International Journal of Agriculture Innovations and Research
Volume 4, Issue 2, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy) :
Received : 06/09/2015 | Accepted on : 12/09/2015 | Published : 21/09/2015

Preparation of Bioplastics from Starch Blends

K. Aravind
Student, Department of Biotechnology, GIT, GITAM University, Visakhapatnam, INDIA.

P. Komali Devi
Student, Department of Biotechnology, GIT, GITAM University, Visakhapatnam, INDIA.

Surya Teja
Student, Department of Biotechnology, GIT, GITAM University, Visakhapatnam, INDIA.

Dr. B. Sarada
Assistant Professor, Department of Biotechnology, GIT, GITAM University, Visakhapatnam, INDIA.

A.V. Lalitha
Research Scholar – GITAM University, Visakhapatnam, INDIA
Email: tushara.lalitha22@gmail.com; Phone: 9490991476.

***Abstract* – The effect of the combination of starch and plasticity generating materials like latex and Aloe Vera, which are biodegradable in nature are used for the production of bio polymers. So, the mixture of some starch materials and these plasticity generating materials were blended. Blending is something where the physical characteristics for two compatible or incompatible polymeric components are mixed under different conditions resulting in the developing of a new materials. Polyhydroxy alkanoates (PHA's) are aliphatic poly esters nature produced are more specifically homo polymers and co polymers of hydroxy butyric acid. These two components i.e., starch components and latex and aloe Vera are mixed in certain proportions and sun dried, scrapped and were analysed by using FTIR(Fourier Transform Infrared Red spectroscopy).**

***Keywords* – Bioplastics, Blending, Starch, PHB, FTIR, Colacassia, Ipomea, Calotropis, Latex.**

I. Introduction

With the increased applications of plastics, a remarkable amount run into ecosystem as wastes. The resulting waste plastic products caused serious environmental pollution being threat to ecology and human health[1,2] .The only way to overcome this problem is to produce bio degradable sources from the renewable sources. According to ASTM standard, D-5488-94D and European norm EN13432 "biodegradable" means "decomposition of the material into carbon dioxide, methane, water, inorganic compounds and bio mass"[3,4] . In recent years a vast number of Bio-degradable polymers had been produced. Bio degradable polymers have been classified into 4 types according to their synthesis process and the materials used to obtain the bio degradable polymers. One being Polymers from biomass such as agro-polymers from agro resources (e.g. Starch or cellulose and then Polymers obtained by microbial Production such as the poly hydroxy alkanoates (PHAs), then Polymers conventionally and chemically synthesized from monomers obtained from agro-resources. e.g., the polylacticacid (PLA) finally, Polymers obtained from fossil resources. The first three classification polymers are obtained from the renewable resources[5,6]. The study and utilization of natural polymers is an ancient science. Typical examples, such as paper, silk, skin and bone arts, can be easily found in museums around the world. However, the availability of petroleum at a lower cost and the biochemical inertness of petroleum-based products have proven disastrous for the natural polymers market. It is only after a lapse of almost 50 years that the significance of eco-friendly materials has been realized once again[7,8]. These ancient materials have rapidly evolved over the last decade, primarily due to the issue of the environment and the shortage of oil. Modern technologies provide powerful tools to elucidate microstructures at different levels, and to understand the relationships between structures and properties. These new levels of understanding bring opportunities to develop materials for new applications[9,10]. The inherent biodegradability of natural polymers also means that it is important to control the environment in which the polymers are used, to prevent premature degradation. For example, the water solubility of many natural polymers raises their degradability and the speed of degradation, however, this moisture sensitivity limits their application. Another limitation of many natural polymers is their lower softening temperature[11,12,13].

Starch is the one of the important sources that is used for producing bio polymers. Starch is mainly obtained by cereals and from plant tubers.The bio- materials that can be used instead of bio-plastics are polynucleotides, polyamides, polysaccharides, polyoxoesters, polythioesters, Polyanhydrides, polyisoprenoids and polyphenols. The PHB can be modified by blending with high and low molecular components which are inexpensive and provides a simple route to modify the properties of the polymeric material and to obtain less rate polymers when compared to traditional polymers [14,15,16].Various attempts have been made to blend PHB with synthetic and natural polymers to know the influence of secondary components on the physical properties and biodegradabilit. From a biotechnological point of view, the ability of bioplastics to be biodegradable makes them a desirable substitute for petrochemical – based plastic, an environmental pollutant[17,18].

