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COMBINED APPROACH FOR SYNTHESIS OF EDIBLE FILM BIODEGRADABLE ATTRIBUTES

Singh Himanshu[1] , Sharma Ankita[2]

[1] student, [2] Assistant professor

1Email Id – himanshu12011998@gmail.com

2 Email Id- Ankita.fas@mriu.edu.in

Department of nutrition and Dietetics/Manav Rachna International Institute of Research and Studies, Haryana State, Faridabad.

ABSTRACT

For decades, different form of plastic like polystyrene (PS), polyethylene (PE), polypropylene (PP), and polyethylene terephthalate (PET) have been widely dominating the food industry as a packaging material. These plastic packaging are non-biodegradable and of all the plastic generated for packaging only 5% is recycled, this causes serious problem as high-level plastic waste impact on environment by polluting it.

This study emphasizes on developing biodegradable packaging using bio polymers that are found in plants and utilizing the fruit and vegetable waste. The film has been developed with the combination of 4% carrot waste, 4% banana peel, 4% starch and glycerol. The developed film has properties like biodegradable and edible.

The film samples were analyzed on various parameter such as tensile strength, moisture analysis, FTIR analysis, SEM analysis and XRD analysis. Through analysis it was found that sample B has highest tensile strength which indicate that is has better bond formation, sample C has highest moisture content that can be correlated in decreasing the tensile strength of the film.

FTIR analysis depict the various peaks of the starch, glycerol, dry carrot peel extract and banana peel. The SEM analysis showed the surface structure of the film sample in which sample A more smother surface and sample B and sample C are meshier and more fibrous. The XRD analysis describe the peak of the starch and banana peel extract.

It can be concluded that sample B film was best formed in against sample A and C
Keywords: Biodegradable, FTIR Analysis, SEM Analysis, XRD Analysis

INTRODUCTION

For decades, different form of plastic like polystyrene (PS), polyethylene (PE), polypropylene (PP), and polyethylene terephthalate (PET) have been widely dominating the food industry as a packaging material. These plastic packaging are non-biodegradable and of all the plastic generated for packaging only 5% is recycled, this causes serious problem as high-level plastic waste impact on environment by polluting it.

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This has led to climate change since they have accumulated in the ecosystem. Also, they are resistant to microbial degradation so to reduce the solid plastic waste they are used in landfills. In recent years, there is more focus on developing a cost – competitive, biodegradable film which reduces the dependency on fossil fuel. (1)

PACKAGING MATERIAL

The recent trends in food packaging industry have been focused on use of eco-friendly packaging that improve the food quality and food safety and these materials are gathered from the nature. The preservation of food has an important function in the packaging industry. Its other functions include maintaining the food quality, extension of the self-life, protection of food product from the negative impact of transportation which are retardation and detoriation. The food packaging system should provide protection to the food product from factors such as moisture, oxygen, heat, micro-organism, unpleasant odour and prevent loss of aroma. In the international market there is increasing demand of the stable eco-friendly material that are able to retain the natural feature of the food product for extended period of time (2).

BIODEGRADABLE PACKAGING(BIOPOLYMERS)

Biopolymer are the polymer that are molecules that are generally extracted from nature and renewable sources. Biopolymer are synthesized from living organisms (plants and animals). Their main feature includes biodegradability and eco-friendly nature. The biopolymers can be classified in various aspects such as origin, method of synthesis, application, cost effectiveness and chemical structure.

"According to the American Society for Testing and Materials (ASTM), biodegradable plastics are the plastics that degrades because of the action of naturally occurring microorganisms such as bacteria, fungi, and algae."

They are synthesized from natural renewable resources and have similar feature such as thermal properties, oxygen transmission rate, water vapor transmission rate, elongation on break and tensile strength to traditional plastic packaging like PE (polyethylene), PP (polypropylene), PET (polyethylene tetraphthalate) etc.

DIFFERENT FORMS OF BIOPOLYMER USED IN EDIBLE FILM

Potato Starch

Starch is one of most abundant reserve polysaccharides found in plants. Starch has various functional properties are inexpensive, biodegradable and easy to use. It is a renewable resource that can be obtained from the postharvest leftover. Starch is a natural occurring biopolymer from various botanical sources such a wheat, barley, pea, tropioca and potato (1)

Starch has a granular structure. Starch is composed of two macro molecules: amylose and amylopectin, amylose is liner chain of D-glucose monomers that are link together by α1-4 glycosidic linkage & amylopectin is the branched linkage of D-glucose unit that are linked together by α1-4 glycosidic linkage and α1-6 glycosidic linkage. The amylose: amylopectin ratio differs in different types of starch that are obtained from different plants.

