ISSN: 0976-3031

Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 9, Issue, 4(I), pp. 26137-26139, April, 2018

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

BIODEGRADATION OF *HIBISCUS* MUCILAGE AND POTATO STARCH BLENDED WITH LDPE: A COMPARATIVE STUDY

Ramkesto Kumar and Sanjay K.Sharma*

Department of Chemistry, JECRC University, Jaipur, India

DOI: http://dx.doi.org/10.24327/ijrsr.2018.0904.1999

ARTICLE INFO

Article History:

Received 5th January, 2018
Received in revised form 20th February, 2018
Accepted 8th March, 2018
Published online 28th April, 2018

Key Words:

Plastics, Biodegradation, LDPE, Mucilage, Starch

ABSTRACT

Accelerated use of synthetic plastic materials in packaging has led to serious ecological problems. Biodegradable polymers are material that could be converted to natural compounds such as water, carbon di-oxide, methane and other biological components by means of microorganisms like algae, fungi, bacteria. In this article a comparative study of degradations of hibiscus mucilage and potato starch blends with LDPE has been done. Samples with different concentrations of hibiscus mucilage and potato starch (as 5%, 10%, 15%, 20% and 25%) were prepared. Glycerol was used as a plasticizer and Fe_2SO_4 was used as a pro-oxidant. The biodegradation of blends of hibiscus mucilage and Low Density polyethylene (LDPE) was compared with the biodegradation of blends of potato starch and LDPE with the same levels of concentrations. The comparative evaluation of biodegradation in soil has been studied in terms of loss of mass, density, tensile strength and elongation as well as in terms of crystallinity. The loss of mass of hibiscus mucilage and LDPE blend was found 25.8 % after six months of soil burial, where as the blend of potato starch with LDPE was found 21.42 %. Tensile strength of mucilage blend was decreased by 12.1 %, whereas of starch blend was decreased by 11.29% and elongation is reduced by 54.1 % and 28.17 % respectively after six months of soil burial. The density is decreased by 14.3 % and 8.67 % for mucilage and starch blends respectively after six months of soil burial. Further the crystallinity is deviated by % and % for mucilage and starch blends respectively. It has been found that more degradation occurred with mucilage blends rather than potato starch blends.

INTRODUCTION

Accelereted use of synthetic plastic materials in packaging has led to serious ecological problems due to their total non-biodegradability in the natural environmental conditions. The approaches such as incineration, thermal degradation, landfills, bio-degradation, oxo-degradation and photo-degradation had been made to resolve the solid waste problems (Singh, 2008). Biodegradable polymers are material that could be converted to natural compounds such as water, carbon di-oxide, methane and other biological components by means of microorganisms like algae, fungi, bacteria and other natural occurring agents (Borghei, 2013). One of the major strategies to facilitate disintegration and subsequent degradation is by direct degradation of LDPE by microorganisms using only the polymer as sole carbon source (Roy, 2008). Biodegradable plastics offer a lot of advantages such as increased soil fertility, low accumulation of bulky plastic materials in the environment (which invariably will minimize injuries to wild animals), and reduction in the cost of waste management (Tokiwa, 2009).

Mucilage is a mixture of polysaccharide mixture (Kumar, 2017). The mucilage powder was taken out from leaves of *Hibiscus rosa-sinensis* (China rose) of Malvaceae family which was arranged from Bandel area of Hooghly district (W.Bengal, India).

Starch is a polymer and semi-crystalline in natural, composed of two major components 1, 4-α-D-glucopyranosyl: amylase and amylopectin (Khiar, 2011). Starch is a inexpensive materials used as additives. Starch contained plastics did not have any adverse effect on quality of food or other packed materials (Raj, 2004).

In the present article, the compounds of low density polyethylene with hibiscus mucilage and potato starch were made. A comparative study of effect of mucilage and starch concentrations on mechanical, physical, rheological, thermal and chemical properties done.