II. Materials and Methodology

Starch materials were prepared by taking different sources like Colacasia and Ipomea batatus and are made into paste with the help of a blender. The latex from the plant calatropis is collected by pinching the tips of stems and branches of the plants and was collected in a bottle. The collected latex from the plant source is to be purified. Simultaneously aloe vera leaves are taken and their skin is removed and the gel inside is collected and made into a fine paste 5.0, 10.0 grams of colacasia paste and Ipomea batatus were taken in a beaker and 10ml of Aloe vera paste

International Journal of Agriculture Innovations and Research
Volume 4, Issue 2, ISSN (Online) 2319-1473

Table - 1

S. No.	Biomass content			
	Amount (gms)	Source	Amount(gms)	Source
1	5	Colacasia	10	Aloe vera
2	10	Colacasia	10	Aloe vera
3	5	Ipomea batatus	10	Aloe vera
4	10	Ipomea batatus	10	Aloe vera
5	5	Ipomea batatus	10	Latex of Calatropis
6	10	Ipomea batatus	10	Latex of Calatropis
7	5	Colacasia	10	Latex of Calatropis
8	10	Colacasia	10	Latex of Calatropis

was added in each of the container. And simultaneously, 5.0, 10.0grams of Ipomea batatus was taken in each different beakers and to each of them 10ml of latex extracted from Calatropis is added respectively. The above mentioned combinations were mixed well by the process of blending using a magnetic stirrer. The mixed samples were taken and were spread on a plate for the process of sun drying and were allowed for sun drying for a span of 2 weeks and were observed daily. After completion of drying, i.e complete absence of moisture in the samples, the plates were scrapped by the help of a spatula and were powdered. The product was sent for FTIR analysis.

III. Results & Discussion

The FTIR results of the samples are observed and the peaks are compared with the standard PHB Peaks.

Standard PHB

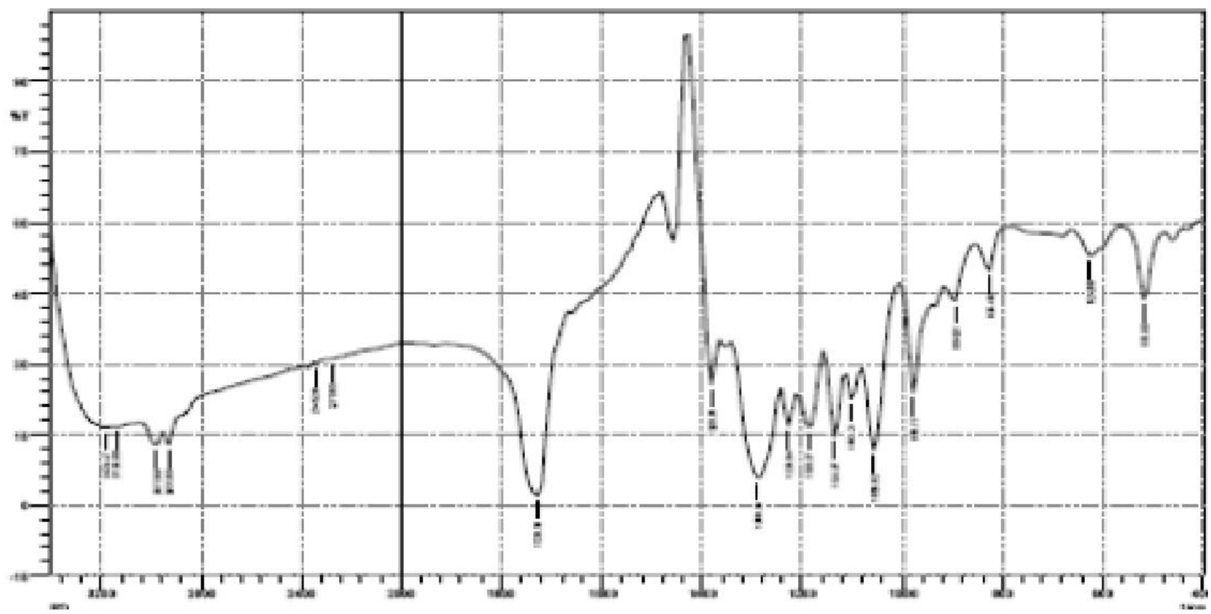

Figure - 1

Sample 1

From the spectra, sample bands are observed similar with the standard spectra and according the results obtained by oliveria et al.., [19] in the regions of 1651.8 cm^{-1} correspond to the stretching of the C=O where as a series of the intense bands located at 1150.00 cm^{-1} which was found exactly similar with the standard spectra and correspond to the stretching of the C-O bond of the ester group. The sample bands were observed similar with the standard spectra and according to the results obtained Pandiyan et al.., [20] in the region of 665.90 cm^{-1} correspond to the presence of C=O, 2921.19 cm^{-1}($CH_2CH_2CH_3$), 1415.41 corresponding to ester carbonyl groups present in hydroxyl acids. Two peaks in the region of 1150.00 and 1651.8 cm^{-1} were exactly the same in the standard PHB, confirming the presence of PHB in the extracted PHB sample.

