

APPLICATION OF BIOPLASTICS IN BULK PACKAGING: A REVOLUTIONARY AND SUSTAINABLE APPROACH

¹ Ambrish Pandey, ² Pankaj Kumar, ³ Vikas Singh



1. Assistant Professor, Department of Printing Technology, Guru Jambheshwar University of Science & Technology, Hisar, Haryana, India

2. Assistant Professor, Department of Printing Technology, Guru Jambheshwar University of Science & Technology, Hisar, Haryana, India

3. Student.B.Tech (PACKAGING TECH.), Department of Printing Technology, Guru Jambheshwar University of Science & Technology, Hisar

ABSTRACT

In this paper we have discussed about the possible practical approach to adopt the bioplastics in the field of Bulk Packaging. There are lot of hazardous effects of petroleum based plastic and packages on the environment. So there is a need of rethinking for the use of this kind of materials which create threat to the society and environment through different kinds of packaging. Here an effort is made by collecting the available data from different open sources and same is compared for initiating positive approach to replace the conventional plastics with bioplastics, which are bio-degradable, compostable, energy efficient and proven suitable though studies and comparison for use in bulk packaging. In bulk packaging now-a-days there are lot of plastic being used for FIBC, IBC, Woven sacks, Shrink wraps etc. So comparing the physical, chemical and other properties of bioplastics and its type, it is suggested that its use at the place of conventional petroleum based plastics can be a revolutionary step for environmental protective and sustainable packaging. The gas barrier, water vapour transmission rate, oxygen permeability, mechanical properties as well as thermal properties of bioplastics are very near and in some cases better than the conventional plastic. The recent researches are making them more efficient in case of its use in bulk packaging with cost considerations.

KEYWORDS

BIODEGRADABILITY, COMPOSTABILITY, DEGRADATION, BULK PACKAGING, OXYGEN PERMEABILITY, MECHANICAL PROPERTIES, WATER VAPOUR TRANSMISSION RATE, FLEXIBLE INTERMEDIATE BULK CONTAINERS (FIBC), INTERMEDIATE BULK CONTAINERS (IBC).

INTRODUCTION

From recent past, the world is becoming cognizant about the hazardous effect of plastic bags on the environment. To support this, researchers have come up with natural option of Bioplastics. Plastics are being used all over the world. Right from drinking cups to parts for automobiles. Plastics are extremely important to the job market as well as for packaging throughout the world. Since plastics are involved with peoples everyday lives. Therefore production of biodegradable plastics to make plastics more compatible with environment has become necessary.

Option of Bioplastics focus on performance and price to become viable packaging alternatives in future. It is better than the alternate bio fuel which is adopted in partial manner mainly in U.S.A., and is based on the corn crops in order to utilize excess land and food products and same can be utilized for the alternate plastic instead of wasting it. Currently, the bioplastics industry is in its infancy and, as a result, does not require a significant proportion of land for feedstock supply. Approximately 2.5 kg of maize produced on 2.5 square metres of land is required to produce 1 kg of PLA. In the USA around 36 million hectares of maize is grown annually and around 17 thousand hectares is required to produce 70 thousand tonnes of PLA. This land use equates to 0.1% of the total US maize land area. In UK the most likely crop feedstock for bioplastic manufacture is wheat. A plant producing 132,000 tonnes of PLA per annum would only require a small percentage of the wheat produced in the UK. This slight increase in demand could be met through use of some of our exported wheat, through improved crop yields and more efficient use of farmland. Considering this data we can predict that with improved crop yields and efficient use of farming we can meet the demand of crops used in the manufacturing of bioplastics without any diversion of land and on food availability. It is also safe in manifolds than conventional plastic because bioplastics are very much safe, and they contain no toxins at all. With traditional plastics harmful chemicals and by-products can be released during the breakdown and decay period, but this is not the case with plastic that is biodegradable. This all natural plastic breaks down harmlessly and is absorbed back into the earth. There is no chemical leaching into rain water or the ground to threaten the health and safety of people or animals nearby. It biodegrade and break down into carbon dioxide, water, biomass at the same rate as cellulose (paper). Bioplastic when disintegrate is indistinguishable in the compost and is not visible. Its biodegradation does not produce any eco-toxic material and the compost can also support plant growth. Biodegradable Plastic is plastic which degrades from the action of naturally occurring microorganism, such as bacteria, fungi etc. over a period of time. Considering the above faces of its productivity and properties of non-toxicity and biodegradability about 90% within one year depending upon the environmental conditions, this can also be used as food for fishes and other marine species.

Bioplastics packaging is being slowly adopted by food service companies and grocery store delis for use as film for sandwich wraps or for clamshell packaging for fresh products such as vegetables, fruits, salads, pasta or bakery goods. In view of this it becomes important to find durable plastic substitutes especially in short-term packaging and disposable applications. The continuously growing concern of the public and government for the problems related to plastic has stimulated research interest in bioplastics as alternative to conventional plastics; so, bioplastic packaging has a great potential in a country like ours where we have land, water and energy resources and we cannot rely on landfill or recycling of packaging wastes particularly when the non-biodegradable packaging materials are becoming a visible nuisance and eyesore in big cities. It seems, in the age where sustainability is one of the biggest issues facing the packaging and bulk packaging industry, its application will spread like wildfire.

BIOPLASTICS

Bioplastics are a form of plastic derived from renewable biomass source, such as vegetable oil, corn-starch, potato-starch or microbia, rather than fossil-fuel plastics which are derived from petroleum.

History: - Bioplastics are not new, in the 1850s, a British chemist created plastics from cellulose, a derivative of wood pulp. Later in the early 20th century, Henry ford experimented with soy-based plastics in his automobiles. After that, biodegradable plastics began being sparking interest during the oil-crisis in seventies. The 1980's brought items such as biodegradable films, sheets and mold-forming materials. As prices of petroleum products are increasing day by day and therefore the need of bioplastic appeared and research started in this context.

