobility and consequently the material softens and becomes less brittle. The semi-crystalline granules are converted into a homogenous and amorphous plasticisation of starch.

Biodegradation of Starch based bioplastics:

Biodegradation of bioplastics can be achieved by physical, chemical and biological processes. The physical and chemical process sometimes leads to release of toxic chemicals into the environment. To overcome this problem, they can be degraded by biological process. They can be degraded and converted to water and Carbondioxide by microbial activities. Bacteria and Fungi are attracted to starch based blend. Microorganisms break the polymeric chain and consume materials through aerobic and anaerobic process. Microorganisms secrete a variety of enzyme into the soil and water, which begins the breakdown of the polymers. Amylase are the enzymes that catalyse hydrolyses of starch into sugars.

Biodegradation of polymer involves following steps:

1. Adherence of the microorganisms to bioplastic surface. Adherence leads to the formation of biofilms.
2. Growth of microorganisms by utilizing the degraded polymer as an energy and food source (Assimilation)
3. Degradation of polymer (Fragmentation by hydrolysis)
4. Final disintegration of polymer (Mineralization)

Some strains which are capable of degrading the starch based bioplastic are *Pseudomonas sp., Bacillus sp., Aspergillus sp., and Mucor sp.,* where amylases are responsible for degradation.

Bioplastics in Food Packaging:

Food Packaging is essential to store food products, protect them from the surrounding environments and maintain the food quality in all stages from packaging to consumption. Petrochemical polymers, often called plastics, are the widely used polymers for packaging food and beverages due to their high performance and low cost. But plastics, used for food packaging may transfer some plastic molecules (monomer, additives, solvent residues, plasticisers, etc) into packed food resulting health risks and poor food quality.

The plastics used in food packaging have certain negative impacts as follows:

a. Recycling may reduce the landfills but only little attention is given for recycling plastics and often discarded after use.

b. If not recycled, they are usually thrown in landfills where they lasts for a very long time without degradation.
c. Many countries face problem in finding space for landfills, especially in highly popular cities.
d. Since plastics are made from petroleum products, the manufacture of such packaging materials relies on petroleum reserve and are non-renewable.

So to replace the non-degradable plastics, biodegradable starch based bioplastic are employed. The natural polymers that can be directly be consumed by human beings or animals with no health risk. When these biodegradable polymers are employed in packaging, they should fulfil some requirements: excellent sensory qualities, high barrier properties, high mechanical strength, high microbial stability, free of toxics, safe for health, simple to produce, non-polluting and low cost.

Starch based bioplastics have wide ranging functionality, relatively low cost and great ability to form transparent, tasteless, odourless films, with very good oxygen barrier properties, which are very useful for food preservation purposes. In fresh cut products, the effects of starch based coatings can also be beneficial for the maintenance of quality and safety during storage. It has been shown that fresh -cut process increases the metabolic activity mainly as a result of the enzymes polyphenol oxidase (PPO) causing discoloration and peroxidase (POD) causing enzymatic browning as well as de-compartmentalization of enzymes and substrates in tissues causing changes in flesh colour. PPO can induce the browning occurrence by catalysing the oxidation of phenol to o-quinones which are polymerized to produce brown pigments.

Postharvest techniques maintaining the quality of fresh-cut fruit have been investigated by several researchers including physical and chemical treatments. Many anti-browning agents or mixtures have been investigated like: calcium ascorbate with citric acid and N-acetyl- L-cysteine , citric acid, ascorbic acid with citric acid and calcium chloride ,4-hexylresorcinol with potassium sorbate and D-isoascorbic acid and modelling of the effects anti-browning agents on colour change in fresh-cut (Vijaykumar T *et al.*,2017).

Preservation:

Food additives are substances added intentionally to foodstuff, to increase the durability of the product and enhance or modify its properties, including its appearance, flavor or structure, provided it does not detract from its nutritional value. Substances can be of natural or synthetic origin, usually without appreciable nutritional value, that are added to food in small amounts during the manufacture (industrial change or during packaging). There are a significant number of food preservatives (antimicrobial agents) that protect foodstuff against the action of microorganisms (fungi and/or bacteria) and thereby extend the shelf life. **Sodium benzoate** is a widely used food preservative, It can be produced by reacting sodium hydroxide with benzoic acid. After entrance of sodium benzoate to the body, the intestinal cycle occurs, and sodium benzoate binds to trypsin and can increase the activity and result in the restructure of trypsin. Trypsin is released from the pancreas and has an important role in the digestion of food products. However, this has not been fully proven and requires further studies and research.

