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NOVEL SYNTHESIS OF BIODEGRADABLE POLYMER FROM CUCURBITA PEELS AND WASTE NEWSPAPER SHEETS



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Abstract:

Today the world is cluttered with petrochemical plastic. Environmental pollution due to industries and dumping of wastes. Plastics are the main threat to the environment as they are non-biodegradable. To reduce the problem of plastic waste that has continuously suffocated the planet and led to contamination of the environment, there is another way of choice to give a solution to this issue, from where bioplastic emerges. Hence there is a need to produce plastic from materials that can be readily eliminated from our biosphere in an "eco -friendly". Pumpkin seeds and peels are waste generated from the Cucurbita (pumpkin) processing industry and have the potential to utilize for biodegradable film development. The purpose of this study was to utilize the by-products of the pumpkin processing industry for developing biodegradable packaging films. Such biodegradable films were developed with pumpkin peels and pumpkin peel-newspaper pulp and including starches, cellulose, glycerine, vinegar or other biopolymers. The hydrogen bond between pumpkin powder and raw material in the composite film was successfully achieved and maintained outstanding mechanical properties according to FTIR analysis and water absorption tests and biodegradable tests were conducted.

Keywords: Biodegradable, Cucurbita (Pumpkin) peels, Starch, waste Newspaper, glycerine

1. INTRODUCTION:

The processing of fruits and vegetables generates enormous amounts of garbage each year, which pollutes the environment so, it can be reused in innovative ways. Pumpkin is a member of the Cucurbitaceae family. Especially, pumpkin peels, which are produced during processing and discarded as agricultural by-products, are rich in pectin [1]. Due to their high pectin content, pumpkin peels have been utilized to extract alcohol-insoluble polysaccharides (natural polymer) and describe pectic polysaccharides from pumpkin peels [2]. Due to the phytochemicals, they contain, pumpkins are utilized as a food source and medicine [3].

Biodegradable polymers with environmental pollutants could be reduced as organic waste, thereby releasing carbon dioxide and water [4]. The findings demonstrate that the polymer may be manufactured into sheets that can be utilized for food packaging in addition to being biodegradable [5]. A photodegradable plastic is one whose deterioration is brought on by exposure to sunlight; a degradable plastic that is oxidatively degradable is one whose destruction is brought on by oxidation [6].

Therefore, the objectives of this study were undertaken to develop biodegradable films from pumpkin peels and pumpkin peels-newspaper pulp and study their characteristics.

MATERIALS AND METHOD

Preparation of Bio-plastic from Pumpkin peel (B):

2gm pumpkin peel powder (A), 5gm corn starch, 3gm glycerine, 2gm gelatine, and 1gm citric acid were added into 100 mL distilled water. The mixture was stirred for 10 min. Then the mixture was heated on a hot plate at 100 °C, and manual stirring was done for 1-1.5 hr. It was then poured onto a Teflon-coated glass plate and spread uniformly & dried at room temperature. It took 4 days for the mixture to dry out. Wt. of dried bioplastic from pumpkin peel = 9.65 gm.

Preparation of Bio-plastic from pumpkin peel (with filtrate) (C):

2gm pumpkin peel powder (A), 5 gm corn starch, 3 gm glycerine, 2gm gelatine, and 1gm citric acid were added into 100 mL distilled water. The mixture was stirred for 10 min at 80-90 °C. The filtrate was heated on a hot plate at 100 °C, and manual stirring was done for 1-1.5 Hr. It was poured onto a Teflon-coated glass plate and spread uniformly. Put it at RT for drying. It took 4 days for the mixture to dry out. Wt. of dried bioplastic from pumpkin peel = 8.25 gm

Preparation of Bio-plastic from Newspaper Pulp & Pumpkin peel (D):

The 5 gm waste newspapers are segmented into small pieces in the mill and 10 ml water is added to them to obtain a lignocellulosic fibrous pulpy material stirred continuously to finally obtain what is known as paper sludge. This paper sludge was added to 10 ml distilled water, 2 gm pumpkin peel powder, 5gm glycerine, 5gm vinegar & 5gm corn Starch. The mixture was stirred for 10 min. The mixture was heated at 130-140^{0}C with stirring. It was then poured onto a glass tile and spread uniformly. It is allowed to dry in sunlight for 3 days. After 3 days the mixture dried out and the polymer film was removed. Weight of polymer film = 10.58 gm.

