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STUDY OF REDUCTION OF CARBON FOOTPRINT BY APPLICATION OF BIO-PLASTIC IN MILK PACKAGING

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ABSTRACT

Introduction of Bio-plastic in milk packaging helps in reduction of carbon footprint from environment. Bio-plastics are the green plastics, which are either bio-based in nature or Bio-degradable or have both properties. From early days our society is using conventional petroleum based plastics which are made from petroleum and produce a lot of carbon footprints during its life cycle and they have many other drawbacks also like dependency on petroleum, hiking price of petroleum, waste management problems etc. So, due to increasing environmental concern, our society needs a better solution for all these issues and bio-plastic is one of the best solutions for all these environmental issues. Various applications and benefits of bio-plastics in milk packaging are discussed in this article. Comparative study of different tests performed on biodegradable plastic films and conventional plastic films are also discussed in this paper.

Keywords*: Bio-plastic, Milk Packaging, Bio-degradable, Food Packaging, Carbon Footprint, Conventional Plastic, Renewable Resource, Non-renewable Resource.*

1. INTRODUCTION

Plastic is a part of our life, we use plastic in many applications on daily basis. But this plastic have a lot of problems like it is made from petroleum based raw materials which are limited in stock, price of petroleum is increasing day by day and creates a lot of environmental problems. To overcome all these problems a new type of plastic is developed in society known as bio-plastic. The word bio-plastic is derived from two words bio + plastic. Bio means life and plastic means synthetic material made from wide range of organic polymers, this plastic is made from agricultural raw materials, so it reduces the dependency on petroleum. Bio-plastic is not a single type of plastic, it is a group of plastic which are made from renewable resources like soya, sugarcane, potato, plant oils etc. and it degrades with in limited time from few days to few months according to available environment conditions.
Bio-plastics are further categories in three segments:
Bio-based Bio-plastic: This type of plastic is made from renewable agricultural resources such as corn starch, sugarcane, potato, plant oil, cellulose etc. For example: PE **(**Polyethylene), PA (Polyamide), PET (Polyethylene terephthalate) etc.
Bio-degradable Bio-plastic: This type of plastic degrades naturally within few days without addition of any artificial additives. For example: PBAT (poly-butyrate adipate terephthalate), PCL **(**Poly Caprolactone) etc.
Bio-based, Bio-degradable Plastic: This type of plastic has both properties and that's why it is known as bio-based, bio-degradable plastic. For example: PLA (Poly lactic acid), PHA (Polyhydroxylalkanoate) etc.

2. DISADVANTAGES OF CONVENTIONAL PLASTIC IN MILK PACKAGING

Conventional plastic is used for milk packaging from hundreds of years. It is a part of our life but it has some drawbacks also which are as follows:

- **Increasing price of petroleum:** Price of petroleum is hiking rapidly.
- **High emission of CO_2:** Production of conventional plastic does high emission of CO_2.
- **Non degradable in nature:** Conventional plastic does not degrade for many of years and create land filling.

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- **It is the cause of many diseases:** Conventional plastic is not degraded upto many years, when plastic garbage is mixed with water bodies create several harmful and communicable diseases.

3. APPLICATION OF BIO-PLASTICS IN MILK PACKAGING:

In modern era, demand of bio-plastic is growing more and more. Milk industry is one of the important application areas for bio-plastic. Life of milk pouches is very small. These are one time usable pouches. When we use conventional plastic, after using the product empty pouches are thrown away as waste in garbage, which creates land filling problem because life of conventional plastic is 1000 of years and it does not degrade for 1000 of years. But if we use bio-degradable bio-plastic it will degrade within in few days or few months.

Bio-plastics are excellent barrier to oxygen, high transparency, good puncture resistance and non-toxic properties. At present, market of bio-plastic in milk packaging is very small. According to survey reports, market of bio-plastic in milk packaging is about 1-2% up to 2015. But market of bio-plastic in milk packaging is negligible in India; it is less than one percentage. Milk pouches are most common type of milk packaging, but till now they are made from conventional plastic. 1000 ml (One Litre) and 500 ml (1/2 Litre) pouches are used for milk packaging for daily use in India.