Composition: - Bioplastics can be made from many different sources and materials. They are produced from renewable biomass sources, such as vegetable oil, corn-starch, potato-starch or microbiota, a number of fibers including those obtained from pineapple and henequen leaves and banana stems. Corn is the primary source of starch for bioplastics, although more recent global research is evaluating the potential use in bioplastics for starches from potato, wheat, rice, barley, oat and soy-sources.

Also, bioplastics can be made using bacterial micro-organisms or natural fibers such as jute, hemp & Kenaf. Sometimes various nanometer-sized particles especially carbohydrate chains called polysaccharides or other biopolymers that don't dissolve in water, with clay are added to add certain properties like, low water-vapour and gas permeability, increased shelf-life with better strength. But there is a need to identify the other suitable plants available for this specific purpose.

Classification of Bioplastics

Starch based plastics: - Starch the storage polysaccharide of cereals, legumes and tubers is a renewable and widely available raw material for bioplastics. Flexibiliser and plasticizer such as sorbitol and glycerin are added so that starch can also be processed. As a packaging material starch alone does not form films with adequate and required mechanical properties of high percentage elongation, tensile and flexural strength unless it is treated by either plasticization, blending with other materials, genetic or chemical modification or combinations of different approaches. For which corn is the primary source of starch, although considerable amounts of starch are produced from potato wheat and rice starch.

Bioplastics produced from classical chemical synthesis from biobased monomers: - Using classical chemical synthesis for the production of polymer gives a wide spectrum of possible "bio-polyesters". Polylactic acid is the polymer with the highest potential for a commercial production of renewable packaging materials. However, a wide range of other bio polyesters can be made. Theoretically, all the conventional packaging materials derived from mineral oil today in coming future can be produced from renewable monomers gained by fermentation. Today, this approach is not feasible due to the cost of the production of the monomers has economical constraint.

Polylactic Acid (PLA) plastics: - Polylactic acid, PLA is a biodegradable, thermoplastic, aliphatic polyester derived from lactic acid. The lactic acid source of PLA is itself produced from the fermentation of agricultural by-products such as corn-starch or other starch-rich substances like maize, sugar or wheat. PLA has high potential for packaging applications. The properties of the PLA material are highly related to the ratio between the two mesoforms of the lactic acid monomer. Using 100% L-PLA results in a material with a very high melting point and high crystallinity. A 90%/10% D/L co-polymers gives a material which can be polymerized in the melt, oriented above its T_g and is easily processable showing very high potential of meeting the requirements of bulk packaging. PLA may be formed into blown films, injection moulded objects and coatings. PLA is the first novel biobased material produced on large scale.

Bioplastics produced directly by natural or genetically modified organisms: - Poly Hydroxy alkanooates (PHA's) and Poly Hydroxy butyrate (PHB) is the most common polyester produced by certain bacteria processing glucose or starch. The properties of PHA's are dependent and relates upon the composition of monomer unit, the microorganisms used in fermentation, as well as the nature of the carbon source used during the fermentation process. It is a typical highly crystalline thermoplastic PHA are elastomers with low-milting points and a relatively lower degree of crystallinity. A very interesting property of PHA's with respect to food packaging applications is their low water-vapour permeability which is close to that of LDPE. The renewable resource-based plastic has similar properties to polystyrene. PHB resembles isotactic polypropylene (iPP) in relation to melting temperature (175-180°C) and mechanical behaviour. PHBs T_g is around 9°C and the elongation to break of the ultimate which is very important in bulk packaging application especially in flexible intermediate bulk containers and bulk shrink packaging. It has been reported in the literature that annealing can dramatically improve the mechanical properties of PHB by changing its lamellar morphology while subsequent ageing is prevented to a large extent. Incorporation of 3HV or 4HB co-monomers produces remarkable changes in the mechanical properties. Stiffness and tensile strength decrease with increase of toughness with increasing fraction of the respective co-monomer. Medium chain length PHAs, unlike PHB or its copolymers, behave as elastomers with crystals therefore, can be regarded as a class of its own with respect to mechanical properties. Elongation to break up to 250-350% has been reported and a Young's modulus up to 17 MPa.

Polyamides 11: - PA11 is a biopolymer derived from natural oil. It is also known under the trade name Rilson B commercialized by Arkoma. It is used in high-performance application like automotive fuel lines, pneumatic airbrake tubing and flexible goods means they too have good mechanical properties as they are used in automotive and electrical stuffs.

Polycaprolactones: - It is a biodegradable thermoplastic polymer derived from the chemical synthesis of crude oil. Polycaprolactones has good water, oil, solvent and chlorine resistance. It is mainly in thermoplastic polyurethanes, resins for surface coatings adhesives and synthetic leather and fabrics.

BULK PACKAGING

Packaging is system of preparing goods for transport, distribution storage, retailing and end use. It is means of safe delivery to ultimate consumer in sound condition at economic cost. There are basically three different kind of packages categorized on the basis of use, function, containment of the package.

The first kind of package is unit package, it contain product for one shot is for family requirement, it provides all information related to the product, it also provides aesthetic values and convenience factors to support sales. Intermediate packaging facilitates distribution in the overall marketing system. Bulk, the most important one helps in the complete containment of product or product groups. It facilitates inventory and bulk distribution of package product and also protects them during transportation. To define Bulk Packaging, we can use one of two approaches. The most obvious way is to lay down a basic minimum unit content threshold which is 25 kgs. or 25 liters but this poses certain limitations. The other is to look at the packaging system that what basic function it performs. Using the latter approach, it would be logical to assume that we would want to look at all major applications or packages that are not meant for retail consumption but are only targeted at consumption by manufacturing and processing industries or by organization who are 'bulk' consumers. In other words, we are looking at packages that contain products which are meant for large-scale or industrial consumption as intermediate inputs for further processing, distribution and re-sale in smaller denominations.