Corresponding author:* **Sanjay K.Sharma
Department of Chemistry, JECRC University, Jaipur, India

MATERIALS AND METHODS

Materials

Low Density Polyethylene of 16MA400 grade produced by high pressure process was obtained from Reliance Polymers, India. The mucilage was isolated from the leaves of Hibiscus rosa-synensis commonly known as China rose. Starch powder was extracted from the potato (*Solanum tuberosum)*. Glycerol about 98% purified of Merk Co., Germany was used as a plasticizer. Fe_2SO_4 hydrated crystal purified of Merk co., Germany was used as pro-oxidant.

Methods

The isolated hibiscus mucilage and extracted potato starch was added in similar quantity of glycerol and Fe_2SO_4 (1 mass % of LDPE) conventionally. The formulated polymers were processed with different levels of variations of hibiscus mucilage and potato starch separately in two roll mill at around 150^0 C for about 10 minutes of mixing. Sheets were prepared of uniform thickness in compression moulding under heat and pressure. A sheet of virgin LDPE was also prepared to be used as controlled reference. The sample sheets of all concentrations were shaped into strips and buried into the soil for six months to evaluate biodegradation.

The tensile strength and elongation at break were determined by using tensile testing machine (H10K, Tinius Olsen) as per standard test method ASTM D 638. The test was carried out at a speed of 50 mm/minute. The mean values of three specimens for each concentration were reported.

The melt flow rates of the samples of different concentrations were measured at 190^0C temperature and 2.16 kg. load as per standard test method ASTM D 1238 by using melt flow indexer (Modular 7027, Ceast, Italy).

The density of the samples was determined as per standard test method ASTM D 792 by using density apparatus (Mettler Toledo).

The thermal properties in terms of crystallization temperature and degree of crystallinity of the mucilage based, starch based compounds and virgin LDPE were characterized, using Mettler Toledo (Switzerland) differential scanning calorimeter (DSC). The weighed samples of 5-10 milligrams were heated in the temperature range of 25^0 to 160^0 C at a heating rate of 10^0C per minute in nitrogen atmosphere to determine the melting temperature of the compounds before and after soil burial. Then the samples were cooled from 160^0 to 25^0C at 10^0C per minute cooling rate in nitrogen atmosphere to check the percentage crystallinity and crystallization temperature. As a reference an empty aluminium crucible was used. Indium and Zinc were used to calibrate the instruments.

RESULTS AND DISCUSSION

The biodegradation of blends of hibiscus mucilage and Low Density polyethylene (LDPE) with different levels of concentrations (5%, 10%, 15%, 20% and 25%) was compared with the biodegradation of blends of potato starch and LDPE with the same levels of concentrations. The comparative evaluation of biodegradation in soil has been studied in terms of loss of mass, density, tensile strength and elongation. The variation in the above mentioned properties after six months of soil burial for both kinds of blends have been expressed in Table - 1 and also plotted in Figure 1, 2, 3 and 4.

Table 2 Variations in Crystallinity of Hibiscus Mucilage and Potato Starch Blends After Soil Burial for Six Months.

Concentrations of Green Additives (Mucilage & Starch)	Variations in Crystallinity After Six Months of Soil Burial (In %)		
	100 % Virgin LDPE	Mucilage Blends	Starch Blends
0 % Compounds	0.66	-----	-----
20 % Compounds	-----	10.62	6.64
25 % Compounds	-----	20.78	12.64

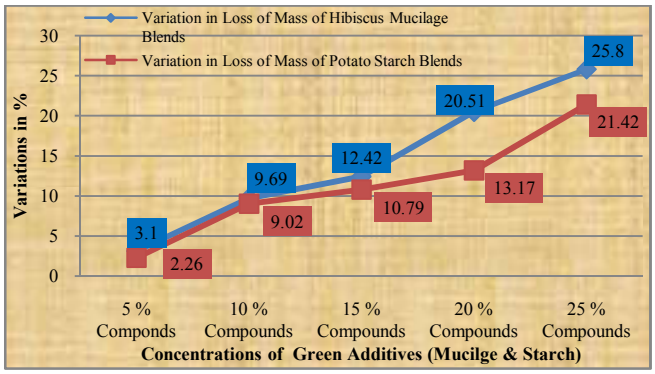

Figure 1 Variations in Loss of Mass V/S Concentrations of Green Additives

Table 1 Variations in Different properties of Hibiscus Mucilage and Potato Starch Blends after Soil Burial for Six Months.