Traditionally, food companies use polymeric films to package fresh fruits and vegetables because of their large availability at relatively low cost and their good mechanical performance, good barrier to O2 and CO2. Nowadays, there is a growing trends in fresh fruits and vegetables packaging sector to replace the petrochemical based packaging films with more environmentally- friendly biodegradable material.

The aim of the present work was to obtain bioplastics from different sources that have antimicrobial ability to restrain or inhibit the growth of spoilage and or pathogenic microorganisms and to assess the degradation of those bioplastics using microorganisms and amylase enzyme isolated from bacteria and fungi. For determining the effectiveness of the bioplastics, several testing method can be used, most of them are based on the commercial antibiotic tests used generally in the microbiological practice for many years. The evaluation methods of sensitivity of particular microorganisms against the bioplastic is the disk diffusion method. The antimicrobial effect was tested on *Staphylococcus aureus* (gram positive bacteria), *Escherichia coli* and *Pseudomonas aeruginosa* (gram negative bacteria) using zone of inhibition test on solid media. The major application of starch based bioplastic in the work is to apply in food packaging.

3. MATERIALS & METHODS

Collection of sample:

Starch based Bioplastic was initially prepared by extracting starch from the available natural sources. The starch containing sources like potato, cassava, banana peel, mango seed and corn starch are collected from the local market. The precursor starch from these sources are obtained by various processes.

The potato, cassava and mango seed are shredded into small pieces. The shredded pieces are blended in 100ml water. The starch slurry was filtered and later placed in the tank for settling. Starch sediment was separated from the slurry and then washed again with distilled water. After the second settling, starch sediment was dried using the oven with temperature 60℃ for removal of water.The banana peel and corn starch are directly obtained from the local market and processed.

Processing of sample (Bioplastic Preparation) :

Bioplastic from Potato starch:

About 15g of dried potato starch was mixed with 150ml of water and homogenised using magnetic stirrer at 2rpm for 5 mins.After homogenisation, 18ml of 0.1M HCl and 12ml of glycerol was added and the mixture was allowed to heat for 15mins and the stirrer was brought to 3rpm.The mixture took 45mins to form a opaque gel.The gel was spread on foil paper and allowed to dry.

Bioplastic from Cassava starch:

About 5g of cassava starch was diluted with 97ml of water and they were homogenised using magnetic stirrer.Then 3ml of glycerol was added to the mixture and heated upto 80℃.The mixture took 45mins to form a opaque gel.The gel was spread on the foil paper and dried.

Bioplastic from Corn starch:

About 10g of corn starch was mixed with 50ml water.About 5ml of glycerol and 5ml of vinegar is mixed with the diluted corn starch and heated at low flame.The mixture is spread and dried.

Bioplastic from Banana peel:

The Banana peel was shredded into pieces and boiled for 30 mins. The water is decanted and they were dried. After the peels were dried, they are placed in a beaker and using hand blender, the peels are pureed until uniform paste is formed. About 25g of banana paste was mixed with 3ml 0.5N Hcl and 2ml of glycerol and heated at 120°C. They were allowed to cool at room temperature.

Bioplastic from Mangoseed:

About 5g of mango seed starch was diluted with 100ml water. The diluted starch is mixed thoroughly and 15ml of glycerol was added to the mixture. The mixture is heated using hot plate until opaque gel was formed. Then the mixture is spread on a foil paper and dried.

Degradation by burring in soil:

The degradation of 5 different bioplastics was observed by burring in the soil. The sample was cut into 2cm x 2cm. The initial weight of the sample was taken and buried in the soil. The degradation was observed by calculating the weight at 3 days interval. The weight was checked for 12 days.

Degradation by amylase enzyme:

Starch based Bioplastics are generally degraded by microorganisms using amylase enzyme. The amylase enzyme producing bacteria (*Pseudomonas sp., Bacillus sp.,*) and fungi (*Mucor sp., Aspergillus sp*.,) was isolated and in starch containing medium. The organism was inoculated into the medium and incubated in the shaker for 24hrs. The culture was centrifuged at 10,000rpm for 15 mins. The supernatant (amylase enzyme) was collected and the bioplastic was immersed into the enzyme and kept undisturbed for 12 days. The amount of starch degraded by the amylase enzyme was determined by spectrophotometer at 560nm.

