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Eco-Friendly Bioplastics from Natural Raw Materials

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ABSTRACT - *Plastics are widely used in the world being very aware at the same time that how rapidly it is destroying our environment. We at BioPlas+, have taken an initiative to develop an alternative for plastic which is non-polluting and affordable at the same time- Bioplastic. Our present work focuses on developing bioplastic from all-natural resources and daily products like mango, banana peels, avocado seeds, sugarcane fiber along with cornstarch, vinegar, agar etc. Our main aim is to reduce the effect of plastic on the environment thus reducing the carbon footprint of a country, at the same time recycling waste products. Bioplastic produced by our company can be used for any purpose that is usually served by traditional plastics minus the toxicity produced by plastics. Using Bioplastic is highly recommended in today's world, it not only makes you a responsible citizen but gives you a better world to live in.*

Keywords: Bioplastic, Natural Resources, Environment, Plastics, Pollution

1. INTRODUCTION

Plastics have vast usage across worldwide. It has uses in numerous packaging applications. It is also used widely for household purposes. With this increasing usage of plastic, pollution associated with plastic is also increasing. Plastic pollution is the accumulation of objects and particles made up of plastic in the Earth's environment that constantly affects the wildlife.

Burning of plastics result in release of poisonous chemicals and can cause respiratory problems. Plastic is a material made to last forever. It is a non-biodegradable substance which takes 1000 years to decompose. Yet 33% of all plastics are just used once and then thrown away. Chemicals which are present in plastics can be absorbed by human bodies. Some of these compounds can alter hormones present in human bodies or can cause harm in some other ways. Harmful chemicals present in plastic which are buried into landfills can spread into groundwater. Currently, it is estimated that there are 100 million tons of plastic in oceans around the world [1]. As plastic is such a long-lasting material, its effects are all long term. One should avoid using plastic because these are lightweight and can get easily picked up by wind and travel long distances by wind and water to create pollution. The present work focuses on reducing plastic pollution by suggesting an alternative of plastic that is bioplastic. Bioplastic is made up of plant starches and gelatins/agar. It doesn't have the polluting potential as plastics have. Bioplastic is easily degradable and reduces greenhouse gas emission. It is eco-friendly, cost effective, recyclable. Bioplastic is an effective way of keeping the huge advantages and versatility of conventional plastics but mitigating their disadvantages.

Hence, the present work focuses on developing Bioplastics- an alternative of conventional plastic.

2. MATERIALS REQUIRED

TABLE-1: RAW NATURAL PRODUCTS

S.NO	MATERIAL NAME	USE OF MATERIALS
1	Gelatin	Used as a raw material in extruder for good film-forming, well gas and oil resistance, low price, non-toxicity and biodegradable properties.
2	Banana peels	Used as a raw material in the extruder where it is melted down and forms a base for the bioplastic

3	Avocado seeds	Used as a raw material in the extruder where it is melted down and forms a base for the bioplastic
4	Sugar	Pure starch is able to absorb humidity, and is thus a suitable material for the production of bioplastics. The properties of starch bioplastic is largely influenced by amylose/amylopectin ratio. Generally, high-amylose starch can result in better mechanical properties.[2]
5	Corn Starch	Corn starch is the starch of the corn grain and has taken on the principle role in the production of Bioplastics.[3] Bioplastics, also known as organic plastics, are a form of plastic derived from renewable biomass sources (such as corn starch) rather than fossil fuel plastics which are derived from petroleum.[4] Basically acts as a base for the bioplastic produced.
6	Frying oil	The waste cooking oil is added to the "raw materials" already used to produce Bio-on bioplastics (beet molasses and sugar cane, fruit and potato wastes, carbohydrates in general and crude glycerol)[5] but, for the first time, the carbon source which feeds the biopolymer production process is of a lipid nature. Thanks to a preventive treatment systems for waste frying oil, the bioplastic produced has the same characteristics as that generated from other wastes, co- and by-products of agro-industrial productions.[7]
7	Vegetable Derivatives	Used as a raw material in the extruder where it is melted down and forms a base for the bioplastic
8	Vinegar	Vinegar, a 6% in volume solution of acetic acid liberates acetate ions and hydrogen ions in solution.[8] This is important, because ions react with the starch polymers and make them be disordered more easily in the solution. This disorder, resulting from the disruption by the water and the ionization by the acetic acid, makes the resulting cast film more homogenous.