Concentrations of Green Additives (Mucilage & Starch)	Deviation in Loss of Mass (In %)		Deviation in Density (In %)		Deviation in Tensile Strength (In %)		Deviation in Elongation (In %)	
	Mucilage Blends	Potato Starch Blends	Mucilage Blends	Potato Starch Blends	Mucilage Blends	Potato Starch Blends	Mucilage Blends	Potato Starch Blends
5 % Compounds	3.10	2.26	2.7	0.86	5.5	2.41	14.2	12.83
10 % Compounds	9.69	9.02	7.0	3.25	6.9	2.74	23.8	14.62
15 % Compounds	12.42	10.79	9.1	6.5	1.4	5.8	26.5	13.76
20 % Compounds	20.51	13.17	11.0	6.98	11.8	9.1	38.7	22.62
25 % Compounds	25.80	21.42	14.3	8.67	12.1	11.29	54.1	28.17

The crystallinity of blends of hibiscus mucilage and Low Density polyethylene (LDPE) with different levels of concentrations (0 %, 20% and 25%) was compared with the biodegradation of blends of potato starch and LDPE with the same levels of concentrations. The variations in the crystallinity after six months of soil burial for all kinds of blends have been expressed in Table – 2 and also plotted in Figure 5.

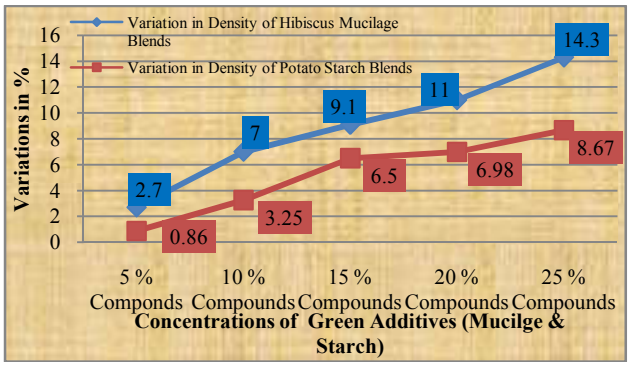

Figure 2 Variations in Density V/S Concentrations of Green Additives (Mucilage & Starch)

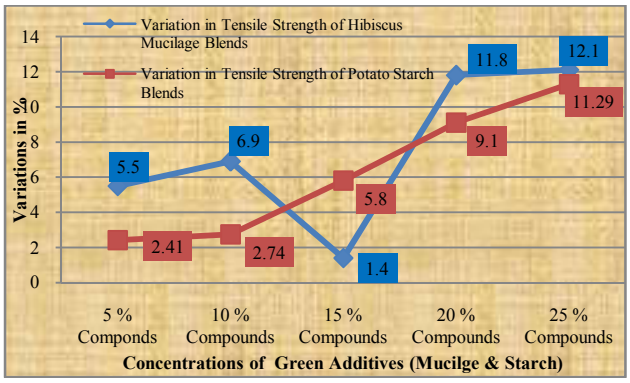

Figure 3 Variations in Tensile Strength V/S Concentrations of Green Additives (Mucilage & Starch)

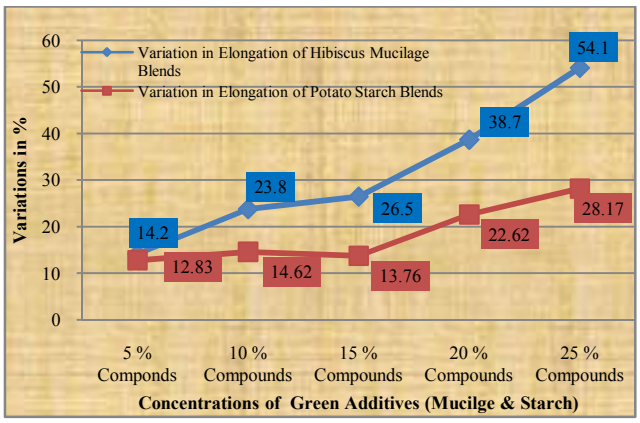

Figure 4 Variations in Elongation V/S Concentrations of Green Additives (Mucilage & Starch)

