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Use of Biodegradable Packaging : an Innovative Practice for Sustainable Business

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ABSTRACT: Biodegradable packaging is generally defined as any form of packaging that will naturally disintegrate and decompose. The term "biodegradable" has typically been used very broadly for any sustainable packaging material that will naturally break down – under any conditions and in an undefined amount of time. By this definition, anything from a wooden box to a cellulose-based wrapper is biodegradable. The difference being that the wrapper will biodegrade within weeks, while the wood will take decades or even centuries. Some of the sustainably-stamped biodegradable packaging that is being sold today will still cause harm to the environment! Packages that are certified compostable safely biodegrade in a commercial or home compost environment. The certification assures that the package will compeltely and safely decompose under certain conditions, and within a pre-defined time frame. You can be sure your bag or box will completely break down within 6 months to a year in a home or industrial compost, leaving nutrient-rich soil behind. It results in improved sustainability. This involves increased use of life cycle inventory (LCI) and life cycle assessment (LCA) to help guide the use of packaging which reduces the environmental impact and ecological footprint. It includes a look at the whole of the supply chain: from basic function, to marketing, and then through to end of life (LCA) and rebirth. Additionally, an eco-cost to value ratio can be useful The goals are to improve the long term viability and quality of life for humans and the longevity of natural ecosystems. Sustainable packaging must meet the functional and economic needs of the present without compromising the ability of future generations to meet their own needs. Sustainability is not necessarily an end state but is a continuing process of improvement.

KEYWORDS: biodegradable, sustainable, packaging, naturally degrade, supply chain, ecosystems, improvement, certification

I. INTRODUCTION

Biodegradable packaging is commonly thought to be made only from bio-based or plant-based materials, but the truth is, that's not true. Biodegradability depends on the molecular structure and strength of a material's polymer chain, rather than its source. To biodegrade, the polymer structure (string of monomers) that make up the material must be able to disintegrate, or break down, into tiny pieces that can be safely digested by microorganisms. This means biodegradable packaging can be made from bio-based and fossil-based polymers! Conventional plastic packaging is made up of strong carbon chains (like PE, PET, and PP) and takes a long time (centuries!) to break down, so these are not considered biodegradable.[1]

Biodegradable packaging, such as paper or cellulose, has a weak molecular structure so it will disintegrate quickly. A fossil fuel is a hydrocarbon-containing material formed underground from the remains of dead plants and animals that humans extract and burn to release energy for use (like gasoline or natural gas). Fossil fuel, just like other organic materials, is made up of carbon chains.[2]

Fossil-fuels are usually identified with the strongest, non-biodegradable plastics. However, there are some petroleum-based plastics composed of weaker types of carbon chains, which degrade efficiently and completely (like PBAT) while maintaining the strength and flexibility that makes plastic packaging so attractive for packaging manufacturers and users. These are ideal for biodegradable food packaging, as they provide the durability and reliability of plastic, with the environmental benefits of biodegradability[3].

TIPA, one of the world-leaders in specialized R&D for compostable packaging, uses a blend of fossil fuel-based and bio-based materials in our certified biodegradable films and packaging.

There are several biodegradable packaging types, however not all are suitable for food packaging. Here is a list of common and uncommon types of biodegradable packaging in use today:[4]

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- Hemp: Sourced from the cannabis plant, hemp is highly biodegradable, resilient, and versatile. However, hemp is still an expensive source for bioplastics and not yet commercially available in its polymerized form.
- Paper: Paper is one of the oldest, traditional forms of compostable packaging. It biodegrades very rapidly and can easily and efficiently be recycled. The downside is that paper does not provide the same protection or sealing as other kinds of packaging, so it's not appropriate for a lot of food packaging.
- PLA: PLA is bio-based and can be molded like conventional plastic into packaging, however it's slow-composting, even in an industrial composter.
- Cellulose: Plant-based packaging degrades very easily and is a great solution for short-term packaging, but it can't provide shelf-life or proper barrier for food products and easily discolors when stores.
- Seaweed: Like cellulose, seaweed-based material is highly biodegradable, and a great for short-term packaging, but unstable and unsuitable for food packaging, transport and storage.[5]

Biodegradable food packaging demands a hardy, protective material that will protect the product's freshness and integrity, while being able to withstand the necessary transport and storage conditions over many months. At the same time, it must be fully biodegradable within a reasonable amount of time.
TIPA compostable packaging is partially bio-based and partially fuel-based with specialized polymers that are highly durable yet easily biodegrade at end-of-life.