Preparation of Bio-plastic from Newspaper pulp & Pumpkin peel (cost-cutting purpose) (E): Small pieces of 10gm waste newspaper & 10ml water is added to obtain a lignocellulosic fibrous pulpy material stirred continuously to obtain paper sludge. This sludge was added to 10ml distilled water, 5gm pumpkin peel powder, 2gm glycerin, 1gm vinegar & 1gm corn starch. The mixture was heated at 130-140^{0}C with stirring. It was then poured onto a glass tile and spread uniformly. It is allowed to dry in sunlight for 3 days. The polymer film was removed & weighed. Weight = 15.86 gm

Table 1: Costing of the formulated Biodegradable polymer (as per wt. obtained)

Raw Material	Price/50 gm	Quantity for Film B & C	Price For Film B & C (in Rs.)	Quantity for Film D	Price for Film D (in Rs.)	Quantity for Film E	Price for Film E (in Rs.)
Pumpkin Peel Powder	30 Rs.	2gm	1.2	2gm	1.2	5gm	3
Corn Starch	2 Rs.	5gm	0.2	5gm	0.2	1gm	0.04
Glycerine	40 Rs.	3gm	2.4	5gm	4	2gm	1.6
Gelatine	18.5 Rs.	2gm	0.74	-	-	-	-
Citric acid	2.7 Rs.	1gm	0.054	-	-	-	-
Vinegar	2.5 Rs.	-	-	5gm	0.25	1gm	0.05
Waste News Paper	0.25 Rs.	-	-	5gm	0.025	10gm	0.05
TOTAL COST (in INR – Rs.)			**4.594**		**5.675**		**4.74**

Table 2: Comparison of final costs of synthesized biodegradable films

FILM SAMPLE	Wt. Obtained (gm)	Costing (In Rs.)	Costing per Kg (In Rs.)
B	9.65	4.594	476
C	8.25	4.594	556
D	10.58	5.675	536
E	15.86	4.74	298

Costing of Film E is relatively more beneficial, 15.86 gm of film obtained at the cost of 4.74 Rs. Film E is relatively less costly than other prepared films B, C & D in bulk also. So, the designed experiment for cost-cutting purposes is successful.

Water Absorption Test:

A small piece of fill was cut in 2 cm x 2 cm. Then the Initial weight of the cut-fill sample was measured. The sample was then placed in 50 ml of water at room temperature for 24 hr. The sample was then taken out from the water and wiped off. the final weight was recorded. The amount of water uptake was calculated by using the following formula.

$$WA(\%) = \frac{Final\ weight\ (gm) - initial\ weight\ (gm)}{initial\ weight\ (gm)} \times 100$$

RESULT AND DISCUSSION

Water Absorption Test

When choosing an appropriate source for bioplastic, water resistance is a key feature to consider. The plasticized starch BP film was subjected to a 24-hour room temperature water absorption test to get the most accurate water uptake results. According to Table 3, the BP film with pumpkin peel with filtration had the maximum water uptake.

Biodegradability Test

Biodegradable plastics must decompose in certain situations, such as compost, soil, or aquatic settings by naturally occurring microorganisms as such bacteria, fungi, and algae. Biodegradable tests were carried out, in which bp film was passed in soil for several days and measured their degradation in soil for environment-friendly

Table 3: Data for water absorption of BP films.

Sample BP Film	Initial Weight BP film (gm)	Final Weight BP Film (gm)	Water Absorption Water uptake (%)
B	0.31	0.46	48.38
C	0.21	0.36	76.19
D	0.22	0.34	54.54
E	0.23	0.33	43.47