Ash test:

The Sample was heated at the temperature as such that the organic compound and its derivatives were destroyed and evaporated, yielding mineral elements and organic compound residues. The ash content should be less than 1%.

Water uptake activity:

The Water uptake activity was investigated by cutting film with size approximately 2x2cm and then weighed the mass. The film was put into a container filled with distilled water for 24hours. After immersion in water, the film was removed and weighed to measure the wet weight. Water uptake was calculated as follows:

$$\text{Water uptake} = \frac{\text{Wet weight} - \text{dry weight}}{\text{Wet weight}} \times 100$$

Antimicrobial activity of Bioplastic:

For determining the antimicrobial effectiveness of a bioplastic, the most common method, Kirby Bauer method was used. The antimicrobial activity was tested against Gram positive – *Staphylococcus aureus* and Gram negative – *Escherichia coli & Pseudomonas sp.,*

Muller Hinton Agar media is prepared and sterilized at 121°C for 15 mins. The media is dispensed into the petriplates and allowed to solidify. The organism to be tested (*Pseudomonas sp, Staphylococcus aureus* & *Escherichia coli*) was inoculated by preparing lawn. The bioplastic were cutted in the form of discs and placed on the culture medium. The plates were incubated at 37°C for 24 hours. After 24 hours incubation, the zone of inhibition is measured.

Determination of shelf life of fresh cut fruits and vegetables:

The shelf life of fresh cut fruits and vegetables were observed by covering the sample with the prepared bioplastics which were UV treated. The time taken for the fruits and vegetables to get decayed was observed. The preservative sodium benzoate was added to the bioplastic and it can prevent the growth of bacteria and fungi. The fruits and vegetables are cutted into pieces by sterile techniques. The bioplastics were UV treated by exposing them to UV for 1 hour. The fresh cut fruits and vegetables are preserved for 10 days by packaging with corn starch.

The treated bioplastics are employed in packaging of fruits and vegetables listed below.

Vegetables	**Fruits**
Carrot	Pomegranate
Garlic	Orange
Maize	Pineapple
Bitterguard	Strawberry

RESULT & DISCUSSION

Confirmation test of Starch:

The lugol's solution is added to the extracted sample. The linear triiodide ion complex slips into the coil of starch giving an intense blue-black colour indicating the presence of starch. If not starch is present, the colour of the solution remains the same. The physiochemical properties of starch differ from sources to sources of raw materials(Manisha Sonthalia *et al.*,2015). The figure (4.1) shows the blue-black colour indicating the presence of starch and the starch produced from different sources.

Synthesis of Bioplastic:

Potato starch Bioplastic:

The dilute hydrochloric acid added to an aqueous solution of starch to break down the branches amylopectin molecules into straight chained amylose molecules. Once the solution is boiled, the starch becomes soluble in water and loses its semi-crystalline structure and the process is known as gelatinization. Thin whitish colour appeared on the plates; which indicates production of Potato starch bioplastic as shown in figure (4.2) (Keshav Soomaree ,2016)

Cassava starch Bioplastic:

Cassava starch gives good appearance, without stickiness, exhibiting shininess and transparency. The whitish colour appeared on the plates; which indicates production of Cassava starch bioplastic as shown in figure (4.3) (S.L. Ezeoha *et al.*, 2013)

Corn starch Bioplastic:

Bioplastics can either be made into a sheet or a be mold into any shape with a little bit of difference in the duration. They can be made in various colors and have an estheitc look for the consumers to buy. The Thin whitish colour appeared on the plates; which indicates production of Corn starch bioplastic as shown in figure (4.4) (V.Sharon Keziah *et al.*, 2018)

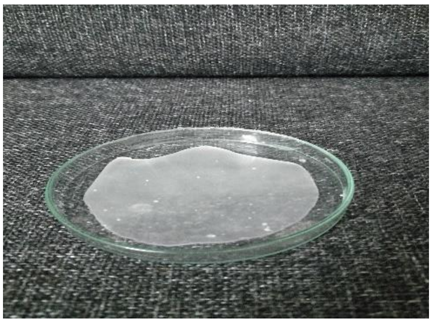
Bananapeel Bioplastic:

The addition of reagents NaOH & HCl increases the polymeric properties of the bioplastics. The Brownish yellow colour appeared on the plates; which indicates production of Bananapeel bioplastic as shown in figure (4.5) (Abhijit Mohapatra *et al.*, 2015)