Waste, in all its forms, is one of the most pressing environmental issues of our time. Every year, some 8 million tons of plastic ends up in the ocean.[6]
As the world's population explodes, and consumerism drives more manufacturing and distribution of products, the amount of waste in oceans and landfills worldwide continues to rise.What is the end game? How can we begin to walk back our impact on the planet?There is no one solution to the eco-crisis. It demands a multi-pronged approach, and biodegradable packaging is one essential tactic among several that will save our planet.The global supply chain is complex – there is no easy return to the culture of local manufacturing. There is an urgent need for a healthier, smarter, and natural packaging solution that can accommodate contemporary consumer needs while keeping our planet safe. That solution is biodegradable packaging. There's a big difference between throwing away a banana peel and a plastic bag. They might both be used to package food, but the banana peel is biodegradable and will disintegrate naturally while the plastic bag will last for decades if not hundreds of years, lingering in a landfill, leeching harmful chemicals or possibly polluting the oceans.[7]

Food is purely organic waste, the ultimate compostable material. But much of the packaging of food products is not. It's shocking to consider that 63% of solid waste produced in the US comes solely from packaging.
By switching to biodegradable plastic packaging, the food industry can leverage this massive source of waste and re-direct it to compost, cultivating nutrient rich soil to support farming to grow more food. Instead of damaging the environment, biodegradable food packaging can become part of a vital circular system that both eliminates waste and boosts food production.

This critical advantage makes compostable packaging the next generation packaging solution for the food industry. New technology makes it possible to produce biodegradable food packaging that is also durable. So, more of our waste can 'behave' like a banana peel, rather than a plastic bag. The most important benefit of biodegradable packaging is the potential to reduce overall waste in the food industry. Instead of discarding tons of plastic to languish in landfills for decades, biodegradable food packaging naturally and completely degrades. Certified compostable packaging, such as TIPA, is designed to biodegrade under regulated conditions within a standard time-period. Packaging that is certified as biodegradable will break down typically within a year in home compost bins, and within 3 to 6 months in industrial composting environments. Biodegradable food packaging drives the circular economy, leveraging packaging waste as compost that adds nutrients to the soil and helps boost food production and farming. Biodegradable food packaging is nontoxic and natural, providing a safe and healthy solution for all types of food and food products.[8]

II. DISCUSSION

Packaging plays a major role in the protection and shelf life extension in the supply chain of a food product. Plastic based packaging has been widely used since decades. These materials made from petroleum based derivatives are expensive, takes many years for decomposing thereby polluting the environment. According to the report by Central Pollution Control Board of India (2013), about 15342 tons of plastic waste is generated every day across the country. Less than 5% of the plastics are recyclable and the rest pollute the land and water bodies thus, affecting the fauna and flora. Dumping plastic wastes makes the harmful chemicals to leach down in the soil affecting the soil fertility and

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incinerating these wastes emits toxic gases, which are harmful to the environment. Recycling of plastic waste is not a permanent solution because of the additives and colour present. Hence, alternative packaging, which are eco-friendly, with a major emphasis to safe guard our environment is the needed measure to combat this issue. Such a packaging must be easily degradable. The term biodegradable refers to those materials that could be easily decomposed by the enzymatic action of the microbes within a short period of time. Polymers used conventionally as packaging materials, are not biodegradable because of the long chain molecules, which make the break down by the microorganisms difficult[1]. Hence, they are considered as environmental waste. Contrary natural polymers have molecules easily degraded by the microorganisms.[9]