4. BENEFITS OF USING BIO-PLASTICS INSTEAD OF CONVENTIONAL IN MILK PACKAGING

Market of bio-plastic is very small in milk packaging industry. But it has unlimited scope of growth in this area. It is an established fact that milk pouches are used only once in their life cycle, after being used milk pouches are thrown away as waste. Milk in pouches is consumed within 3-4 days from the date of packaging. So, here we need to use bio-degradable bio-plastic, which degrades easily and reduces land filling problem. Benefits of replacing conventional plastic with bio-plastic film pouches:

- If conventional milk packaging is replaced with bio-plastics packaging, dependency on petroleum is reduced highly.
- Land filling problem is a great environmental issue but bio-degradable plastics pouches are degraded within few days and helps in reducing land filling problem to a great extent.
- CO_2 emission is reducing upto 80% by using bio-plastic pouches.
- There are some chemicals used in conventional plastic which are very harmful for human being but Bio-plastic is safe as compared to conventional plastics**.**

Tests performed on Conventional plastics and Bio-plastics
All tests are performed on conventional plastic film and Biodegradable films to check the different properties like Tensile Strength, Elongation Test, COF Test, Surface Treatment Test, GSM Test, Heat Sealing Test, Drop Test etc. which are as follows:

Tensile Strength and Elongation Test
Tensile strength is defined as the ability of a material to withstand a force. It is measured in units of force per area i.e. Kg/cm^2. Tensile test is performed to check how film will behave when subjected to forces applied in tension in machine direction and grain direction respectively.

Elongation test is performed to check the extent upto which the film can be stretched; this test is performed on Universal Tensile Machine. Readings of elongation test are obtained in percentage.

Steps followed for Tensile Test and Elongation Test are as follows:

1. Cut a strip of 15mm wide and 10cm length in machine direction and cross direction.
2. Clamp the two ends in the machine 50 mm apart from each other.
3. Switch on the machine and wait until the tearing of film.

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4. Note down the readings, readings in red panel gives tearing strength and readings in green panel gives elongation strength.

Universal Tensile Machine

Data from Tensile Tester on Vita Film and various Bio-degradable films

Table 1: Tensile Strength for Vita Milk Package Film and various Bio-degradable Films

Sr. No.	Name of Film	Result (Kg/cm^2)
1	Conventional film in MD	222
2	Conventional film in CD	205
3	20 micron bio-plastic film in MD	88
4	20 micron bio-plastic film in CD	68
5	25 micron bio-plastic film in MD	181
6	25 micron bio-plastic film in CD	163
7	62 micron bio-plastics film in MD	230
8	62 micron bio-plastic film in CD	219
9	65 micron bio-plastic film in MD	226
10	65 micron bio-plastic film CD	222

Data from Elongation Tester on Vita Film and various Bio-degradable Films

Table 2: Elongation Strength for Vita Milk Package Film and various Bio-degradable Films

Sr. No.	Name of Film	Result (%)
1	Conventional film in MD	476
2	Conventional film in CD	605
3	20 micron bio-plastic film in MD	230
4	20 micron bio-plastic film in CD	280
5	25 micron bio-plastic film in MD	280

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6	25 micron bio-plastic film in CD	420
7	62 micron bio-plastics film MD	660
8	62 micron bio-plastic film in CD	685
9	65 micron bio-plastic film in MD	920
10	65 micron bio-plastic film CD	945

COF Test

COF test is performed to check the coefficient of friction between film to film and film to metal. This test is performed to check how easily a film will open when subjected to film to film contact and film to metal contact.

Steps followed for COF Test are as follows:

1. Cut a sample of size 130mm x 250mm from sample.
2. Place the specimen on the bed of the COFF Tester with untreated side on the top.
3. Place metal block (Block size 63mm x 63mm, 200 gm wt.) wrapped in film with untreated side exposed to film on top for checking the coefficient of friction between both untreated sides as in milk packaging both untreated sides come in contact with each other.
4. The motion of the plane starts from left to right hence the sled has to be placed at the left hand to the left hand of the plane.
5. Before activating the push button tare the load indicator.
6. The static friction value will be maximum friction value observed during the travel of the sled for first 10-20 seconds.
7. Now the fluctuating values are observed when the plane is in motion in order to take average mean of the COF of Dynamic friction.

COF Test Machine

Data from COF tester on Vita milk Package film and various Bio-degradable Films

Table 3: C.O.F for Vita Milk Packaging Film and various Bio-degradable Films

Sr. No.	Name of film	Result (μ)
1	Conventional film	0.25
2	20 micron Bio-plastic film	0.31
3	25 micron Bio-plastic film	0.29
4	62 micron Bio-plastic film	0.22
5	65 micron Bio-plastic film	0.20

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GSM Test

GSM test is performed to determine the weight present in per square meter of substrate. This test gives reading in gm/m^2.