Classification based on basic guidelines there is different bulk packaging systems:

- Metal packaging (steel drums and barrels, large cans)
- Rigid plastic packaging (Plastic barrels, IBC's, large bottles)
- Flexible packaging systems (Sacks, woven sacks, FIBC's, films for stretch wrapping, shrink wrapping)
- Paper-based packaging (corrugated fiberboard, multiwall layer sacks, fiber drums)
- Bag-in-box and bag-in-drum systems
- Aseptic bulk packaging
- Wooden packaging (pallets and cases)

Our primary focus will be on the rigid plastic packaging and flexible packaging systems because they have to be replaced in recent future by bioplastics. The need of replacement for the petroleum based plastic with bioplastics is just because

- Producing conventional plastics consumes 65% more energy than producing bioplastic.
- Conventional plastic are mostly toxic.
- Plastics last a long time and do huge damage to environment. Therefore, plastic is absolutely unsustainable and bioplastic is more sustainable.
- Bioplastics saves 30-80% of the greenhouse gas emissions and provide longer shelf-life than normal plastic.

Bulk packaging systems related with conventional plastics are as follows:-

Intermediate bulk containers (IBC): An Intermediate bulk container is a container used for transport and storage of fluids and bulk materials. The construction of the IBC container and the materials used are chosen depending on the application. They are generally cubic in shape and therefore can transport more material in the same volume than cylindrically shaped containers and far more may be shipped in the same space if packaged in consumer quantities. IBCs range in size but are generally between 700 and 2,000 mm or 1,168 to 1,321mm in height. IBCs may ship and store Bulk chemicals including hazardous materials if the IBC is proven suitable. The plastic used in the manufacturing of IBC's are basically polyethylene, polypropylene these are plastics are used because they have lower impact strength, high tensile strength, High compressive strength, excellent dielectric properties, resists to alkalis and acids, resists stress cracking, retains stiffness, low moisture absorption, non-toxic, non-staining, easily fabricated, and high heat resistance.

Flexible intermediate bulk containers (FIBC): A Flexible Intermediate Bulk Container, big bag, bulk bag, or super sack is a standardized container in large dimensions for storing and transporting and storing for example sand, fertilizers, granules of different material and other dry products. It is most often made of thick woven polyethylene or polypropylene and normally measures around 110 × 110 cm and varies in height from 100 cm

up to 200 cm. Its capacity is normally around 1000 kg. Transporting and loading is done on either pallets or by lifting it in loops. Emptying is made easy by a special opening in the bottom or by simply cutting it open. FIBC has certain components like lifting loops, body, base and liners. Lifting loops are basically made up of nylon, polyester or polypropylene with minimum strength of 2500 kg secured to the reinforcing bands. Body is fabricated by PP with special polyester reinforcing bands and liners are made from LDPE/LLDPE.

Woven sacks: Woven sacks are made by weaving of monoaxially-oriented tapes of HDPE, PP and LLDPE. The oriented tapes are woven into a fabric of desired weaving density in flat or circular loom or on a warp-knitting machine for light weight open type bags, sometimes liners are also used for moisture resistivity.

Bulk shrink wrap: Shrink wrap is commonly used as an overwrap on cartons, boxes, beverage cans and pallet loads etc. A variety of products may be enclosed in shrink wrap to stabilize the products, keep them clean, and add a degree of tamper resistance, etc. shrink wrap is done to heavy duty machineries when they are carried from one place to another. The most commonly used bulk shrink wrap is polyolefin. It is available in a variety of thicknesses, clarities, strengths and shrink properties. In this two primary films are either crosslinked, or non crosslinked. Other shrink films include PVC and several other compositions.

Stretch wrapping: Stretch wrap or stretch film is a highly stretchable plastic film and is wrapped around items. The elastic recovery keeps the items tightly bound. It is frequently used to unitize pallet loads but also may be used for bundling smaller items. The most common stretch wrap material is LLDPE, PVC and other PE. Many films have about 500% stretch at break but are only stretched to about one-fifth to three-fifth in use. Once stretched, the elastic recovery is used to keep the load tight. It properties such as break strength, cling, clarity, tear resistance, static discharge, etc. are also important.

So finally we notice that the main fossil fuel based plastics used in the bulk packaging are polyethylene (LDPE, LLDPE, HDPE), polypropylenes (PP), Nylon, Polyvinyl chloride (PVC), Polyester and their different properties are as follows

ASTM or UL test	Property	LDPE	HDPE	POLYPROPYLENE	NYLON	PVC
PHYSICAL						
D792	Density (lb/in ³) (g/cm ³)	0.033 0.92	0.035 0.95	1.22-1.23	1.12 - 1.14	0.051 1.41
D570	Water Absorption, 24 hrs (%)	<0.01	0	0.09-0.1	2.9	0
MECHANICAL						
D638	Tensile Strength (psi)	1,800-2,200	4,600	58 - 104	9.4	7500
D638	Tensile Modulus (psi)	-	-	195,000		411,000
D638	Tensile Elongation at Yield (%)	600	900	12	25	
D790	Flexural Strength (psi)	-	-	72-15	NO YEILD	12800
D790	Flexural Modulus (psi)	-	200,000	6555-6900	1.5	481000
D695	Compressive Strength (psi)	-	-	7,000		
D695	Compressive Modulus (psi)	-	-	-		
D785	Hardness, Shore D	D41-D50	D69	92R	104(R)	115(R)
D256	IZOD Notched Impact (ft-lb/in)	No Break	3	1.9	2.2	1.0
THERMAL						
D696	Coefficient of Linear Thermal Expansion (x 10 ⁻⁵ in./in./°F)	3	6	6.2	4	6.1