International Journal of Agriculture Innovations and Research
Volume 4, Issue 2, ISSN (Online) 2319-1473

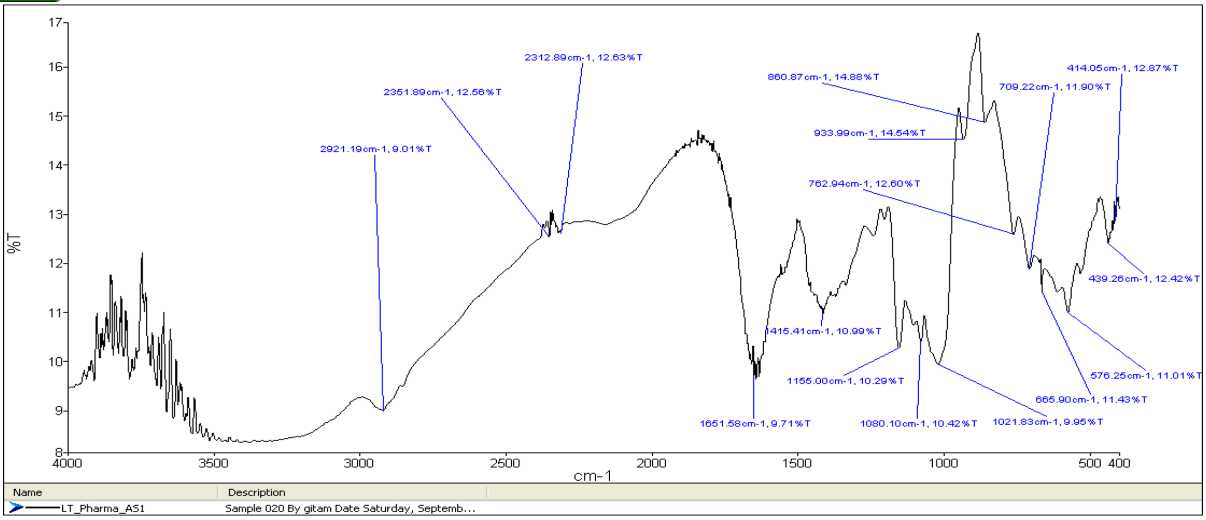

Figure - 2

Sample 2:

From the spectra, sample bands are observed similar with the standard spectra and according to the results obtained by oliveria et al.., [19] in the regions of 1639.19 cm^{-1} correspond to the stretching of the C=O where as a series of the intense bands located at 1155.14 cm^{-1} which was found exactly similar with the standard spectra and correspond to the stretching of the C-O bond of the ester group. The sample bonds were observed similar with the standard spectra and according to the results obtained Pandiyan et al.., [20] in the region of 3400.17 cm^{-1} corresponding to the presence of Hydroxyl (OH) group stretching, 2930.01 cm^{-1} ($CH_2CH_2CH_3$) , 1417.16 cm^{-1} corresponding to ester carbonyl groups present in hydroxyl acids. Two peaks in the region of 1155.14 cm^{-1} and 1639.19 cm^{-1} were exactly the same in the standard PHB, confirming the presence of PHB in the extracted PHB sample.