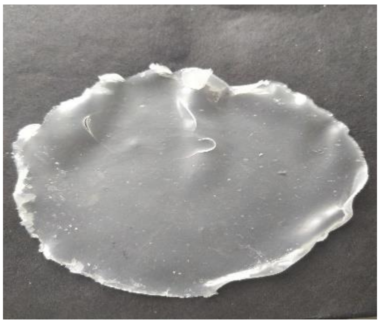
Mangoseed Bioplastic:

Mango seeds have a high enough starch content that potentially as an alternative substitute material in the manufacture of bioplastics. Amylose levels in mangoseeds are expected to provide optimal mechanical properties, and amylopectin levels provide optimum stickiness. The yellowish colour appeared on the plates; which indicates production of Mangoseed bioplastic as shown in figure (4.6) (Maulida *et al.*, 2017)

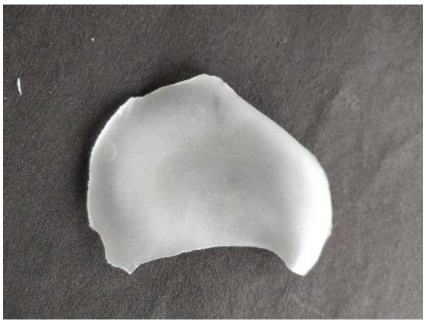
BIOPLASTICS PRODUCED FROM DIFFERENT SOURCES:



Potato starch bioplastic



Cassava starch bioplastic



Corn starch bioplastic

Bananapeel bioplastic

Mangoseed bioplastic

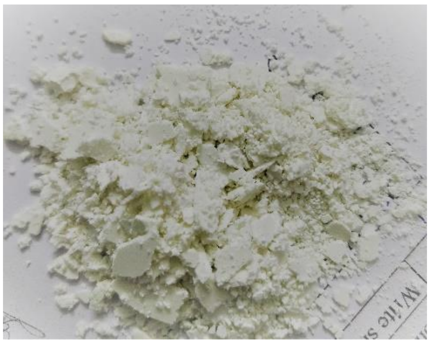
CONFIRMATION TESTS FOR STARCH:


Positive result

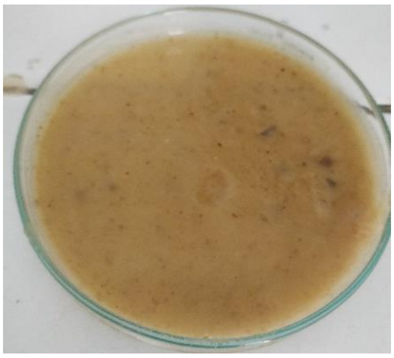

Negative result

EXTRACTION OF STARCH FROM DIFFERENT SOURCES:


Potato starch


Cassava starch


Mangoseed starch


Banana peel starch


Corn starch

Degradation:

Degradation by burring in the soil:

The samples of five different bioplastics showed weight loss which is indicative of biodegradation as given in figure (4.7). Complete degradation was occurred in cassava starch and mangoseed in 12 days. After absorbing water from the soil, hydroxyl group in the cassava starch and mangoseed initiated the hydrolysis reaction; due to this reaction, cassava starch and mangoseed was decomposed into small pieces and quickly disappeared. (Heru Suryanto *et al*., 2017)

Degradation by amylase enzyme:

The amylase enzyme showed degradation of bioplastic when observed at 450nm in spectrophotometer as shown in graph (4.1). The graph shows highest peak in degradation of corn starch by amylase enzyme produced by *Pseudomonas sp.* (Hubber *et al.*, 1997)

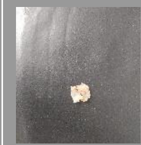
Water uptake activity:

After immersion of Bioplastic in water for 24 hours, the wet weight was measured and the water uptake activity was calculated. Water absorption of bioplastics varied depending on the concentration of glycerol. The more the glycerol is, the higher the water swelling ratio will be. It is associated with hydrophilic properties of glycerol and starch (G.Jungie *et al*., 2004) The table(4.1) shows the values of water uptake activity.