D648	Heat Deflection Temp (°F / °C) at 66 psi at 264 psi	120 / 48 105 / 36	170 / 76 150 / 40	210 / 99 125/52	340	176/80
D3418	Approx. Melting Temperature (°F / °C)	230 / 110	260 / 125	327 / 164		-
-	Max Operating Temp (°F / °C)	160 / 71	180 / 82	180 / 82	175	140/60
C177	Thermal Conductivity (BTU-in/ft ² -hr-°F) (x 10 ⁻⁴ cal/cm-sec-°C)	- -	- -	0.76-0.81 2.6-2.8		0.90 3.1
UL94	Flammability Rating	n.r.	n.r.	H-B	H-B	V-O
ELECTRICAL						
D149	Dielectric Strength (V/mil) short time, 1/8" thick	460-700	450-500	500-660		544
D150	Dielectric Constant at 1 kHz	2.25-2.30	2.30-2.35	2.25	3.7	3.2
D150	Dissipation Factor at 1 kHz	0.0002	0.0002	0.0005-0.0008	0.12	.0096
D257	Volume Resistivity (ohm-cm) at 50% RH	10 ¹⁵	10 ¹⁵	8.5×10 ¹⁴	10-12	5.4 x 10 ¹⁵
D495	Arc Resistance (sec)	135-160	200-250	160		

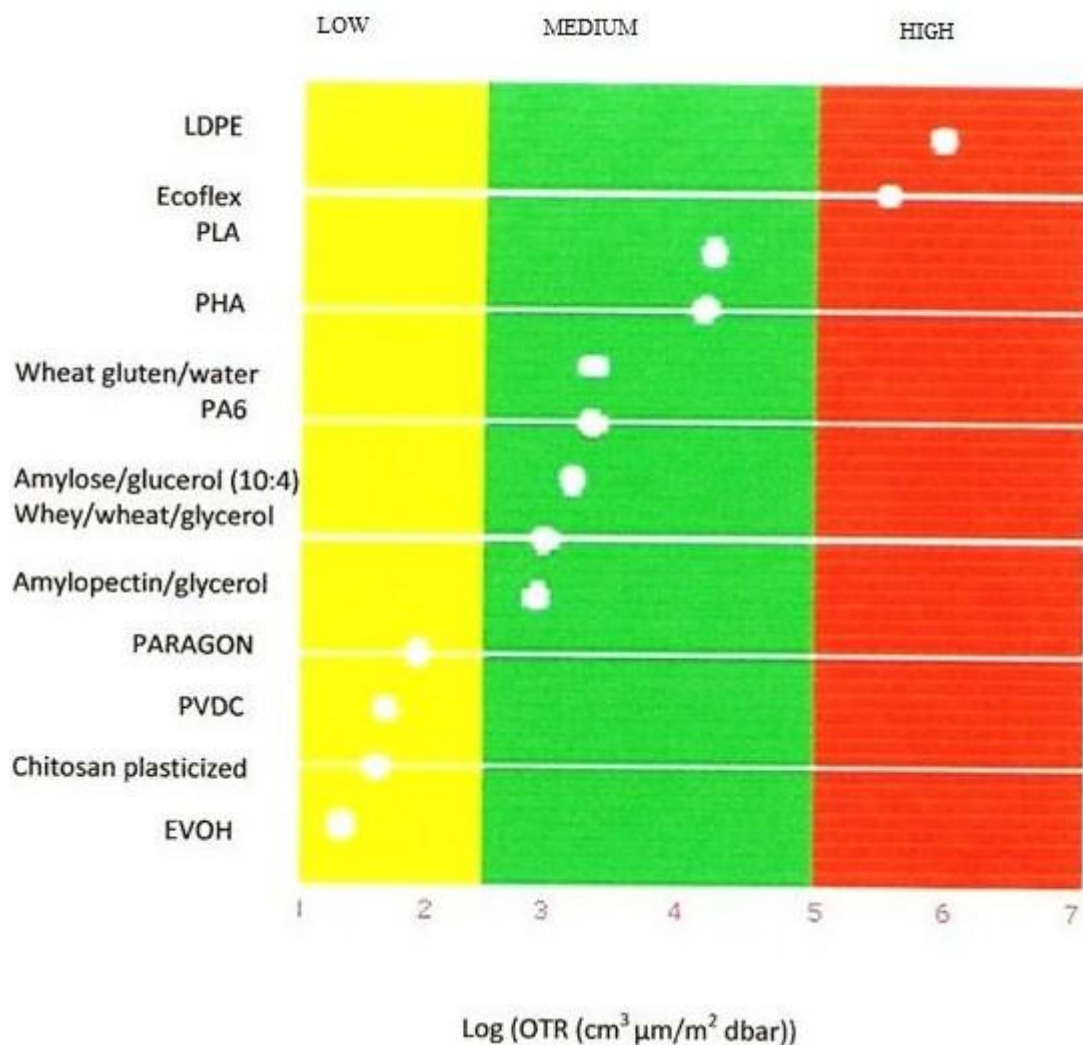
Performance based properties of Plastics used in Bulk packaging are as follows:

Plastics	Water vapour transmission rate g/m ² ,38°C, 90% RH	Gas transmission rate cc/m ² , 24h/atm at 25°C		Heat seal rate, °C
		O ²	CO ²	
LDPE	18.6	7750	41850	158-176
HDPE	4.6-100	2868	8990	162-169
Polypropylene	6.2-100	2325- 3720	7750	170-188
PVC	60	124-465	310-465	158-176
Nylon	388	40.3	155-186	176-220