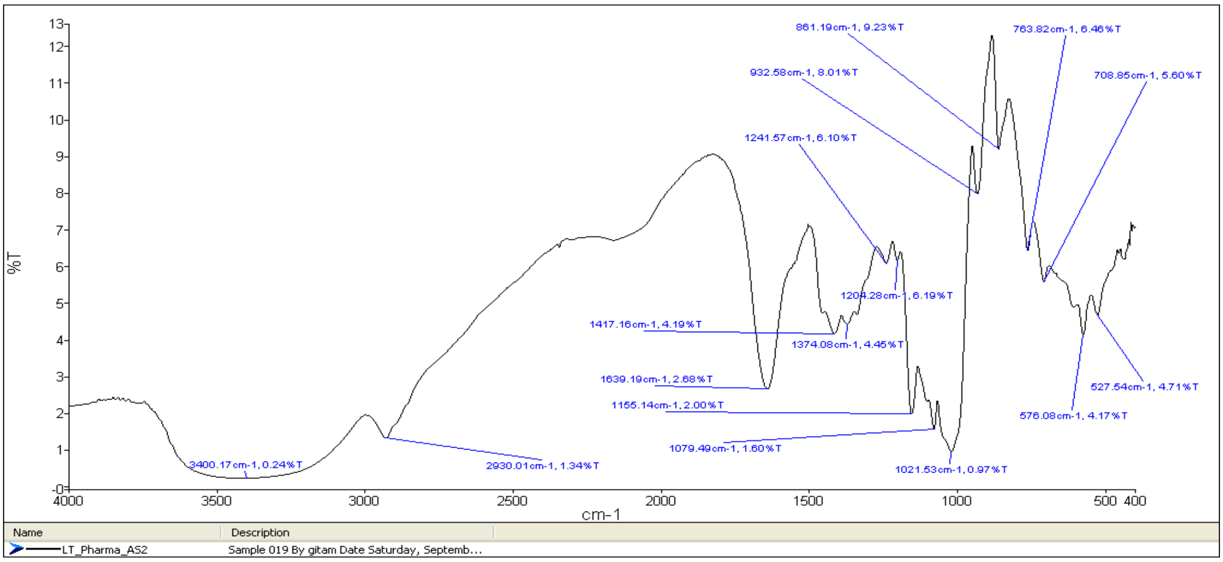

Figure - 3

Sample 3

From the spectra, sample bands are observed similar with the standard spectra and according to the results obtained by oliveria et al.., [19] in the regions of 1651.01 cm^{-1} correspond to the stretching of the C=O where as a series of the intense bands located at 1150.88 cm^{-1} which was found exactly similar with the standard spectra and correspond to the stretching of the C-O bond of the ester group. The sample bonds were observed similar with the standard spectra and according to the results obtained Pandiyan et al.., [20] in the region of 2915.73 cm^{-1} ($CH_2CH_2CH_3$) , 1473.42 cm^{-1} corresponding to ester carbonyl groups present in hydroxyl acids. Two peaks in the region of 1150.88 cm^{-1} and 1651.01 cm^{-1} were exactly the same in the standard PHB, confirming the presence of PHB in the extracted PHB sample.

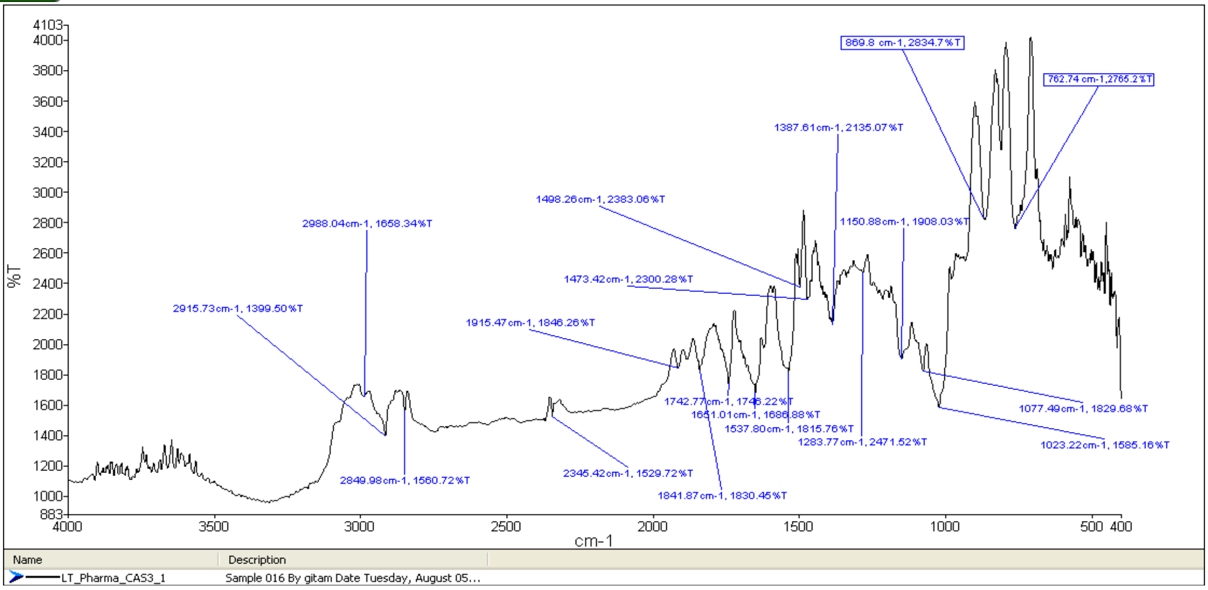

Figure - 4

Sample 4:

From the spectra, sample bands are observed similar with the standard spectra and according to the results obtained by oliveria et al.., [19] in the regions of 1650.97 cm^{-1} correspond to the stretching of the C=O where as a series of the intense bands located at 1151.52 cm^{-1} which was found exactly similar with the standard spectra and correspond to the stretching of the C-O bond of the ester group. The sample bonds were observed similar with the standard spectra and according to the results obtained Pandiyan et al.., [20] in the region of 3326.26 cm^{-1} corresponding to the presence of Hydroxyl stretching[OH] , 2916.11 cm^{-1} ($CH_2CH_2CH_3$). Two peaks in the region of 1151.52 cm^{-1} and 1650.97 cm^{-1} were exactly the same in the standard PHB, confirming the presence of PHB in the extracted PHB sample.