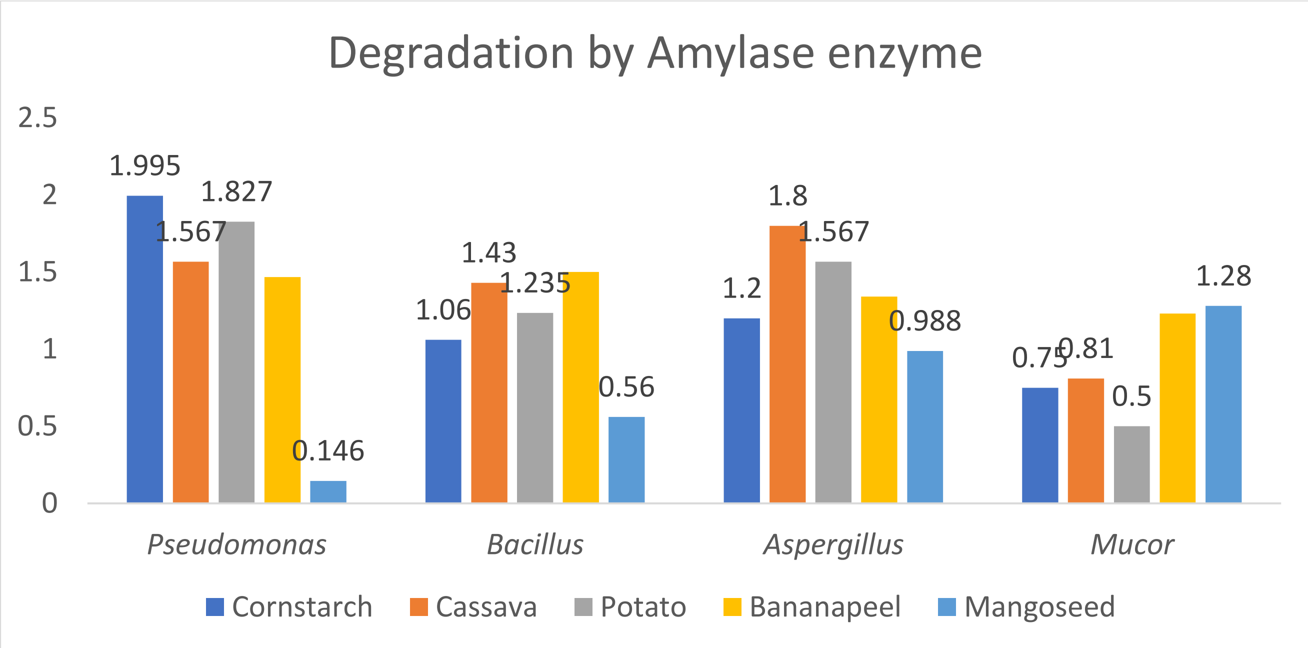
Water Uptake activity:

S.No	Bioplastic	Dry wt	Wet wt	Water uptake activity
1	Cornstarch	0.25g	0.43g	41.8
2	Cassava starch	0.09g	0.11g	18.18
3	Potato starch	0.30g	0.47g	36.17
4	Bananapeel	0.32g	0.33g	3.030
5	Mangoseed	0.36g	0.46g	21.73

DEGRADATION BY BURRING IN THE SOIL:

Bioplastics	0th day	3rd day	6th day	9th day	12th day
Corn starch	 0.81g	 0.73g	 0.65g	 0.30g	 0.11g
Cassava starch	 0.14g	 0.12g	 0.5g	 0.3g	Degraded completely
Potato starch	 0.40g	 0.35g	 0.30g	 0.15g	 0.09g
Banana peel	 0.41g	 0.30g	 0.16g	 0.10g	 0.04g
Mango Seed	 0.38g	 0.27g	 0.17g	 0.08g	Degraded completely

DEGRADATION BY AMYLASE ENZYME:



Ash test:

The table(4.2) shows the time taken for the bioplastic to get reduced to ash. (A.Ananthan *et al.*,2016)

Table 4.2 Ash Test

S.No	Bioplastic	Time Taken
1	Corn starch	20 mins
2	Cassava starch	10 mins
3	Potato starch	30 mins
4	Banana peel	45 mins
5	Mango seed	15 mins

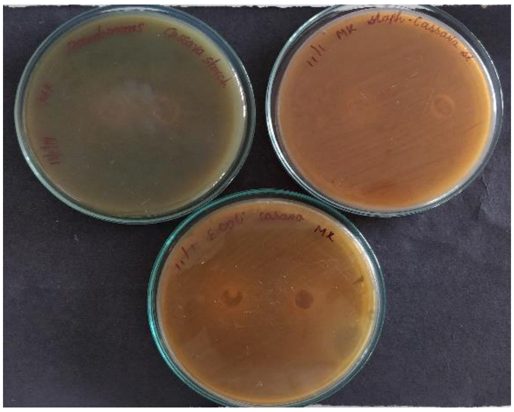
Antimicrobial Sensitivity test:

The table (4.3) shows the antimicrobial sensitivity test for five different sources. Increased antimicrobial activity was seen in corn starch and mangoseed bioplastic against Gram positive (*Staphylococcus sp)* and Gram negative bacteria(*Escherichia coli & Pseudomonas aeruginosa)* (Y.E.Agustin *et al.*, 2016) the figure (4.8) shows the antimicrobial activity of the bioplastics.