PROPERTIES OF BIOPLASTICS AND ITS COMPARISON WITH CONVENTIONAL PLASTICS FOR ITS APPLICATION IN BULK PACKAGING:-

Due to biological biodegradability the use of bioplastics is especially popularising in the packaging sector. The use of bioplastics for shopping bags is very common. Certain characteristics of bioplastics- such as their aroma barrier and ease of moulding make them particularly suitable for use with cosmetics and are continually being developed to make bioplastics better alternatives for such packaging. PLA offers good-moisture barrier properties and is able to withstand the rigors of injection-moulding and blow- or vacuum-forming processes. It is used for loose fill packaging food packaging. PLA has similar characteristics as cellophane, oriented polypropylene (OPP) or oriented polyethylene (OPE). Its performance include high clarity and gloss and high stiffness. Bottles made from PLA can show characteristics similar to PET. Its containers are rigid, strong and have high aroma barrier suitable to pack cold delis items such as fruit, pasta, salads and cheese. PHA's can be incorporated into packaging components such as coatings, laminations and biodegradable printing inks. It is currently being considered for flexible packaging. After the detail study of bioplastics's mechanical, thermal and barrier properties conclusion regarding its use in bulk packaging as an alternative for petroleum based plastics can be obtained.

Gas barrier properties: In most packaging applications the gas mixture inside the package consists of carbon dioxide, oxygen and nitrogen or combinations. Biobased materials have quite same oxygen permeability that of conventional mineral-oil-based materials and it is possible to select from a range of barriers among the present biobased materials. The conventional approach to introduce high-barrier films for packaging of food is to use multi-layers of different films in order to obtain the required properties. A laminate that is often used in packaging consists of an layer of EVOH or PA6 combined with LDPE for mechanical strength and the excellent sealing properties. A similar multi-layer approach for biobased materials may be used to produce materials with the required properties. Starch-based materials could provide cheap alternatives to presently available gas barrier materials like EVOH and PA6 and an equivalent biobased laminate would be an outer- layer of plasticized chitosan, a protein or starch-derived film combined with PLA or PHA. PLA and PHA will protect the moisture-sensitive-gas-barrier made of polysaccharide and protein. Developments have made it possible to improve water vapour and gas properties of biobased materials many-fold by using plasma deposition of glass-like SiOx coatings on biobased materials or the production of nano-composites out of a natural polymer. In general, the oxygen and other gases permeability of a specific material are closely interrelated, petroleum based polymers have a fixed ratio between the oxygen and carbon dioxide permeabilities. This relation is also observed for biobased materials. However, for some biobased materials, like PLA and starch, the permeability of carbon dioxide in comparison to oxygen is much higher than for petroleum based plastics.

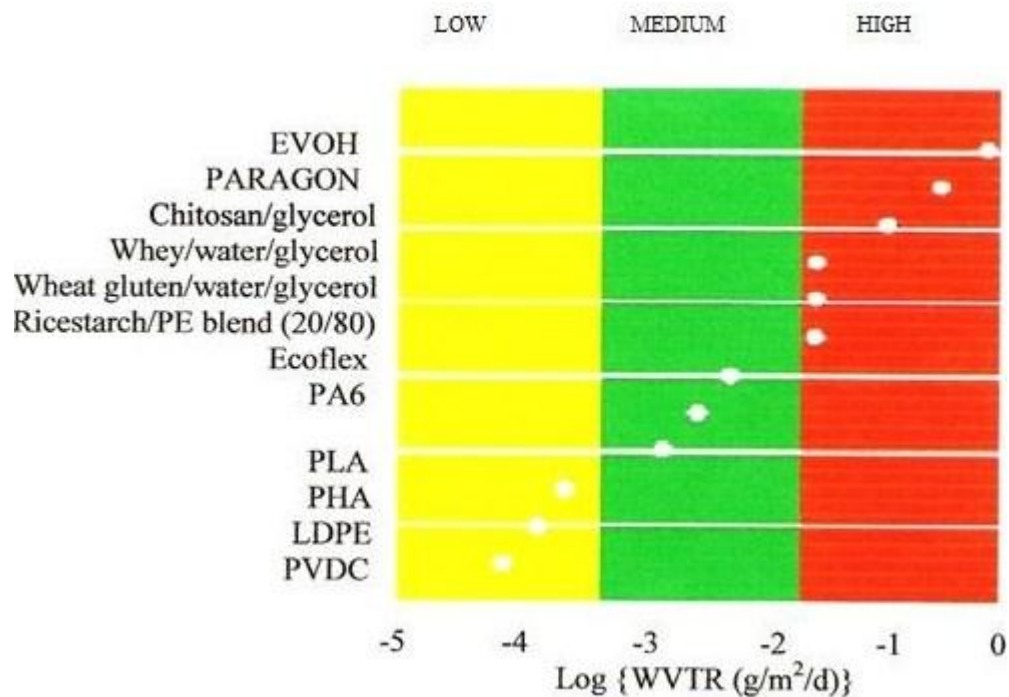


Gas barriers, humidity and microbial growth

As many of these biobased materials are hydrophilic in nature therefore their gas barrier properties are very much dependent on the humidity conditions for the measurements and its gas permeability may increase many

times with when increase in humidity. Same is the phenomenon with conventional polymers. Gas barriers based on PLA and PHA is not expected to be more dependent on humidity. According to the study microbial contamination levels of packages made from conventional and biobased materials are relatively below the standard of 1 organism/cm². A microbial study of cellulose triacetate, a type of bioplastic shows that after years of storage under ambient conditions mostly *Pseudomonas* bacteria is found in the film. Different tests for fungal growth (ASTM G21-96, G22-76, G21-70) has been conducted on the bioplastics, after many years of storage it was found that a low growth of selected food related fungi like *Penicillium* ocured in the same.