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Potato starch can be used in synthesis of biodegradable film, potato is one of the major agriculture crops that belong to Solanaceae family. The cultivation of potato was started from early 17th century, production of potato as an agriculture crop isa about 34.4million which makes India the 2nd largest potato producer in the world. Around 11.26% of the worlds potato production is fulfilled by India. Recently potato starch has been widely researched for biodegradable packaging. (5)

Fruit and vegetable waste

Various fruits and vegetable edible waste material including peels, extracts, residue and puree are beinged research for matrix forming properties for the synthesis of edible film. Fruit and vegetable waste have component such as matrix forming polysaccharide, proteins, and various bioactive component like polyphenols, antioxidant etc. use of these waste material help in utilization of raw material and low commercial value. They also play a major role in decreasing synthetic plastic waste (7)

Methodology

Research methodology is a way of analyzing and solving the research problem. It is a scientific discipline of how to conduct research in scientific way. It involves various steps that are generally performed by the researcher to study and analyses the research problem and to understand the concept behind it. It is required by the researcher to not only know the research method but also the methodology. Research not means the development of certain indices or know how to test the mean, standard deviation, median and mode or knowing the method or technique which can be relevant or not and what they indices means and why. Research Methodology means to understand why the research study is conducted, what is the research problem, how the research problem is been identified, how the data has been collected, method adopted to analyses the data and developing a methodology for a concerning research problem or study.

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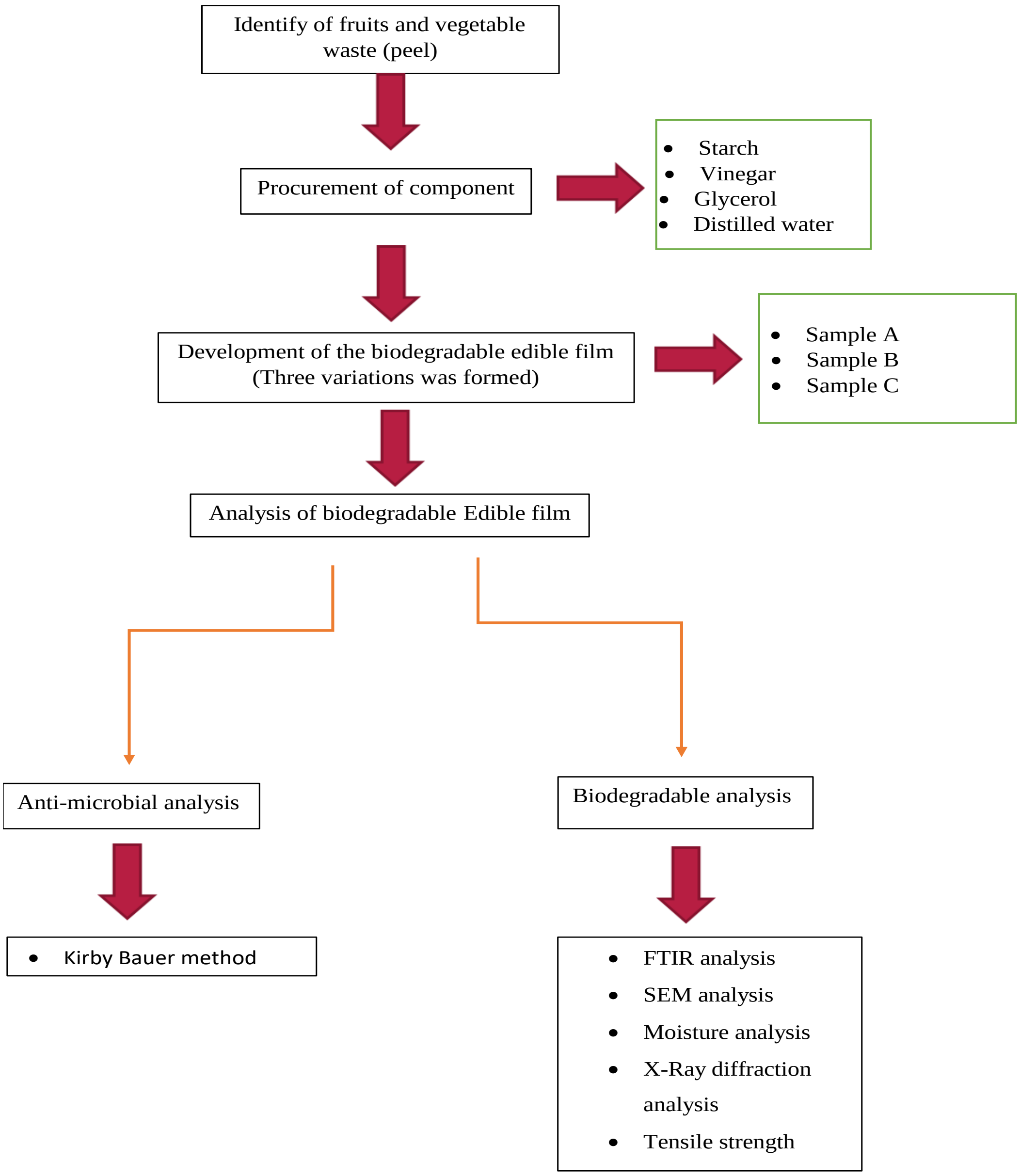
The present study aims to "Synthesis biodegradable edible film with antimicrobial and biodegradable nature using combination of fruits and vegetables waste"



The biodegradable film was developed with three different variations. These variations were shown as sample A, sample B and sample C.