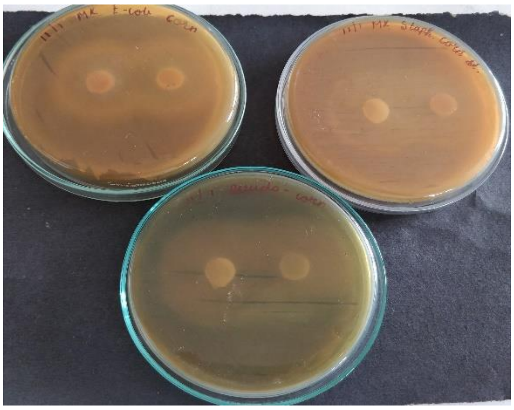
Antimicrobial Sensitivity Test

S.No	BIOPLASTIC PRODUCTION FROM ORGANISMS	CORN STARCH	CASSAVA STARCH	POTATO STARCH	BANANA PEEL	MANGO SEED
1	*Escherichia coli*	4mm	2mm	2.5mm	3mm	3mm
2	*Pseudomonas*	3.5mm	2.3mm	1mm	NIL	0.5mm
3	*Staphylococcus*	4mm	NIL	NIL	NIL	2mm

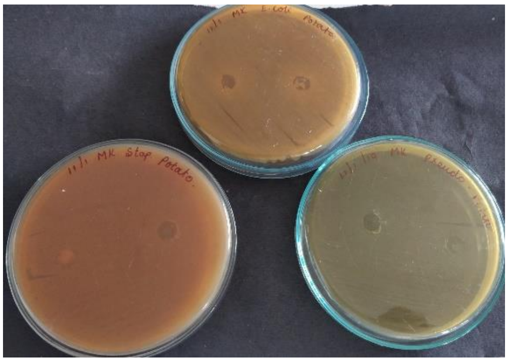
ANTIMICROBIAL ACTIVITY:



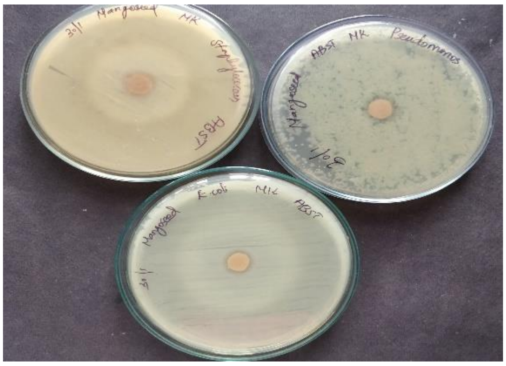
Cassava bioplastic



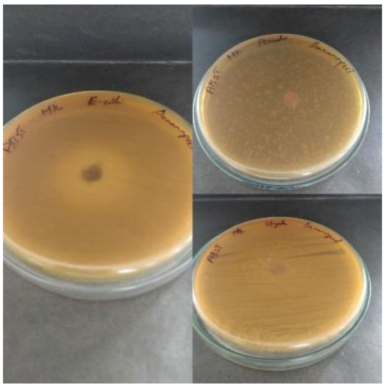
Corn starch bioplastic



Potato starch bioplastic



Mangoseed bioplastic



Bananapeel bioplastic

Comparative analysis of Starch based Bioplastics:

The comparative analysis of Starch based Bioplastics.

Bioplastic Sample	Degradation Activity	Amylase degradation	Ash test	Water Uptake	Antimicrobial Activity
Corn starch	**Moderate**	**High**	**20mins**	**41.86**	**High**
Potato starch	Moderate	Moderate	15mins	36.17	Moderate
Cassava Starch	High	High	45mins	18.18	Low
Bananapeel	Moderate	High	30mins	3.030	Moderate
Mangoseed Starch	**High**	**Low**	**10mins**	**21.73**	**High**

From the comparative analysis it shows that Corn starch Bioplastic and Mangoseed Bioplastic have high antimicrobial activity and degrading ability is moderate to high. The Corn starch Bioplastic is applied further in packaging of fresh cut fruits and vegetables.