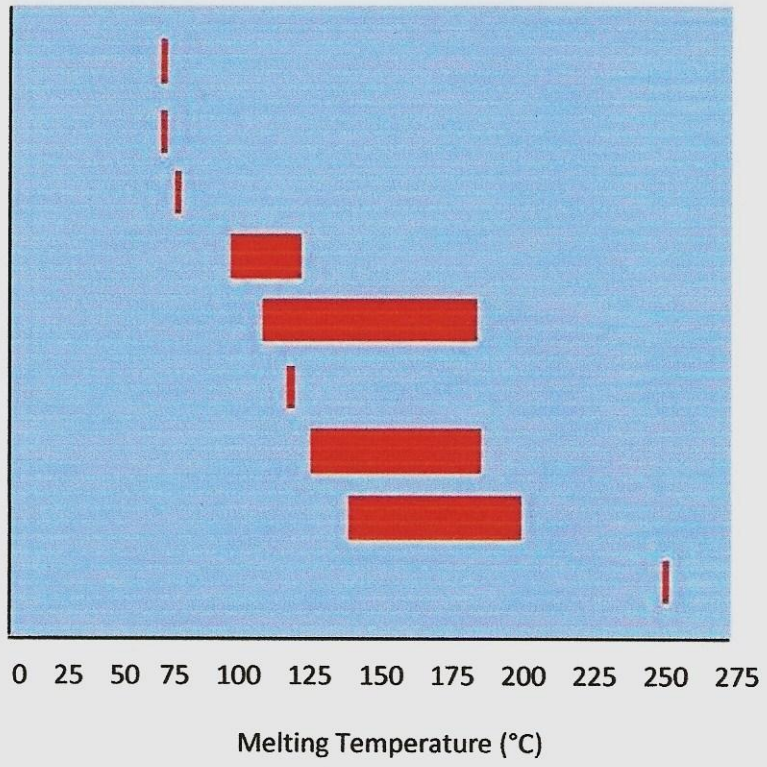
Water vapour transmittance: While comparing the water vapour transmittance of various biobased materials to conventional plastics it comes out that it is possible to produce biobased materials with water vapour transmittance rates comparable with some conventional plastics. Research are currently focusing on this problem and future biobased materials will be compatible in terms of water vapour barriers with conventional conventional pastic materials known today.