TABLE-2: MACHINERY USED

S.NO	**MACHINERY NAME**	**USE OF MACHINERY**
1	EXTRUDER	Helps in melting down all the reactants or materials that are going to be used for the production of Bioplastic.
2	SEALING AND BAG MAKING MACHINE	For the sealing of the plastics produced and the making of usable products out of it.
3	AUTOMATIC THERMOFORMING MACHINE	Used for the formation or the sculpting of various bioplastic products such as medical trays, plates etc.

4	ROTOGRAVURE PRINTING MACHINE	Rotogravure Printing Machine Acid is used to cut the images into the plate.[9] Once the copy is photographed, positives are then made from the negatives.[10] The images are transferred to the rotogravure printing machine surface by use of carbon tissue covered with light-sensitive gelatin. It is a kind of ideal printing equipment for producing paper packing bags for food, supermarket handbags, vest bags and clothes bags.
5	INJECTION MOULDING MACHINE	The person designing the mold chooses whether the mold uses a cold runner system or a hot runner system to carry the plastic and fillers from the injection unit to the cavities.[11] A cold runner is a simple channel carved into the mold.[12] The plastic that fills the cold runner cools as the part cools and is then ejected with the part as a sprue.[13] A hot runner system is more complicated, often using cartridge heaters to keep the plastic in the runners hot as the part cools. [14] After the part is ejected, the plastic remaining in a hot runner is injected into the next part.[15]
6	STORAGE TANK	Storage of Bioplastics which are produced.

2. METHODS INVOLVED IN MAKING BIOPLASTICS AT HOME

A bioplastic is a type of plastic that can be made from plant starches or gelatins/agars[16]. They are better for the environment because they are not derived from petroleum[17]. They can also be easily made at home with a few simple ingredients and a stove.

- Using Cornstarch and Vinegar
- Using Gelatin or Agar
- Molding the Bioplastic

2.1 1) Using Cornstarch and Vinegar

i) Gather the necessary materials:

To make this type of bioplastic, you will need cornstarch, distilled water, glycerol, white vinegar, a stove, a saucepan, a silicone spatula, and food coloring (if desired)[18]. These items should be readily available at the grocery store or online. Glycerol is also called glycerine, so try searching for that if you're having trouble finding glycerol. The following amounts of ingredients are needed to make bioplastics:

1. 10 ml distilled water
2. 0.5-1.5g glycerol
3. 1.5g cornstarch
4. 1 ml of white vinegar
5. 1-2 drops food coloring

ii) Combine all of the ingredients and stir together:

Add all of the ingredients to the saucepan and stir to combine with the spatula. Stir until most of the lumps get dissolved in the mixture. At this stage, the mixture will be a milky white color and quite watery.[19]

1. If you add the wrong amounts of ingredients, just dispose off the mixture and start again.

iii) Heat on low-medium:

Place the saucepan on the stove and set the heat to medium-low. Stir continuously as the mixture heats. It will become more translucent and begin to thicken.[20]

1. Remove the mixture from the heat when it becomes clear and thick.
2. Total heating time will be around 10-15 minutes.

3. Lumps begin to form if the mixture is overheated.
4. Add 1-2 drops of food coloring at this stage, if you would like to color the bioplastic.

iv) Pour the mixture onto foil or parchment paper:

Spread the heated mixture onto a piece of foil or parchment paper to let it coll. If you would like to mold the plastic onto a shape, it must be done when it is still warm. See the last method for details on molding the plastic.

- If you still bubbles then remove by poking them with a toothpick.

v) Allow the plastic to dry for at least two days:

It will take time for the plastic to dry and harden[21]. As it cools, it will begin to dry out. Depending on the thickness of the plastic, it can take longer for it to dry. If you make one small thick piece it will take longer to dry than a thinner larger piece.[22]

- Leave the plastic in a cool place for this process.
- Check the plastic after two days to see if it has fully hardened.[23]

2.2 2) Using Gelatin or Agar

i) Gather the necessary materials:

To make this type of bioplastic, you will need gelatin or agar powder, glycerol, hot water, or saucepan, a stove, a spatula and a candy thermometer. These ingredients should be readily available at your local grocery store. You will need the following amounts of each ingredient:

- 3g (½ tsp) glycerol
- 12g (4 tsp) gelatin or agar
- 60ml (¼ cup) hot water
- Food coloring (optional)
- Agar is a substance derived from algae that can be used in place of gelatin to make the bioplastic vegan friendly.[24]

ii) Stir together all of the ingredients:

Combine all of the ingredients in the saucepan and stir until there are no clumps left. You may need to use a whisk to disperse all of the clumps. Place the saucepan on the stove and start heating the mixture on medium-high heat.