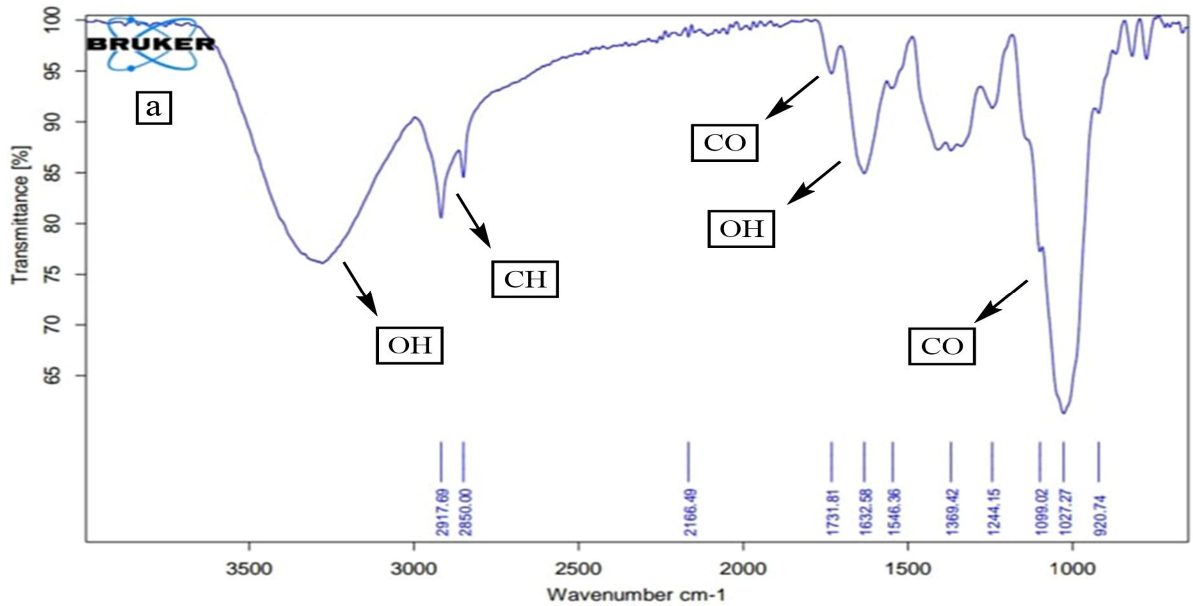
plastic uses. The bp film of the newspaper and pumpkin peel mixture of the film degraded easily within a short period. As shown from the data given in Table 4.

Table 4: Data for Biodegradable test of BP films

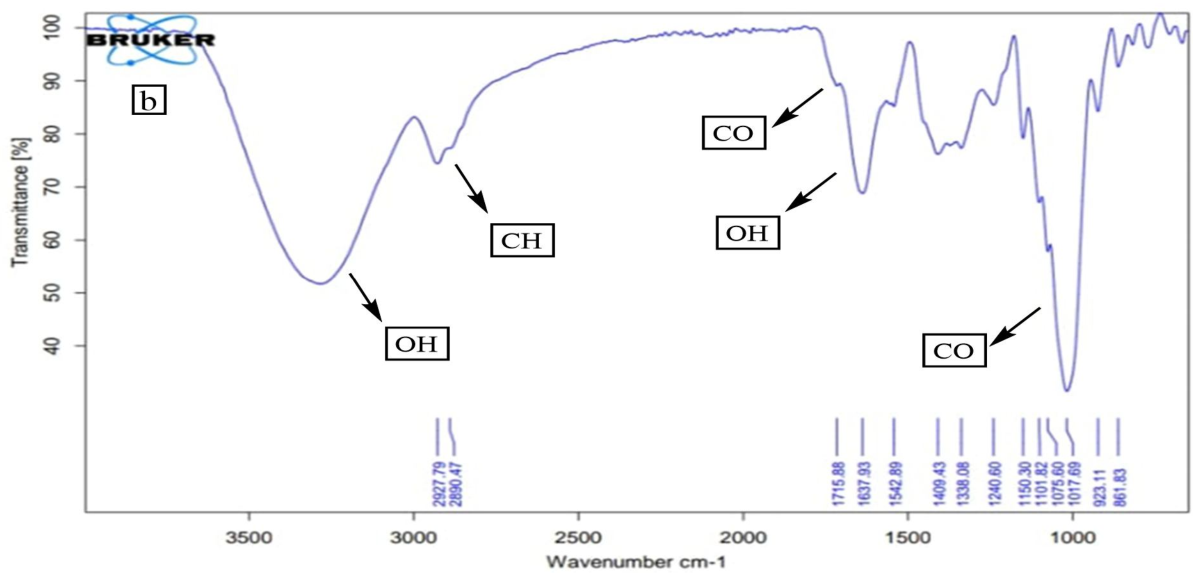
Sample BP films	Initial Weight BP film	Weight After 7 days (gm)	Weight After 10 days (gm)	Weight After 15 days (gm)
B	0.995	0.82	0.70	0.56
C	1.704	1.45	0.92	0.66
D	1.820	1.21	0.78	0.32
E	1.786	1.39	1.21	0.86