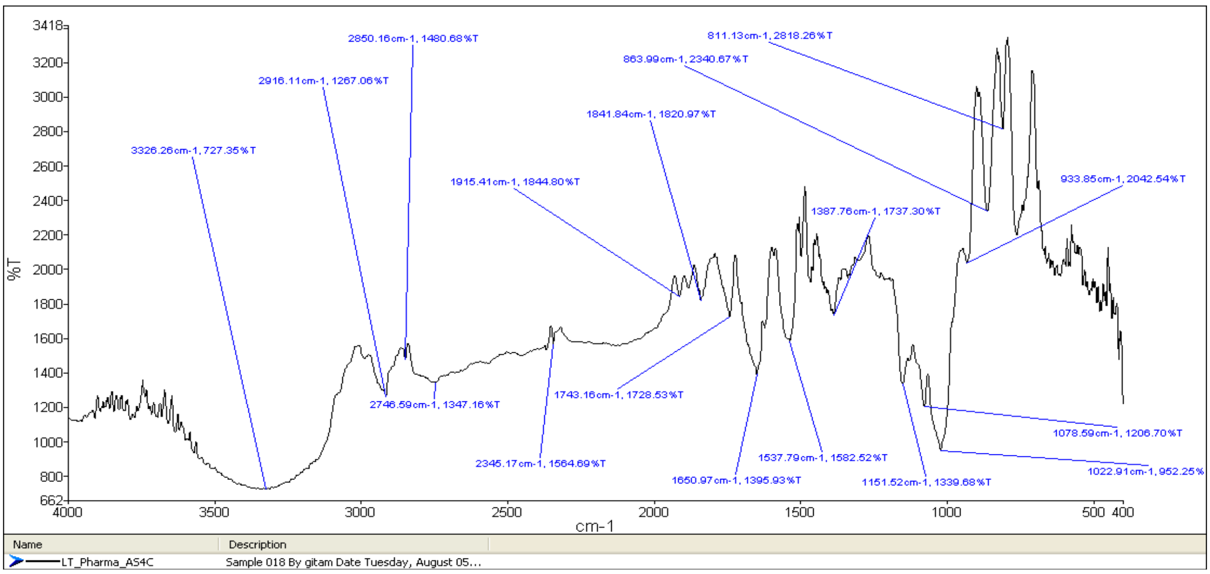

Figure - 5

Sample 5:

From the spectra, sample bands are observed similar with the standard spectra and according to the results obtained by oliveria et al.., [19] in the regions of 1659.80 cm^{-1} correspond to the stretching of the C=O where as a series of the intense bands located at 1150.82 cm^{-1} which was found exactly similar with the standard spectra and correspond to the stretching of the C-O bond of the ester group. The sample bonds were observed similar with the standard spectra and according to the results obtained Pandiyan et al.., [20] in the region of 666.09 cm^{-1} corresponding to the C=O bond presence, 3574.06 cm^{-1} corresponding to the hydroxyl group stretching, 1405.75 cm^{-1} corresponding to ester carbonyl groups present in hydroxyl acids. Two peaks in the region of 1150.82 cm^{-1} and 1659.80 cm^{-1} were exactly the same in the standard PHB, confirming the presence of PHB in the extracted PHB sample.

International Journal of Agriculture Innovations and Research
Volume 4, Issue 2, ISSN (Online) 2319-1473

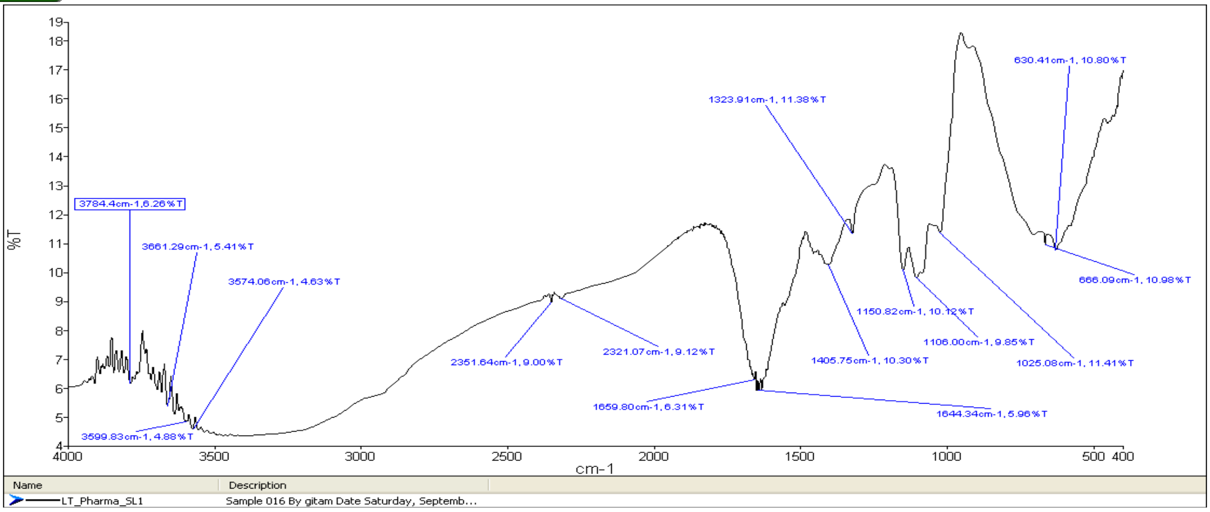

Figure - 6

Sample 6:

From the spectra, sample bands are observed similar with the standard spectra and according to the results obtained by oliveria et al.., [19] in the regions of 1660.21 cm^{-1} correspond to the stretching of the C=O where as a series of the intense bands located at 1152.90 cm^{-1} which was found exactly similar with the standard spectra and correspond to the stretching of the C-O bond of the ester group. The sample bonds were observed similar with the standard spectra and according to the results obtained Pandiyan et al.., [20] in the region of 629.90 cm^{-1} corresponding to the C=O bond presence, 3574.18 cm^{-1} corresponding to the Hydroxyl stretching, 1414.91 cm^{-1} corresponding to ester carbonyl groups present in hydroxyl acids. Two peaks in the region of 1152.90 cm^{-1} and 1660.21 cm^{-1} were exactly the same in the standard PHB, confirming the presence of PHB in the extracted PHB sample.