- If you want to color your plastic, you can add a few drops of food coloring at this step.[25]

iii) Heat the mixture to 95-degree C' (203degree F) or until it begins to froth:

Put the candy thermometer into the mixture and monitor the temperature until it reaches approximately 95 degree C (203-degree F) or begins to froth. If the mixture begins to froth before it reaches temperature, that is okay. Remove it from the heat when it reaches temperature or starts frothing.

- Continue to stir the mixture while it is heating up.

iv) Pour the plastic onto a smooth surface covered with foil or parchment paper:

After you remove the pan from the heat source, you will need to remove any excessive froth. Spoon it out before pouring the plastic out of the pan. Stir everything to remove all clumps from the plastic.

- If you just want to make plastic for fun, pour the mixture out on a smooth surface. Make sure the surface is covered with foil or parchment paper so the plastic can be removed easily.
- If you want to mold the plastic into a specific shape, you will need to do it during this step [26]. Refer to the last method on molding for more details and help.

v) Leave the plastic to harden for at least two days:

The amount of time to make the bioplastic harden will depend upon how thick the piece is.

- Generally, it will take at least two days for it to fully dry out and harden.
- You can make this process a little faster by using a blow dryer on the plastic.
- It's easiest to leave the plastic undisturbed for a few days so it can dry on its own.[27]
- Once the plastic hardens, it can no longer be molded or shaped. It must be done when it is still warm.[28]

2.3 3) Molding the Plastic

i) Make a mold for the plastic:

A mold is the negative of a shape that you would like to make. You can make a cast of an object you would like to reproduce by sculpting two pieces of clay around the object. When the clay dries, remove the two pieces. If you fill each half with the liquid plastic and then put the halves together, you can make a copy of that object. You can also

use a cookie cutter to cut shapes out of the plastic while it is still warm.[29]

- An alternative to making your own mold, is to purchase a mold at a craft or hobby shop.

ii) Pour the hot plastic into the mold:

Once you have a mold, you can use it to make more objects.

- While the plastic is still hot, pour it into the mold.
- Make sure that the plastic gets into the entire mold and try pop bubbles by lightly tapping mold on the counter.[30]
- To make the object easier to remove when it dries, coat the mold with a non-stick spray before pouring the plastic in.

iii) Let the plastic dry for at least two days:

The plastic will take a few days to dry and fully harden. The amount of time it takes to dry depends on the thickness of the object. If the object is very thick, it can take longer than two days to fully harden.[31]

- After two days, check the plastic. If it still appears to be wet, let it stir for another day and check it again. Continue to do this until the plastic is fully dry.

iv) Remove your plastic from the mold:

After waiting a few days, the plastic will be fully hardened and dry. At this point, you can remove the plastic from the mold. You have now made your own plastic version of whatever object you chose to mold.[32]

- You can reuse this mold to make as many plastic versions of the object as you like.

3. BIOPLASTIC PRODUCTION BY INDUSTRIAL PROCESSES

3.1 1. Compounding

Compounding constitutes, following the production of the base polymer, the first preparation process for the refining and modification of plastics by means of extrusion. Through preparation, the characteristics profile of the plastics can be selectively altered and thus adapted to the subsequent process and the desired product characteristics.[33] For this, the plastic is melted in the extruder, whereby it is mixed with additives, fillers, reinforcing materials or a combination thereof. After homogenisation and degassing of the compound, it is formed – usually as strands – using a tool, then cooled and processed into plastic granules.