Determination of shelf life of fresh cut fruits and vegetables:

Analysis of food product after 7 days of packaging using Corn starch Bioplastic:

S.No	Food Product	Preservatives	Effect on product
1	Pomogranate	Sodium Benzoate	Lowest moisture loss, preserved colour, decreased fungal contamination.
2	Orange	Sodium Benzoate	Slowed down weight loss, preserved colour.
3	Strawberry	Sodium Benzoate	Extended shelf life, prevented microbial growth, slight reduction in colour.
4	Pineapple	Sodium Benzoate	Extends shelf life, control weight loss, preserve flesh firmness.
5	Carrot	Sodium Benzoate	Improved appearance, reduced the activity of various fungi.
6	Corn	Sodium Benzoate	Prolonged shelf life, inhibited the growth of the *Aspergillus.*
7	Garlic	Sodium Benzoate	Lower moisture loss, reduced the growth of fungi.
8	Bitterguard	Sodium Benzoate	Prevented microbial growth, preserved the better color.

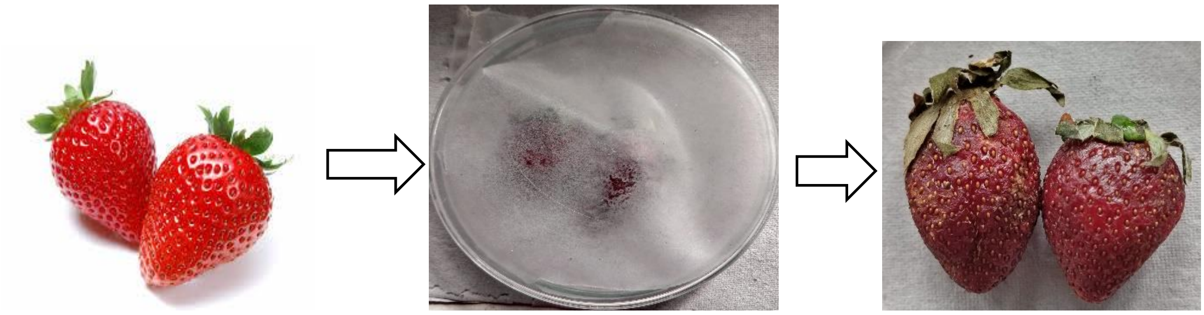
Fresh cut products are characterized by high water transpiration rates and the creation of a moisture and gas barrier lead to weight loss and respiration rate reduction, with a consequent general delay to produce senescence (Valencia Chamorro *et al.*, 2011).

Corn starch bioplastic retained the shelf life of pomegranate, orange, strawberry, pineapple, garlic, bitter guard, corn and carrot. It prevented the fresh cut fruits and vegetables from microbial growth. The packaging of fresh cut products for 10 days also reduced the fungal contamination. Even though, there was slight reduction in colour of strawberry, which may be the initial stage of ripening. Skin colour was not markedly affected by the different CO_2 levels. The fruit became darker with storage as ripening progressed, in accordance with previous reports (Li and Kader, 1989). The amount of anthocyanin is important because of ripeness used for harvesting is the redness resulting from the anthocyanin synthesis(Gil MI, 1997). The figure (4.9) shows the packaging of fruits and vegetables.

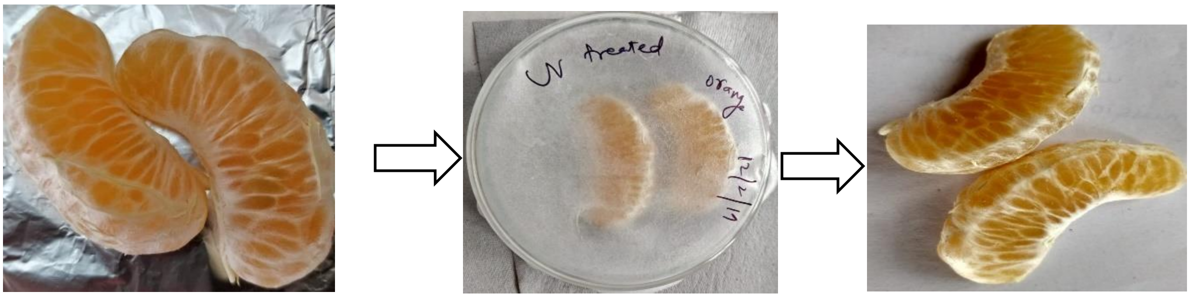
Moreover, the important advantage of bioplastic in food packaging is the reduction of synthetic packaging materials, because these bioplastics are composed of biodegradable raw materials (Dhall, 2013).