Considering the adverse effect of petroleum based plastics causing environmental pollution, demand has risen for biodegradable packaging in the food sector. Biopolymers are molecules present in cellulose and proteins. They are produced from renewable sources such as plant based materials like starch, cellulose, plant oil, sugar, reed etc.Based on the origin and production method, bio-polymers are classified as below:

Polymers Produced from Biomass

Polymers of this class are extracted from plants, marine and animal sources. Among the plant category, polymers extracted from starch obtained from corn and potato is widely accepted taking into consideration cost and availability etc. Fresh commodities like potatoes, corn, rice are heated to extract the starch molecules. The extracted starch polymers are further processed to arrive at the final package shape. This starch based plastics are completely biodegradable and could be made into sacks, bags and other packages. Because of their easy availability and low cost, starch based biopolymers are produced in large quantities in the world. Polymers can also be extracted from vegetable proteins like chick pea and soya beans.[1] Bamboo is one of the fastest growing plants on the earth making it an excellent alternative to paper and plastic. Cellulose from plant matter is extensively being used for manufacturing biodegradable packaging. Wood pulp is used to create paper and can be recycled into other paper products. Cellulose based film that is similar to plastic can be prepared from wood pulp. Mycelium of mushroom can be combined with seed husks for use as an alternative to polystyrene/styrofoam packaging. Chitin is another polymer obtained from the shells of prawn. It has good antimicrobial properties.[10]

Polymers Produced by Chemical Synthesis

Poly Lactic Acid, commonly referred as PLA is a biodegradable polymer or resin, obtained by fermentation of corn,[12] whey or molasses. It has an excellent permeability to water vapour and is made into thermoformed pads and containers, transparent bottles etc. used for packaging food. PLA containers have a great demand in the world market.

Polymers from Natural Organism

Polyhydroxy alkanoates and bacterial cellulose belong to this group.

Forms of Biodegradable Packaging

Based on the need of packaging different products, biodegradable packaging is produced in various forms viz., gels, film, bag and box [13]. Gel as hydrogel applied as a coating on fruits and vegetables, helps prevent microbial contamination. Biodegradable films are made from renewable biomaterial like corn dextrose. Biodegradable films are resistant to moisture and are easy to compost. They act as oxygen barriers for food packaging; used to wrap perishables and to seal containers. Biodegradable bags are also made from biomaterials. They are strong and resistant to breakage and considered safe for packaging food materials. Bio-oriented polystyrene from corn is used for producing biodegradable boxes with lid.[11]

Merits and de-merits of Biodegradable Packaging

Biodegradable packaging is made from eco-friendly materials. Hence, it is easier to recycle. They require less energy to produce. They are non- toxic [13] with reduced carbon emission and help to reduce climate change. Though, biodegradable packaging has many advantages over plastics, they have their own limitations. Long term usage of biodegradable packaging from plant source may lead to more requirement of plant matter for their production. They may also require special facility for composting [3] due to the fact that certain single use plastics derived from thermoplastic starch is obtained by mixing with small amounts of petroleum based polyester, which is hard to be broken down by certain bacteria. Landfilling is another issue emerging due to biodegradation.

Biodegradable packaging can be a best alternative to plastics when used in conjunction with metal containers. They offer best packaging solution for perishables against microbes. The dependence on fossil fuel is reduced due to possible

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shift from plastics. Even if biodegradable packaging has not reached its full bloom to save our eco system, judicial use of this alternative packaging is advisable.

According to National Geographic, there are over five trillion pieces of plastic debris in the world's oceans. The main sources are inadequate waste disposal and littering, with consumers using plastic once and throwing it away when they could recycle it. One area where this is an issue is packaging.[14]

Research by McKinsey found that 55% of consumers are concerned about the environmental impacts of packaging, with 70% of buyers saying they'd pay more for sustainable packaging.