Material pre-drying compared to process degassing in the computer

Similar to the conventional plastic PET, bioplastics also contain materials for which special attention must be paid to their residual moisture content, as they tend to absorb moisture (they are hydrophilic) [34]. In order to be able to process these materials by means of compounding, two different methods are generally available: • material pre-drying in terms of the drying of solid matter using appropriate drying equipment and • process degassing during the compounding procedure.[35]

3.2 2. Injection Moulding

Injection Moulding is the most frequently-used processing procedure for plastics. Extremely small components through to large plastic mouldings can be inexpensively manufactured in large quantities for direct usage. The plastic is thereby melted in the injection moulding machine and injected under high pressure into an injection mould. The material and its part are shown in the following figure.[36]

3.3 3. Foaming

Foaming of plastics is a processing method which is used in order to reduce the material weight and/or the density. Furthermore, foam structures exhibit insulating properties. With foaming, a propellant is added to the plastic during processing, which results in the material/component having a specific, two-phase foam structure.[37] As bio-based plastics have, to a certain extent, a higher density than petroleum-based plastics, it would be logical to exploit density-reducing possibilities in order to develop improved properties.

The foaming of plastics is a complex process; this also applies to the utilisation of bioplastics. Bio-based plastics are generally similarly-foamable to conventional plastics and do not require enhancement of the system technology. However, in this sector there is still too little generally-accessible processing information available.[38] The processing procedure is further complicated through specific features exhibited by some biopolymers. Stable foam structures can therefore only be created if a compatibility/tolerability exists between the bioplastic and the respective effective propellant. Furthermore, bioplastics which tend to absorb moisture through their specific degradation behaviour cannot be utilised permanently for long-term applications.

3.4 4. Colouring

Colouring is just as important for bioplastics as for conventional plastics. There are virtually no plastic products which are not coloured. One of the main reasons for this is to increase the product appeal, which in turn leads to higher sales numbers. In the field of bioplastics, however, hardly any relevant findings have been available until now.[39]

An important factor when colouring is the nature and quality of the colouring. According to DIN 55943, the term „colouring agent" covers all colouring substances. These in turn are divided into the groups „dye" and „pigment", and may be of organic or inorganic origin. Dyes are soluble in the application medium and pigments are insoluble. Some colouring agents are thereby more resistant than others. Red colouring agents, for example, are generally less resistant to UV effects. The colouring of plastics is usually carried out during extrusion or in the injection moulding process.

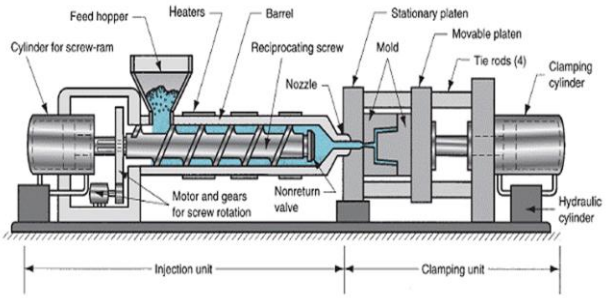

Fig-1: Injection moulder

3.5 5. Processing Behaviour

Processing Behaviour plays a role, for example, as regards the printing of plastics. A high-quality print is just as important for bioplastics as it is for conventional plastics, in order to decorate the products following the production process and to increase product appeal. One important market here is the packaging industry, which requires basic information concerning the printability of bioplastics in order to utilise them.[40] For the toy industry, a subsequent refinement is also essential in order to increase product appeal.

3.6 6. Extrusion blow moulding

Extrusion blow moulding is one of the standard methods for the production of hollow plastic technical mouldings (canisters, fuel tanks, air ducts in motor vehicles, etc.) and in the packaging sector (in particular plastic bottles and containers, etc.).[41] For this procedure, the plastic melted in the extruder is extruded as a tube, the so-called preform, and inflated by means of compressed air in a hollow mould[42]. The material solidifies on the cooled wall of the cavity and the article can be removed. Despite the vast potential application field for bioplastics in blow moulding, only a small amount of experience has been gained through their application until now. A simple substitution of a conventional material through a bioplastic is not generally possible, as a specific adjustment of machining and process parameters (temperature control, etc.) is necessary.[43]