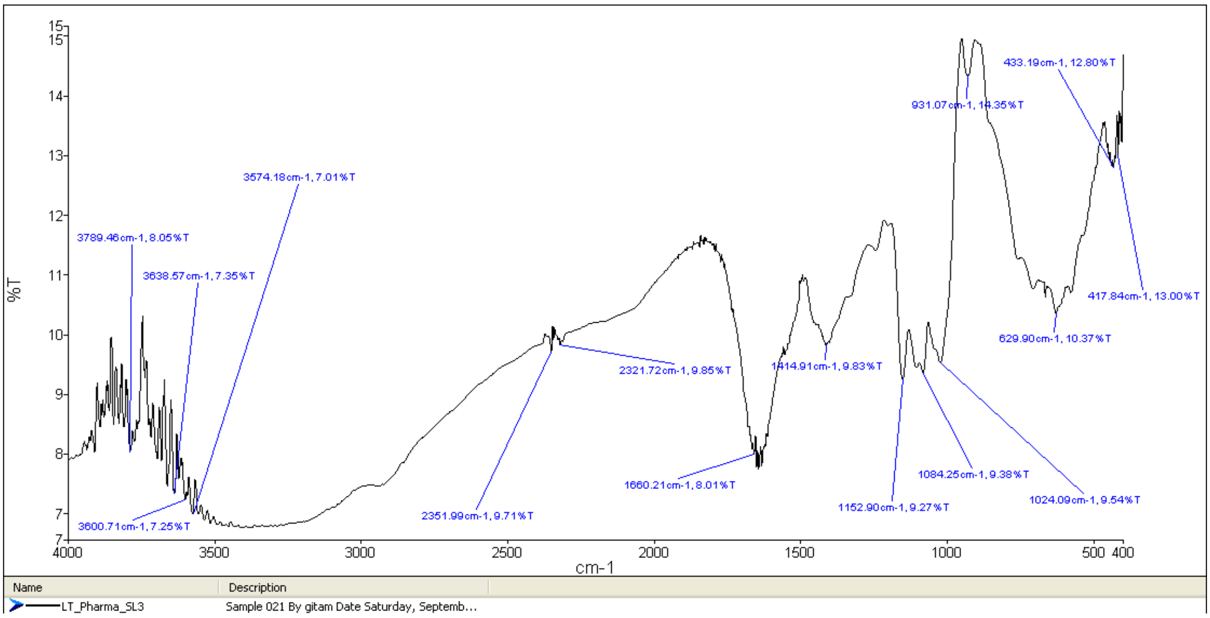

Figure - 7

Sample 7:

From the spectra, sample bands are observed similar with the standard spectra and according to the results obtained by oliveria et al.., [19] in the regions of 1639.10 cm^{-1} correspond to the stretching of the C=O where as a series of the intense bands located at 1152.95 cm^{-1} which was found exactly similar with the standard spectra and correspond to the stretching of the C-O bond of the ester group. The sample bonds were observed similar with the standard spectra and according to the results obtained Pandiyan et al.., [20] in the region of 612.64 cm^{-1} corresponding to the C=O bond presence, 3403.18 cm^{-1} corresponding to the Hydroxyl stretching, 2934.35 cm^{-1} ($CH_2CH_2CH_3$), 1407.18 cm^{-1} corresponding to ester carbonyl groups present in hydroxyl acids. Two peaks in the region of 1152.95 cm^{-1} and 1639.10 cm^{-1} were exactly the same in the standard PHB, confirming the presence of PHB in the extracted PHB sample.