Steps followed for measuring GSM are as follows:

1. Cut a sample of 10cm x 10cm from sample.
2. Switch on the tester.
3. Place the sample on the plate of tester.
4. Note down the readings.

GSM Tester

Data from Thickness Tester on Vita Milk Package Film and various Biodegradable Films

Table 4: GSM for Vita Milk Package Film and various Bio-degradable Films

Sr. No.	**Name of film**	**Result (g/m^2)**
1	Conventional film	45
2	20 micron Bio-plastic film	18
3	25 micron Bio-plastic film	23
4	62 micron Bio-plastic film	56
5	65 micron Bio-plastic film	58

Heat Sealing Test

It is a machine used to seal products using heat. It is used to combine two same or different films using heat. Temperature can vary from 100°C-200°C.

Steps followed for Heat Sealing Test are as follows:

1. Cut a sample of desired size.
2. Switch on the heat sealing machine.
3. Place the sample on lower jaw of machine.
4. Press the upper jaw for 1-2 sec. for perfect seal.

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5. Keep sealing until the perfect temperature for sealing is not achieved.
6. Note down the temperature.

Heat Sealing Machine

Data from Heat Sealing Machine on Vita Milk Package Film and Bio-degradable Films

Table 5: Heat Sealing Temperature for Vita Milk Package Film and various Bio-degradable Films

Sr. No.	Name of film	Result (°C)
1	Conventional film	120
2	20 micron Bio-plastic film	90
3	25 micron Bio-plastic film	95
4	62 micron Bio-plastic film	130
5	65 micron Bio-plastic film	150

Drop Test

Drop test is performed to check out the suitability of the package if our package is suitable for milk packaging or not. Take standard size pouches of milk. Drop the pouches from a height of 1.2 m on a flat smooth surface. Each pouch shall be dropped four times in the following sequence:

Steps followed for Drop Test are as follows:

- On flat side of pouch
- On opposite side of pouch
- On flat longer edge of pouch
- On opposite longer edge of pouch
- Check the pouches for any leakage, if no than sample have passed the test, if yes than sample have failed the test.

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Drop Test Machine

Data from Drop Test Machine on Vita Milk Package Film and various Biodegradable Films

Table 6: Drop Test for Vita Milk Package Film and various Bio-degradable Films

Sr. No.	Name of film	Result
1	Conventional film	Pass
2	20 micron Bio-plastic film	Fail
3	25 micron Bio-plastic film	Fail
4	62 micron Bio-plastic film	Pass
5	65 micron Bio-plastic film	Pass

Degradation Time for Conventional Film and different Bio-degradable Film

Table 1.6 Degradation time of Vita Milk Packaging Film and various Bio-plastics Films

Sr. No.	Name of film	Degradation time
1	Vita film	100 or more year
2	20 micron Bio-plastic film	One and half year to two year
3	25 micron Bio-plastic film	Up to half year
4	62 micron Bio-plastic film	Up to one year
5	65 micron Bio-plastic film	Degrade up to one and half year

5. FUTURE OF BIO-PLASTIC IN MILK PACKAGING

Milk production market of India is growing more rapidly as compared to world milk production market. According to latest survey report, India produces 146.37 million tons milk in 2014-2015. Out of which approximately 30% of total milk is packed in plastic pouches (approximately 40 million tons). This milk requires approximately 200 million kg of plastic for packaging. When 200 million kg plastic is incinerated, it releases approximately 600 million kg of CO_2. Till now bio-plastic is not used in milk packaging because of non availability of bio-plastic. Researcher hopes that in near future there will be a big demand of bio-plastic and more number of suppliers/ distributers come in market. That will create good impact on reduction of carbon footprint generated by conventional plastic use for unit pack/ user pack of CO_2 that we have studied in project.

Keeping in view bio-plastic will gain momentum automatically. Use of biodegradable bio-plastic will be suggested for such one time usable applications. At present bio-plastic industry is growing by 15% from last year and it is hoped to grow 19% more from this year production of bio-plastic.

6. CONCLUSION

Introduction of bio-plastics, especially in the milk packaging industry market, is an important step for a sustainable market. By using bio-plastics, great extent of CO_2 gas emission can be reduced, which is the main reason for environmental pollution. Some bio-plastics are bio-based, so they have unlimited raw material supply chain. Bio-plastics, which we are going to replace with conventional plastics in milk packaging industry, are biodegradable in nature. As test report indicates, bio-degradable bio-plastics are compatible as conventional plastics in all properties which are required for packaging pouches.

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