It can be fundamentally stated that the processing parameters and the necessary adaptations to the extrusion blow moulding process for bioplastics lie within the framework of the requirements necessary for conventional plastics (e.g. substitution of a polyolefin through a co-polyester).[44] However, in the group of bioplastics there are few types of materials which have been optimised with respect to the blow moulding process. Almost all of the investigated materials are film or extrusion types.[45] The material manufacturers must therefore carry out and offer adjustments – then nothing would stand in the way of the extrusion blow moulding of bioplastics.[46]

3.7 7. Flat film production

Flat film production is a widely-used procedure for the production of bio-based or compostable plastic films which are now part of our everyday lives.[47] Shopping bags with bio-based or seedling symbols are offered by almost every major supermarket and chemist chain. A further example is rustling "florist's film", which is made from transparent bioplastics. Last but not least, there is also the compostable mulch film which, ploughed into the soil, is almost completely degraded between two vegetation periods.[48]

Fig- 2: Three-layer film extrusion system

A recent analysis of the bioplastics market shows a wide variety of bioplastics which have been specifically designed for film applications and which can be processed with standard systems engineering.[49] However, a tendency is also evident – above and beyond the aforementioned simple product applications – which seeks to penetrate the market segments with more demanding products which are currently occupied by petrochemical standard plastics. These include, for example, thermoformed packaging for dairy and meat products.[50] From a technical perspective, the material property deficits such as inadequate barrier properties or insufficient puncture and tear resistance of bioplastics are often responsible for a limited market penetration in the higher-value packaging segment. An effective aid can hereby be achieved through a multi-layer film structure, in which the positive characteristics of differing bioplastics are combined with one another.[51]

4. BUSINESS MODEL CANVAS

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
• Farmers- especially who are into sugarcane, sugar beet, corn and cassava harvesting. • Small industries which are agriculture-based would supply us with raw materials-PLA, renewably sourced polymers. • Machinery industries from whom we would be buying us the required machines necessary for bioplastic production. • A biotechnology industry to promote innovation.	• Promoting the product i.e. 'bio-plastics' to generate demand by highlighting its main points. • Maintenance and replacement of machine. • Ensuring that we are reaching the production target. • Experimenting with new technologies and check if we can upgrade the quality of bio-plastics. • Checking whether the R&D team is acquainted with innovation and new trends within the industry and ensuring that the product stays abreast of these trends.	• Disposable cutleries(dish/plates/spoons/straws) - day to day products can be made from bioplastics. • Bioplastics made out of daily products like mango, banana peels, avocado seeds- Avoplast. • Edible plastic that contain natural starch/vegetable derivatives. • Cost reduction(light-weight) → High market demand → High salary. • Sanitary pads use bioplastics – tie-up with packaging companies to compete with plastics.	• Dedicated Personal Assistance: It includes assigning a customer representative to a specific customer so they are consistently engaging with the same person which in return builds trust and get to know our product i.e. bio-plastic in a better way. • Self-service: In contrast, this relationship includes no direct relationship between a business and their client.	• Everyday household use by common people • Disposable catering service ware providers • Medical equipment manufacturers • Plastic goods manufacturers • Cosmetic packagers • Packaging services • Shop owners for giving their products to customer • Baby product manufacturers like toys and teethers
	Key Resources		**Channels**	

- Materials needed- sugar, CO2, rice, corn starch, distilled waste, frying oil, banana peel.
- Labors for manufacturing of bioplastics in factories.
- Machines to make the bioplastics like Automatic Bio-degradable plastic bag.

- Social media campaigns can be held as to why bioplastics can be better/ show trials/ demos to public as to how it is edible after testing its credibility.
- Online- website / offline shops to sell bioplastic daily products.
- Sales/ partnerships (the partner's channels).
- Give free samples of bioplastic products with partnered products/ any products for people to use it.

Cost Structure

- Operating cost of BIOPLASTIC production
- Investment cost of BIOPLASTIC production
- Capital and Technology
- Land cost
- CH4 emission
- CO2 emission
- Opportunity land of cost

Revenue Streams

- Profit could be done by making bioplastics out of daily products like mango and banana peels.
- By reducing the cost, high market demand will prevail followed by increase in profit.
- Bioplastics can be made from waste materials in our own offices so as to reduce the production cost and also reducing the cost of waste management plan.