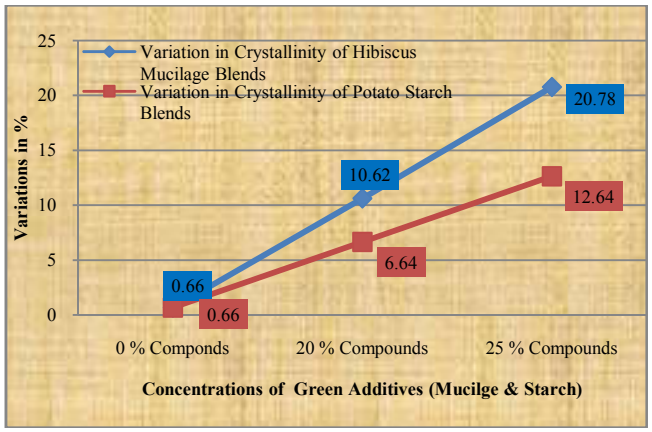

Figure 5 Variations in Crystallinity V/S Concentrations of Green Additives (Mucilage & Starch)

CONCLUSIONS

The loss of mass of hibiscus mucilage and LDPE blend was found 25.8 % after six months of soil burial, where as the blend of potato starch with LDPE was found 21.42 %. Tensile strength of mucilage blend was decreased by 12.1 %, whereas of starch blend was decreased by 11.29% and elongation is reduced by 54.1 % and 28.17 % respectively after six months of soil burial. The density is decreased by 14.3 % and 8.67 % for mucilage and starch blends respectively after six months of soil burial. Further the crystallinity is deviated by % and % for mucilage and starch blends respectively. All the above variations shown that the biodegradation occurred in soil by microorganisms, which were present in the soil. From the above results it has also been observed that hibiscus mucilage blend was degraded more than the potato starch blend under the same conditions of disposal/burial.

In this research work a comparative study of degradations of hibiscus mucilage and potato starch blends with LDPE has been done and it is found that more degradation occurred with mucilage blends rather than potato starch blends.

Acknowledgement

Research Scholar is thankful to Central Institute of Plastics Engineering and Technology (CIPET, Jaipur) for providing access to their laboratory facilities for this study. Scholar is also grateful to the President, JECRC University, Jaipur (Raj) for register our topic for research work.

References

1. Singh B. and Sharma N.,"Mechanistic implications of plastic degradation", *Polym. Degrad. Stab.*, 93, 3, 561-584 (2008).
2. Borghei Mehdi, Khoramnejadian Shahrzad and Hejazi Bijan, "Comparison of Kinetic biodegradation of potato starch based and corn starch based low density polyethylene compound in aerated sludge", *BioTechnology An Indian Journal*, 7,5, 163-168 (2013).
3. Tokiwa Y., Calabia B.P., Ugwu C.U. and Aiba S., "Biodegradability of Plastics", *Int. J. Mol. Sci.*, 10, 9, 3722-3742, (2009).
4. Roy P.K., Surekha P., Tulsi E., Deshmukh C. and Rajagopal C., "Degradation of abiotically aged LDPE films containing pro-oxidant by bacterial consortium", *Polym. Degrad. Stab.*, 93,1917-1922 (2008).
5. Kumar R. and Sharma S.K., "Evaluation of Biodegradation of Low Density Polyethylene (LDPE) Using Hibiscus Mucilage as a Green Polymers", *International Journal of Chemical Sciences*, 15, 4, 187 (2017).
6. Raj B., Sankar U., "LLDPE/Starch Blend Films for Food packaging application", *Adv. Polymer Technol.*, 23,1,32-45(2004).
7. Khiar A.S.A., Arof A.K., "Electrical Properties of Starch/Chitosan-NH4NO3 Polymer Electrolyte", World Academy of Science, Engineering and Technology, 59, 23-27(2011).