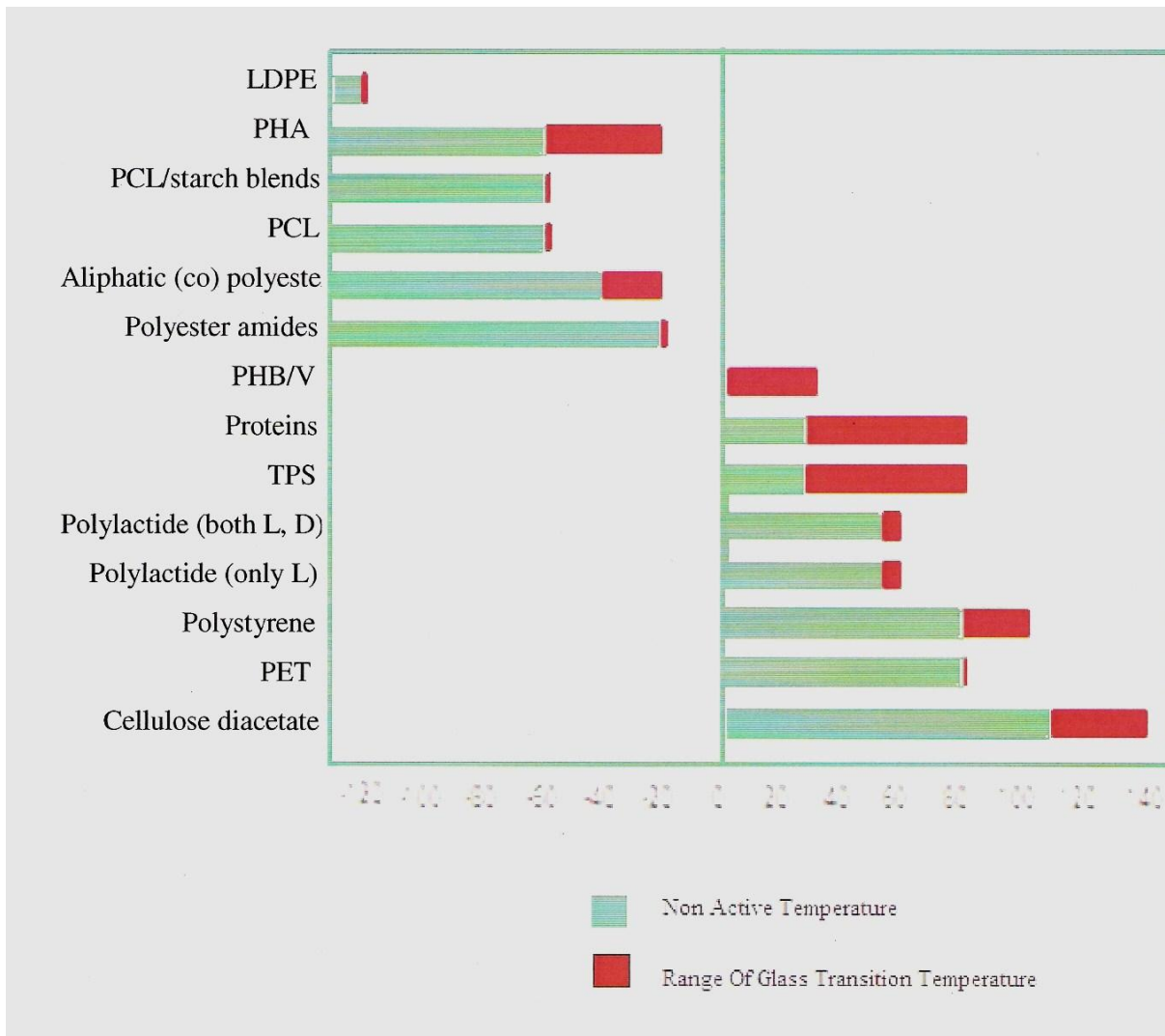


Thermal and mechanical properties: The thermal and mechanical properties of the materials are important for processing and for use of the products derived from these materials. Most biobased polymer materials act in a similar fashion to conventional polymers. This indicates that both polystyrene, polyethylene and PET-like materials can be found among the available biobased polymers. The mechanical properties in terms of modulus and stiffness are not much different compared to conventional polymers.

The modulus of most biobased and petroleum derived polymers can be tailored to meet the required mechanical properties by plasticizing, blending, crosslinking. A polymer like bacterial cellulose could be used in materials to meet special mechanical properties.

PCL/Starch Blend
Polycaprolactone
PHA
Aliphatic Polyester
PHBV
LDPE
Polyester-amides
Polylactide (L)
PET





The manufacturing processes which can be used for a bioplastic bulk packaging are extrusion, co-extrusion, blow moulding, injection blow moulding and thermoforming. Bioplastics can be processed in all of these process to a potential bulk package.

PROPERTIES OF BIOPLASTICS (ASTM standard)

Physical properties	
Mold shrinkage	0.0125-0.0155 in/in
Density	1.4g/cm ³
Apparent viscosity(180°C, 100 sec ⁻¹)	950 Pa-s
Thermal properties	
Melting point	160-165°C
Heat distortion temperature	143°C 78°C
Vicat softening temperature	147°C
Mechanical properties	
Tensile strength	26 MPa(3800psi)
Shrinkage	0.93% caliper
Tensile modulus	3400 MPa(494,000psi)

Tensile elongation brake	3%
Compressive yield Stength	65MPa (approx)
Compressive Modulus	2GPa (approx)
Flexural strength	44 MPa(6390psi)
Izod impact strength	26 J/m(0.5 ft lbs/in)
Hardness	54 shore D(90°C,2.16kg)
Bending module	387 MPa
Moisture absorption	0.16% (23°C, 50% RH)
Transparency	High
Oxygen barrier	Medium-high
Other Properties	
Stackability	Fair
Puncture Resistance	Excellent
Crystallinity	60

Bioplastics also provides very good printability, without any pre-treatment. Apart from this PLA have particularly high glossiness, high transparency, and good aroma or fat barriers, high oxygen barrier properties, antistatic properties.

Now comparing with the petro-based plastic we find that bioplastics have enough potential that it can be implemented in the IBC, FIBC, Shrink wrapping, and as liners in the bulk packages.

Biological derived polymers may be used for the production bulk packages with the same technology used for conventional materials. These data proves that they are no where less in any physical, thermal, mechanical and barrier properties than conventional plastics.

Bioplastics have following several other important advantages over conventional plastics in bulk packaging which are as follows:

- Compost derived in part from bioplastics increases the soil organic content as well as water and nutrient retention, with reducing chemical inputs and suppressing plant diseases.
- Starch-based bioplastics have been shown to degrade 10 to 20 times quicker than conventional plastics.
- On burning traditional plastics, create toxic fumes which can be harmful to people's health and the environment. If any biodegradable films are burned, there is little, if any, toxic chemicals or fumes released into the air.
- Safe Biodegradability: In degradation test it was found that more than 90% of samples degrade in 10 months, according to the measurements of weight loss and CO₂ production. There are water soluble biocomposites with solubility depending on the amount and the molecular weight and its crystallinity. Bioplastics like PHBV, PHB are biodegradable in soil, river, water, sea-water aerobic and anaerobic sewer sludge and compost. For example PHBV mineralizes in anaerobic sewer sludge to CO₂, water and some percentage of methane to the extent of nearly 80% in 30 days. Another example is application of a special biocomposite in making of laundry bags for hospital and other institutions, where the bag dissolve during the washing and biodegrade after disposal into sewage. Samples of bioplastic compost, obtained by mixing the test material with organic waste, are compared with samples of a reference compost produced only with organic waste and was found that the effect of compost samples on the plant growth is assessed and during degradation, does not release substances toxic for the plants and environment. Composting is not the only environment in which the degradation of the biobased materials can occur. Soluble biobased material can be

flushed in the sewage system and can be biodegraded in waste water treatment plants. Bioplastic materials can also be used in agriculture where the degradation takes place in soil.

- **Safe for Medicinal Use:** Quite a number of applications are suggested or tested or used in medicine. Most of the bioplastics like PLA, PHB, PHBV are non-toxic and compatible with living cells, producing an extremely mild foreign body response and the biodegradation rate is excellent. Applications such as controlled drug, surgical equipments, surgical swab, wound dressings and even blood compatible membranes can be quoted as typical applications for considerations in hospitals. These materials unlike cotton, small pieces of material from swab or dressing can be left in wound without danger of inflammation. These applications especially in medicine is considered by their optical activity and piezoelectric properties.
- Compared to conventional plastics derived from petroleum, bio-based polymers have more diverse stereochemistry and architecture of side chains which enables research scientists a great number of opportunities to customize the properties of the final packaging material.