Fig-3: Business Model Canvas of our company, BioPlas+

5. RESULTS AND DISCUSSIONS

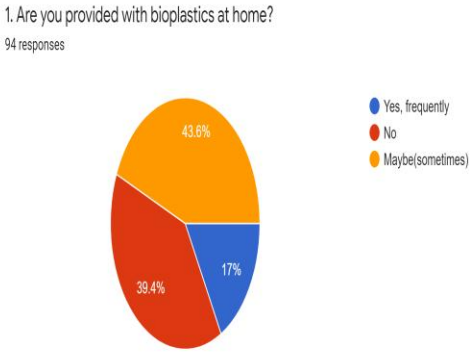

Chart- 1: Provision of bioplastics at home

As we can see, most of the households have shifted from plastics to an eco-friendlier alternative, however since bioplastic is a new technology, people who don't deal with packaging or kitchen wares everyday are not much aware. The shift in mindset has started and will take some more time to fully encourage everyone to switch over to bioplastics.

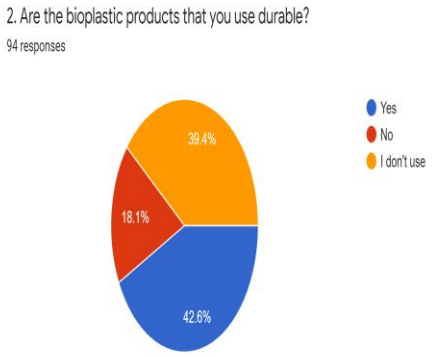

Chart- 2: Durability of bioplastics

Most of our customers say that our range of bioplastic products are durable and they can repeatedly use them for different purposes for a long time. Their storage is pretty easy just like plastics, just that bioplastics shouldn't be kept under direct sunlight or else they degrade. In 2010, disposable bioplastics contributed to more than 60% of the total bioplastic production capacity.[52] However, six years down the lane, the durable bioplastics contributes to an enormous 77% of the overall bioplastic production

capacity which is estimated to grow above 80% by 2020.[53]

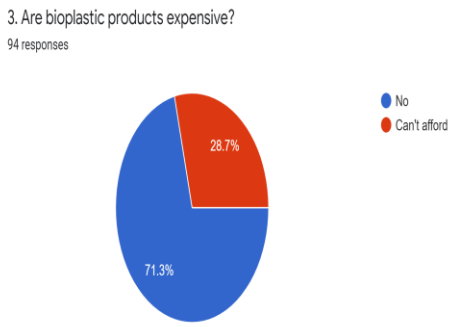

Chart-3: Cost of bioplastics

Most of our users get their bioplastics from the society-building they stay in and to them, it comes free. Our customers at shops get it free as well or sometimes even small discounts on their overall purchase when they choose bioplastics over plastics to carry their goods. This way, we aim to raise awareness about bioplastics and pursue customers to opt for it.

Small shops, though charge for bioplastics but the price range is between 2-3 rupees, thus making it affordable to most of the population.

The reason bioplastics are getting cheaper is because of the shift in raw-materials used. With the help of technology bioplastics can be made cheaply from low-quality, woody biomass from agricultural residue, tree waste, and grasses instead of food crops, sugars and corns where the process was expensive, and raised food prices by diverting edible crops.[54]

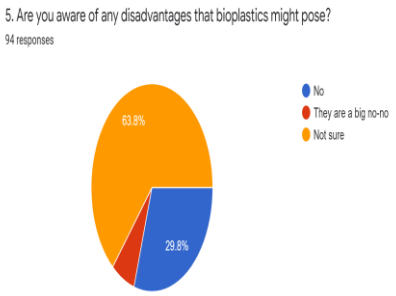

Chart-4: Awareness on disadvantage of bioplastics

The pros of bioplastics are that they are:

1. Eco-friendly and reduce pollution
2. Renewable, biodegradable and easily disposable.
3. Non-toxic and do not contain BPA unlike plastics.
4. Less reliant on fossil fuels.
5. Pioneers in less Co2 production.

But there are cons of it too, which our loyal customers have observed and we would want to take steps to correct them in the future. Here are some:

1. Bioplastics cause more littering because people think that since they are bio-degradable they can throw it anywhere. This of course doesn't give them the liberty to throw as degradation takes time.
2. We, as a bioplastic industry has a lot of competition with the food manufacturing units as bioplastics require corn, rice, etc as raw materials, but this is a misleading argument commonly used against bioplastics as the raw material is an industrial-grade corn which is not grown for human consumption.