FTIR Characterization

The spectra were taken in 256 scans between 4000 and 400 cm^{-1} using Spectrum 100 Bruker FTIR. Using FTIR analysis, the spectra of pumpkin peel powder and the bp film of pumpkin were carried out which have been compared. Based on spectral study Fig.1 the powder and bp film peaks are similar to each other with a film containing pumpkin powder. The observed peak -OH group in pumpkin powder that involved in bp film as both observed. The peak observed at 1000-1150 cm^{-1} is of the C-O stretch of an anhydrous-glucose ring. The stretching of C-O-H groups makes this bond frequently present in the structure of carbohydrates.



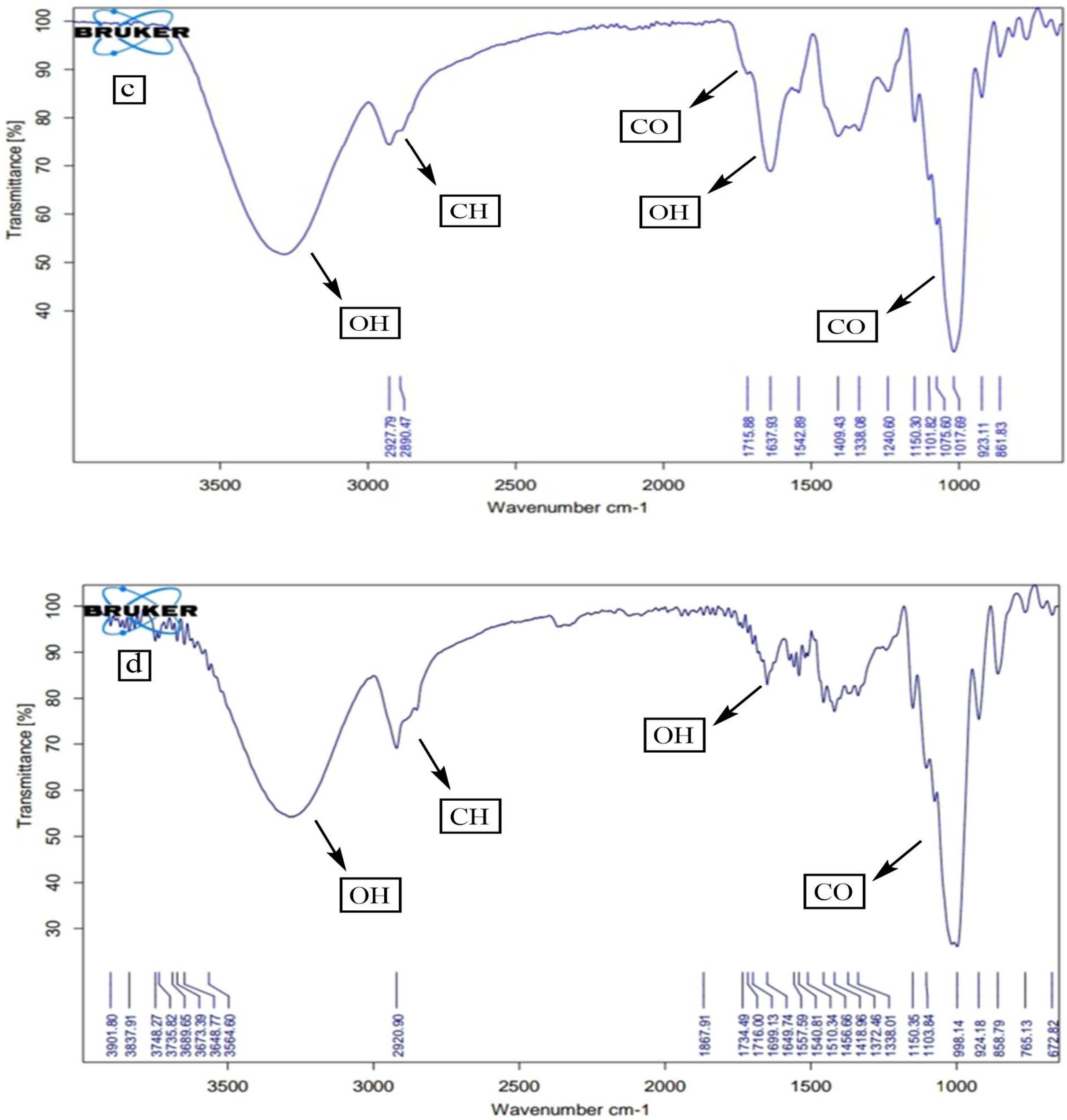
IR Data: Pumpkin Pill Powder (A)