Whether it's food or fashion, packaging is a key part of the consumer experience. However, there's pressure to improve certain properties of packaging so it can meet customers' ever-growing needs more sustainably and economically.[15]

Here are nine biodegradable packaging types you should use for your brand:

1. Cardboard
2. Paper
3. Corn Starch
4. Biodegradable Packing Peanuts
5. Water Soluble Plastic
6. Organic Fabric
7. Bamboo
8. Acid-Free Tissue Paper
9. Kraft Paper

III. RESULTS

Biodegradable packaging is made from materials that micro-organisms like bacteria can decompose. This ability to decompose rapidly contributes to a healthier environment, helping control waste build-up in landfills. While many types of biodegradable packaging materials are naturally-derived, such as cellulose and starch, synthetic materials can also be biodegradable.

Cardboard- We know cardboard is widely recycled and a household staple for packaging. But do you know the different types of this everyday material and their functionality?

Carton board- Carton board is flexible, easily flat packed and has a smooth side for printing designs and finishes. This type of cardboard is commonly used for cosmetics, cereals and other food packaging. Embossing can make a topographical difference to accentuate a part of the package.[16]

Corrugated cardboard- A popular packaging choice for many brands and industries, corrugated cardboard is made by pressing a piece of carton board in hot corrugators to create the s-curves. The pressed sheet is sandwiched between two carton board pieces to create a lightweight and durable material. Highly customisable and very cost-effective, this cardboard is used for packaging large items and shoeboxes because of the stable cushion effect it creates.

Paper- Although paper packaging is probably something we associate with food shopping and Lush cosmetics, paper is one of the oldest forms of flexible packaging used to protect delicate items of value. Now swing tickets and packaging can be produced using recycled papers or sourced from sustainable forests. You no longer have to settle for something eco-friendly but has a grainy and inexpensive feel. With today's different finishes and printing techniques, you can create compelling designs that are kind to the environment and a selling point. Paper can be a strong material once compacted, which is ideal for helping delicate garments keep their shape. It's also a great alternative to polythene air pillows, which might take up less space on the warehouse floor but require more work for the consumer to recycle. In contrast, paper is easy to recycle.[17]

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Cornstarch- Unwanted waste can be regenerated into a useful material that can package and protect goods. Bioplastics don't cause any pollution if disposed of correctly, as their composition is made up of completely edible biomasses which contain zero toxins. Corn-based packaging material can be made into fibre or film and the raw material is sustainable, cheap and easy to produce. Plastic packaging and containers made from renewable resources that can be reused as fertiliser is something all brands should be implementing.

Biodegradable packing peanuts- Although considered a nuisance, biodegradable packing peanuts are an eco-friendly way to package and secure the safety of goods. They can be thrown in the compost bin after use and even dissolved in water.With a slightly higher weight than their plastic polymer-based predecessor, suppliers may be cautious of the transition to starch-based peanuts because of the potentially higher shipping costs.However, a small price increase is minimal in comparison to the damage plastic-based peanuts cause to the environment. Consumers appreciate brands making an effort to become sustainable, as increased shipping costs won't be something that crosses their minds.[18]

Water soluble plastic- Water soluble plastic is made from polyvinyl alcohol (PVOH), a synthetic polymer created without heavy toxic metals. It dissolves when it comes into contact with boiling water. This packaging is used for garment bags. This material acts like the wrapping film found on a dishwasher or laundry tablet. It's currently used for high-quality, eco-friendly garment bags.

Organic fabrics- Organic fabrics such as plant-based, naturally-grown cotton are biodegradable materials that can be easily composted without leaving any harmful toxins behind. Other materials include hemp, tapioca and palm leaves, which take around 100 days to decompose.

Bamboo- Bamboo is one of the fastest growing plants in the world and doesn't require pesticides, meaning it has a lower environmental impact and is completely renewable.Due to its durability, many companies are now turning to bamboo as an alternative to wood products. It's also completely compostable within two to six months.[19]

Acid free tissue paper- Acid-free tissue paper guarantees healthier biodegradability when composted with traditional tissue paper. This type of paper uses fewer chemical agents in its manufacturing process and because it's made from either wood fibres or recycled materials, it's also entirely recyclable. Acid-free tissue paper offers great protection for packaging without staining items and is ideal for wrapping products.