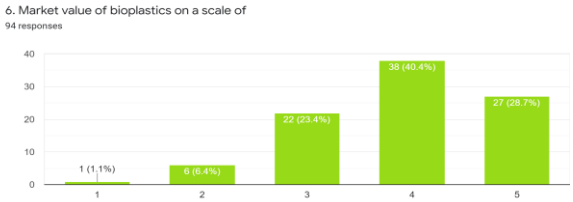

Chart- 5: Market value of bioplastics

The global bioplastics & biopolymers market size is expected to grow from USD 10.5 billion in 2020 and USD 27.9 billion by 2025, at a CAGR of 21.7% during the forecast period.[55] This high growth is driven primarily by the growth of the global packaging end-use industry and others like that of consumer goods, automotive & transportation, agriculture & horticulture, and textile, etc.

Focus of governments on green procurement policies and regulations increase the demand for bioplastics & biopolymers. These regulations include banning or implementing additional surcharges on the use of conventional plastics in applications, such as shopping bags, packaging materials, and disposables.

So, market share has been pretty excellent since it's advent and we owe it to our customers.

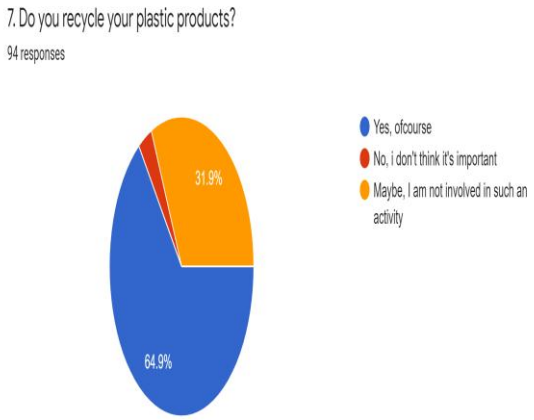

Chart-6: Recyclability of plastics

As time goes on, we are becoming more evolved and aware about our environment and so are our technology and most customers. Consumers are smart and they know what's the best option for them, how to minimize their cost and carry out their daily chores with the things present at home without needing extra resources. We are happy to know that our consumers recycle our products and even petroleum plastics and dispose of them only after a long use. This helps contain waste without generating extra.

6. CONCLUSION

According to our research, we have found out that even though plastics are bad for the environment and aquatic life, ironically it is engineered to last long. You may have noticed that some plastics gradually start to go cloudy or yellow after exposure to daylight (more specifically, in the ultraviolet light that sunlight contains). To stop this happening, plastics manufacturers generally introduce extra stabilizing chemicals to give their products longer life.[56] With society's ever-increasing focus on protecting the environment, there's a new emphasis on designing plastics that will disappear much more quickly.[57] "Environment-friendly" plastics fall into three types:

- Bioplastics made from natural materials such as corn starch.[58]
- Biodegradable plastics made from traditional petrochemicals, which are engineered to break down more quickly.[59]
- Eco/recycled plastics, which are simply plastics made from recycled plastic materials rather than raw petrochemicals.[60]

Unlike traditional plastics and biodegradable plastics, bioplastics generally do not produce a net increase in carbon dioxide gas when they break down (because the plants that were used to make them absorbed the same amount of carbon dioxide to begin with).[61] PLA , for example , produces almost 70% less greenhouse gases when it degrades in landfills.[62] Another good thing about bioplastics is that they're generally compostable and can break down in a matter of weeks.

Keeping all the pros of bioplastics under consideration, here at *"BioPlas+"* , we're committed to developing better plastic products i.e. bioplastic in a renewable, ecological way that doesn't harm the environment. We have spent a lot of time and effort closely examining various ways to develop processes for bioplastic manufacturing and utilize plastics made from plants, not petroleum.[63] Bioplastics manufactured here provides customers with the same look, feel and functionality of conventional petroleum-based plastics.

6.1 OUR NEWLY-ARRIVED RANGE OF BioMats™

(In all sizes- Small/ Medium/ Large)

Fig- 3: Newly-arrived BioMats™

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