IR Data (b) pumpkin peel powder BP film

Due to intricate vibrational stretching that naturally takes place in the carbohydrate structure, the peaks seen between 3100 and 3700 cm^{-1} in both spectra correspond to the hydrogen-linked hydroxyl group (O-H). the shift of C-O stretch is been observed at a slightly Lower side of the range as compared to the powder and bp film and a slight increase -OH group.

The sharp peak observed at the range 2850-2950 cm^{-1} is of the C-H peak of the CH_2 group of the powder and bp film. Has been observed there is a broad peak observed in the bp film this is due to bp film moisture which is present in the film. Peaks around wavenumbers 1580 to 1700 cm^{-1} were seen in both spectra and were attributed to the water's hydroxyl group deflection, which was particularly caused by hydroxyl groups bending the mode in water molecules. The other peak observed in both spectra were within the range of 1400-1450 cm^{-1} corresponding to O-H bend and peaks at 1350-1480 assigned to CH_2 bending vibration in the BP film as shown in all figures of IR Data. Below are IR data of BP film C & D respectively.



IR Data (c) Bio-plastic from pumpkin peel (with filtrate) (d) Bio-plastic from pumpkin peel and newspaper mixture

The Peaks observed same in pumpkin peel-newspaper Fig. d and other BP film Fig. a, b, c where peaks range from 1400-1500 cm^{-1} for O-H bend, 1350-1480 cm^{-1} for CH_2 bend, 1580-1700 cm^{-1} for water hydroxy group, 3100-3700 cm^{-1} for hydrogen-linked hydroxyl group (O-H) and 1000-1150 cm-1 are of the C-O stretch of an anhydrous-glucose ring. hydrogen bonds interact specifically, causing the FTIR spectra to shift and widen. As a result, switching to a lower wavenumber makes reference spectra simpler to recognize and compare with.

Challenges: For bulk production of the biodegradable film, a collaboration of industry is needed as this technology requires bulk of pumpkin peel powder and for this purpose, more pumpkins are in need. Further research is going on this agenda of how to generate the bulk of pumpkin peel powder at a relatively cheaper cost and availability. The authors are working on the resolution of challenges.

CONCLUSION:

The bioplastic films from the composite of pumpkin peel and pumpkin peel newspaper were successfully formed. The water absorption test shows the hydrophilic nature and water uptake for all bioplastic films with more than 50%. The FTIR characterization of bioplastic film indicates the functional group of pumpkin powder and its relation to bioplastic film. Where most of the major peaks of powder and bioplastic film are identified. As fruit & vegetable peels are discarded by a human being, they are incorporated with starch to give bioplastics. It's high time now to improve the environmental condition in today's era, we need to switch to other alternatives which should be suitable, harmless, useful, and economical. So, for a glorious and sustainable future, the demand for bio-plastic should be increased and so its production. It is also possible that biodegradable plastic would cost less in comparison to plastics. Composition E has the least coasting and commercially acceptable rate of biodegradability. So, given this, we have synthesized various biodegradable plastics using natural materials and its costing shows that they have wide commercial scope.

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