Thus with this added advantages and almost similar properties of LDPE, PVC, Nylon, HDPE, PP we can implement bioplastics in the bulk packaging industry at the places of these petroleum based plastics which are creating environmental pollution by its non degradability and harmful gas emission.

MARKET AND PRICE OF BIOPLASTIC

The world currently utilises approximately 260 million tonnes of plastics per year. Europe uses approximately 53 million tonnes of plastics and the UK utilises approximately five million tonnes of plastics in a year. Bioplastics make up about 0.1% of the global market at an approximate consumption volume of 300,000 tonnes per year and experts predict that this market will grow six-fold by 2011 reaching over 1.5 million tonnes per year. In Europe, bioplastic consumption is approximately 60-100,000 tonnes per year and the UK utilises an estimated 15,000 tonnes per year.

The otherwise nominal bioplastics sector is all set to take a leap in the coming years. According to European Bioplastics Association, the global production capacity for bioplastics is projected to grow four times by 2020. The factors in favour of the bioplastics are the hefty packaging taxes introduced in the Europe and the US, surging oil and feedstock prices that are making conventional polymers more expensive and the European directives designed to establish an infrastructure for compostable bioplastics collection. Conventional plastics have scored over bioplastics in terms of price. In the past, bioplastics packaging has cost roughly 20% to 100% more than the petroleum-based plastic. However, stringent packaging taxes imposed in Europe and US combined with the escalating oil and feedstock prices are leveling the field for bioplastics with petroleum-based plastics. According to Plastics Exchange in Chicago, as a result of the rising oil prices the price of resins like polypropylene (PP) has risen about 45%.

The prices of any biopolymer are likely to be high when it is only produced on a small scale. The scale of production is likely to have a greater influence on the price than the costs of the raw material source and of the chemistry involved. Today prices are bit high but at higher scales of production the price will fall to a range of 1 to 10USD per kg.

CONCLUSION

Comparing the properties of biobased polymeric materials with the conventional synthetic petroleum derived polymers shows a major potential of these polymers for the production of well-performing bulk packages. The biobased materials have an inherent potential of being compostable which must help the commercialization of these materials. As with any emerging technology, continued innovation and global support is essential for bioplastics too for fully demonstrate for its socio-economic benefits and further challenge the status of traditional petroleum based plastics in the field of bulk packaging. In social context biodegradable plastics call for a re-examination of life-styles. They will require separate collection, involvement of the general public, greater community responsibility in installing recycling systems, etc. On the question of cost, awareness may often be lacking of the significance of both disposal and the environmental costs, which are to be added to the processing cost. The developments in the fields of bioplastics looks very promising given the fact that compositions of bioplastics are inexpensive, available annually biodegradable in several environments and incinerable. Thus we can use the bioplastics in our bulk packaging systems where conventional plastic is basically used and save our environment.

ACKNOWLEDGMENT

The authors are thankful and acknowledge the efforts of the authors of the referred books,papers, websites contents and the help and support received from colleagues specially Dr. C.P.Kaushik, Assistant Professor,Department of Applied Chemistry, GJUS&T,Hisar Haryana

REFERENCES:

1. www.science.org.au
2. www.rfsung.org
3. www.zerowaste.co.nz
4. www.greenplastics.com
5. www.eng.iastate.edu
6. www.packaging-gateway.com
7. www.bioplastics24.com
8. Biodegradable Plastics by Dr. A. K. Mohanty
9. Weber, C.J. (Ed.). (2000). Biobased Packaging Materials for the Food Industry.
10. [www.packagingknowledge.com/degradable&biodegradable bags.html](http://www.packagingknowledge.com/degradable&biodegradable%20bags.html)
11. Technical Data Sheets. Novamont, www.novamont.com/ing/html/home.html
12. <http://www.plastictechnology.com/articles/200209fa3.html>
13. P. Halley. Biodegradable packaging for food industry. Package bottling int. vol 4, no4, pp 56-57
14. Plastics in packaging by A. S. Athalye, pp 61-75, pp 183-210
15. Handbook Of Package Engineering (2nd edition) by Joseph F. Hanlol, pp 8-1 8-83
16. www.nia.or.th/bioplastics.
17. www.azocleantech.com/details.asp?news
18. www.biomatnet.org/secure/Air/s235.htm
19. [www.researchandmarket.com/reprtinfo.asp?](http://www.researchandmarket.com/reprtinfo.asp)
20. www.biodeg.net
21. Green Plastic: an introduction to the new science of biodegradable plastics (2002) by E.S. Stevens, pp 118-126
22. Degradable Polymers (Principles and Applications), 2nd edition by Gerald Scott, pp 295-316 pp 379-400
23. Article on Biodegradable Packaging for food industry by I.P. Paltani & G.K. Goyal, NDRI, Karnal
24. Innovations in Food packaging by Jung H. Han, pp 240-243
25. Article on Biodegradable polymers: A rebirth of plastic by Shellie Berkesch, MSU, March 2005
26. Article on Innovative Technologies for Biodegradable Packaging by Lillian Liu, SJSU, Feb 2006
27. Processing & Characterization of Bio-Plastics (Presentation) by Yanir Shaked, UOM, Massachutes

Amrish Pandey

Assistant Professor
Department of Printing Technology, Guru
Jambheshwar University of Science &
Technology, Hisar, Haryana, India
e-mail- amrishpandey12@yahoo.co.in

Pankaj Kumar

Assistant Professor
Department of Printing Technology, Guru
Jambheshwar University of Science &
Technology, Hisar, Haryana, India
e-mail-pankajkumartiwari@yahoo.co.in

Vikas Singh

Student .B.Tech (PACKAGING TECH.), Department of
Printing Technology, Guru Jambheshwar
University of Science & Technology, Hisar
e-mail- vikas.gjust@gmail.com