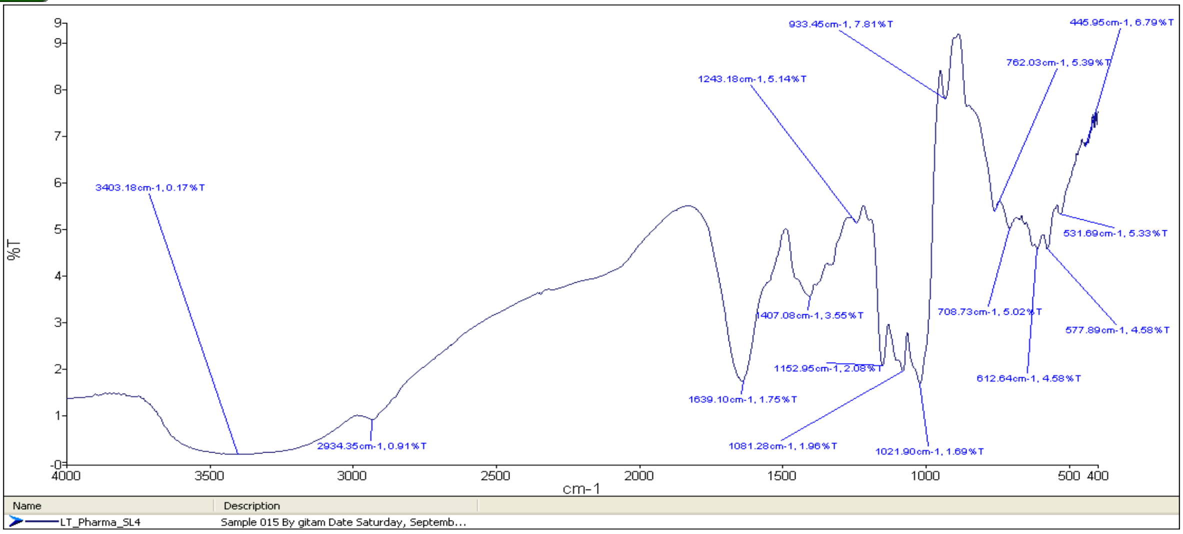

Figure - 8

Sample 8:

From the spectra, sample bands are observed similar with the standard spectra and according to the results obtained by oliveria et al.., [19] in the regions of 1639.68 cm^{-1} correspond to the stretching of the C=O where as a series of the intense bands located at 1151.48 cm^{-1} which was found exactly similar with the standard spectra and correspond to the stretching of the C-O bond of the ester group. The sample bonds were observed similar with the standard spectra and according to the results obtained Pandiyan et al.., [20] in the region of 629.86 cm^{-1} corresponding to the C=O bond presence, 3404.09 cm^{-1} corresponding to the Hydroxyl stretching, 1404.24 cm^{-1} corresponding to ester carbonyl groups present in hydroxyl acids. Two peaks in the region of 1151.48 cm^{-1} and 1639.68 cm^{-1} were exactly the same in the standard PHB, confirming the presence of PHB in the extracted PHB sample.

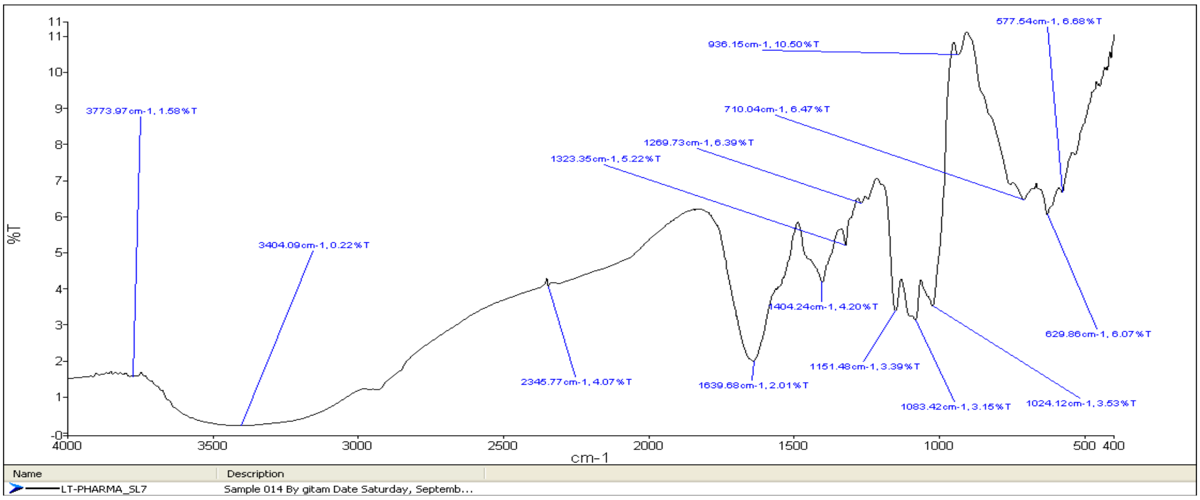

Figure - 9

The above shown peaks are shown in the tabular form below

Table 2

	C=O (stretching) cm^{-1}	C-O (Presence) cm^{-1}	C=O (Presence) cm^{-1}	Hydroxyl group cm^{-1}	$CH_2CH_2CH_3$ cm^{-1}	Ester Carbonyl groups cm^{-1}
Sample 1	1651.8	1150.00	665.90	-	2921.19	1415.41
Sample 2	1639.19	1155.14	-	3400.17	2915.73	1417.16
Sample 3	1651.01	1150.88	762.74	-	2916.11	-
Sample 4	1650.97	1151.52	-	3326.26	-	1473.42
Sample 5	1659.80	1150.82	666.09	3574.06	-	1405.75
Sample 6	1660.21	1152.90	629.90	3574.18	2934.35	1414.91
Sample 7	1639.10	1152.95	612.64	3403.18	-	1407.18
Sample 8	1639.68	1151.48	629.86	3404.09	-	1404.24

International Journal of Agriculture Innovations and Research
Volume 4, Issue 2, ISSN (Online) 2319-1473

IV. Conclusion

The sources used here are a highly plasticity generating materials, so when combined under appropriate conditions, helped in the preparation of biodegradable biopolymers. The blends proportions have proved to be effective and when compared with the standard PHB the peaks corresponded with the samples. The latex blends have proved to be more effective when compared with the aloe vera starch blends.