Kraft paper- Kraft paper has become a popular choice for many brands focusing on sustainability due to its elasticity, durability and resistance to grease and oil. The material is organic, manufactured from virgin wood pulp and made of long maritime pine fibres. Kraft paper will break down into cellulose fibres after several weeks. Kraft paper can be used for various packaging options, including flat-pack boxes and carrier bags.[20]

Benefits of Biodegradable Packaging

1. Free of Toxic Materials

The most significant benefit of using biodegradable packaging is that it's good for the environment. Free of toxic materials and chemicals like phthalates or petroleum, biodegradable packaging is a great alternative to plastics that would otherwise release harmful chemicals into the atmosphere and end up in landfills for years to come.

2. Cost Savings

Biodegradable packaging can also lower production and packaging costs. Biodegradable materials like bioplastics can have weight savings of over 78% compared to alternative materials. This can reduce water usage, solid waste, electricity and emissions of the packaging process. Most of these materials are reusable and can be recycled, meaning brands can use fewer resources and cut inventory costs.

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3. Easier Disposal

Biodegradable packaging simplifies disposal as it doesn't require as many resources to break down.

4. Reduced Footprint

Over 70% of consumers aged 15 to 20 want to buy from companies committed to sustainability. Implementing biodegradable packaging is one way for businesses to reduce their environmental impact and improve their carbon footprint. Biodegradable packaging is an excellent way for companies to meet high environmental compliance standards while attracting new customers who want to be more sustainable in their shopping practices.[21]

IV. CONCLUSIONS

Biodegradable packaging maintains sustainable business. If you want to attract more customers and earn the favor of your current buyers, one way to do it is to use biodegradable packaging. In addition, the increasing awareness of the importance of sustainable business practices fuels consumers' resolve for environment-friendly best practices, including supporting businesses that share their desire to preserve the environment. Green is the new black. More and more companies are re-tooling their businesses to incorporate greener and more sustainable practices, both internally and in their corporate image. Companies ranging from nationwide franchise to boutique retailers are pouring resources into meeting this trend.[22]

Unsurprisingly, sales of Lifestyles of Health and Sustainability, or LOHAS, products have already eclipsed the $300 billion mark as of 2008, a 36% increase from just 3 years prior. The backbone of this change is the nearly 80% of US adults who want more sustainable offerings.The change is happening on both the manufacturing and retail fronts, with companies like Proctor & Gamble maintaining scorecards for its supply base and Wal-mart using a proprietary Sustainability Scorecard to boost competition between its suppliers and thusly drive down the impacts of packaging. Some of the ways Berlin Packaging has pushed the sustainability agenda include:

- Early adoption of bio-based resins, including Polyhydroxybutyrate (Biopol).
- Supplying multiple products with enhanced recyclability; all-plastic trigger sprayers is one example.
- Partnering with Eco.logic brands on their fiber-based eco.bottle™.
- Regular work to reduce gram weight in containers and closures.
- Regular work to reduce freight and greenhouse gases by sourcing packaging closer to the filling location or changing package cube efficiency.
- Focus on reducing and eliminating the need for secondary packaging.
- Member of the Sustainable Packaging Coalition™.[22]

Sustainability has benefits for the planet, your businesses community, and even your company itself. As part of a new set of considerations for business owners, sustainability can play a large role in shaping the growth and proust of your business. Sustainable packaging can play a significant role in that growth, and the challenge lies in defining what the winning strategy is for you. Understanding where sustainability lies in your corporate dashboard and what you're willing to give in order to achieve it is essential to building the right strategy. When you have accomplished that, you can then select what tactics will best serve you to achieve your sustainability goals.

Four major groups of action improve packaging sustainability – Used Materials, Spent Materials, Energy Use, and Community. These groups can all play a large role in your sustainability strategy.[23]

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