PACKAGING OF FRUITS BY CORN STARCH BIOPLASTIC:

Before packaging After packaging



Before packaging After packaging

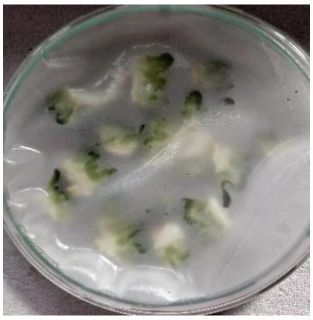


Before packaging After packaging

Before packaging After packaging

PACKAGING OF VEGETABLES BY CORN STARCH BIOPLASTIC:

Before packaging

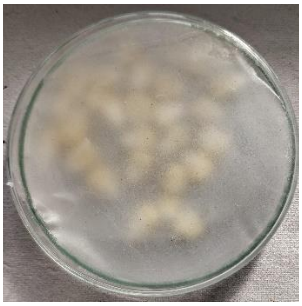


After packaging

Before packaging

After packaging

Before packaging



After packaging

Before packaging

After packaging

SUMMARY AND CONCLUSION

Starch is an agricultural polymer found in a variety of plants including wheat, corn, rice, beans and potatoes. The starch granules as a sources, vary in shape, size, structure and chemical composition. The addition of plasticizer is required to obtain polysaccharide based films. Plasticizers modify (or) improve the mechanical properties, reduce the tension of deformation, hardness, density and viscosity and increase the polymer chain flexibility as well as the resistance to fracture. The starch granules are essentially composed of two main polysaccharides: amylose and amylopectin. The amylose is responsible for the film-forming properties of the starch. Starch granules are insoluble in cold water as the hydrogen bonds hold the starch chain together. However, starch is heated in water, the crystalline structure is disrupted and water molecules interact with the hydroxyl group of amylose and amylopectin resulting in a partial solubilization.

All polymers that are subject to change by microorganisms like bacteria, fungi, algae and protozoa, are considered to be biodegradable. Degradation capacity of the environment is defined as a maximum level of microbial activity that is possible to expect based on conditions of ecosystem where biodegradation takes place. These biologically degraded plastics are more environmentally friendly than the products from petroleum because they decompose in shorter time intervals. Not only the process of decomposition but also the final products of bioplastics degradation are significant only water and carbon dioxide. It is essential to produce antimicrobial packaging in medical, healthcare and food industries. The antimicrobial activity was tested against the common contaminating organisms. Those antimicrobial polymers are employed in packaging of fresh cut fruits and vegetables which are essential in day to day life.

Food packaging of its essential for the food products (fruits & vegetables) to protect from contamination and damage besides conserving taste and quality during the shelf life of the food product. A biodegradable film could be defined as a primary packaging made from biodegradable polymers and food grade additives. A thin layer of biodegradable material can be formed into a film and might be used as a food wrap without changing the original ingredients and process methods.

An additional advantage of this packaging materials is that on disintegration they may act as fertilizer (or) soil conditions, enhancing crops yield. The applications of polysaccharide based films in food products could offer new opportunities to develop novel food packaging systems.

It has been extensively studied because it is abundant, cheap, biodegradable and edible. Among the five different sources of starch based bioplastics, corn starch and mangoseed based are applied in food packaging. Corn starch based packaging is preferable since it is sustainable, cheap and easy to produce. Corn starch is the least expensive and abundant source. UV treated bioplastics are employed in packaging of fresh cut fruits and vegetables were processed aseptically and treated with preservative (sodium benzoate). Upon packaging, the shelf life of fruits and vegetables are retained and prevented from microbial growth.

In conclusion, the starch based Bioplastics produced from different sources are readily degradable by soil microorganisms and amylase producing organisms. The corn starch based Bioplastic applied in food packaging retained the shelf life of fruits (pineapple, orange, strawberry, pomegranate). Even though there was colour reduction in strawberry, they were free from microorganisms. The colour and quality of other fruits were retained for 10 days. Also retained the shelf life of vegetables (carrot, bitter guard, garlic, corn) and the colour and quality was retained for 10 days. These findings can replace the non-degradable plastics which are employed in packaging of foods.

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