References

[1] Long Yua,b,, Katherine Deana , Lin Li , Polymer blends and composites from renewable resources, elsivier 2006.

[2] K.C. Reis[a,] J. Pereira[a], A.C. Smith[b], C.W.P. Carvalho, N. Wellner[b], I. Yakimets[d] Characterization of polyhydroxybutyrate-hydroxyvalerate (PHB-HV)/maize starch blend films , Journal of Food EngineeringVolume 89, Issue 4, December 2008, Pages 361–369.

[3] Godbole S, Gote S, Latkar M, Chakrabarti T. Preparation and characterization of biodegradable poly-3-hydroxybutyrate-starch blend films, Bioresour Technol. 2003 Jan;86(1):33.

[4] Antoine Rouillya,b, Luc Rigalb , Robert G. Gilberta, Synthesis and properties of composites of starch and chemically modified natural rubber, (OATAO).

[5] Min Zhang* and Noreen L. Thomas , Preparation and properties of polyhydroxybutyrate blended with different types of starch, Journal of Applied Polymer Science, Volume 116, Issue 2, pages 688–694, 15 April 2010.

[6] Bledzki AK, Gassan J. Composites reinforced with cellulose based fibres. Prog Polym Sci 1999;24:221–74.

[7] King PP. Biotechnology, an industrial view. J Chem Technol Biotechnol 1982;32:2–8.

[8] Wollerdorfer M, Bader H. Influence of natural fibers on the mechanical properties of biodegradable polymers. Ind Crop Prod 1998;8:105–12.

[9] Herrmann AS, Nickel J, Riedel U. Construction materials based upon biologically renewable resources—from components to finished parts. Polym Degrad Stabil 1998;59: 251–61.

[10] Kaplan DL. Biopolymers from renewable resources. New York: Springer; 1998.

[11] Gross RA, Scholz C, editors. Biopolymers from polysaccharides and agroproteins. Washington, DC: American Chemical Society; 2001.

[12] Matveev YI, Grinberg VY, Tolstoguzov VB. The plasticizing effect of water on proteins, polysaccharides and their mixtures: glassy state of biopolymers, food and seeds. Food Hydrocolloid 2000;14:425–37.

[13] Blanshard JMV. Starch granule structure and function: a physiochemical approach. In: Galliard T, editor. Starch: properties and potential. Chichester: Wiley for SCI; 1987. p. 16–54.

[14] Arvanitoyannis I, Nakayama A, Aiba S. Chitosan and gelatin based edible films: state diagrams, mechanical and permeation properties. Carbohyd Polym 1998;37:371–82.

[15] Carvalho A, Job A, Alves N, Curvelo A, Gandini A. Thermoplastic starch/natural rubber blends. Carbohyd Polym 2003;53:95–9. ARTICLE IN PRESS 598 L. Yu et al. / Prog. Polym. Sci. 31 (2006) 576–602.

[16] Kokini JL, Baumann G, Breslauer K, Chedid PK, Herh LS, Madeka H. A kinetic model for starch gelatinization and effect of starch/protein interactions on rheological properties of 98% amylopectin and amylose rich starches. In: Spiess WEL, Schubert H, editors. Engineering and food—physical properties and process control. London: Elsevier Applied Science; 1990. p. 109–21.

[17] Warth H, Mulhaupt R, Schatzle J. Thermoplastic cellulose acetate and cellulose acetate compounds prepared by reactive processing. J Appl Polym Sci 1997;64:231–42.

[18] Mano JF, Sousa RA, Boesel LF, Neves NM, Reis RL. Bioinert, biodegradable and injectable polymeric matrix composites for hard tissue replacement: state of the art and recent developments. Compos Sci Technol 2004;64: 789–817.

[19] Oliveira, F. C., Dias, M. C., Castilho, L. R. and Freire, M.G. 2007. Characterization of poly(3-hydroxybutyrate) produced by *Cupriavidus necator* in solid-state fermentation. Bioresour. Technol., 98: 633-638.

[20] Pandiyan, S. R., Deepak, V., Kalishwaralal, K., Rameshkumar, N., Jeyaraj, M. and Gurunathan,S. 2010. Optimization and fed-batch production of PHB utilizing dairy waste and sea water as nutrient sources by *Bacillus megaterium* SRKP-3. Bioresour. Technol., 101: 705-711.

Author's Profile

A.V. Lalitha
Research Scholar,
GITAM University, Visakhapatnam, INDIA
Email: tushara.lalitha22@gmail.com
Phone No.: 9490991476.