Table 3.1 Composition of Sample A, B & C

Ingredient	Sample A	Sample B	Sample C
Starch	4%	4%	4%
Glycerol	4%	4%	4%
Vinegar	4%	4%	4%
Banana peel extract	4%	5%	6%

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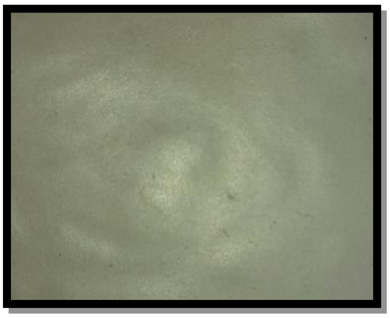
Carrot waste extract	4%	5%	6%
Distilled water	80%	78%	76%

Procedure

- Take potato starch, glycerol in a beaker
- Dissolve them in distilled water
- Add acetic acid to the dissolve mixture
- Mix the mixture with a glass rod over a hotplate at 40°C for 5 mins
- Heat the mixture in a water bath for 70°C for 15 mins
- Prepare for casting of the film
- Pour the mixture on the casting tray
- Dry the cast at room temperature at 48 hours
- Now peel of the cast.

Image 3.1 Sample A, B & C



Sample A

Sample B

Sample C

Results:

- **Tensile strength**

Table 4.1 Tensile Strength of edible film

S. No.	Samples	Tensile strength Kgf/cm^2
1.	Sample A	15.02
2.	Sample B	19.26
3.	Sample C	13.45

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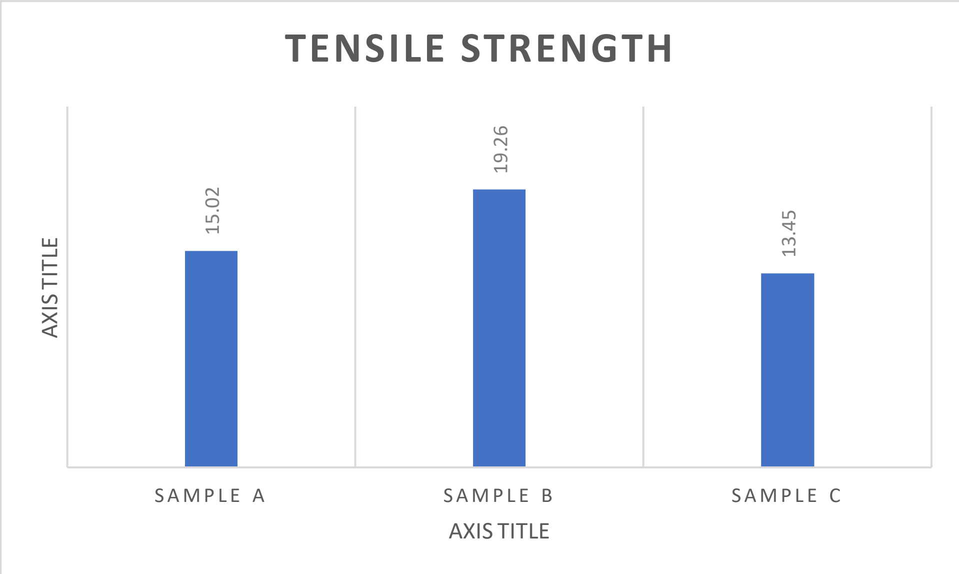
Fig: 4.1 Tensile Strength of edible film



The tensile strength is the force per unit area or the stress that is applied on the biodegradable film. The tensile strength of the biodegradable film sample was analyzed. It was seen that sample B has the highest tensile strength following behind it was sample A which has slightly weaker tensile strength than sample B, sample C has much weaker tensile strength. It was seen that sample B has much better bond formation. It was observed that the fruit and vegetable waste quantity in the edible film was optimal. In sample A, there was even less amount of fruit and vegetable waste which was used, the tensile strength of sample A was far better than sample C which interprets that the higher amount of fruit and vegetable waste in sample C result in poor bond formation which led to decrease in tensile strength

The tensile strength is in order of sample C < sample A < sample B

- **Moisture content**

Table 4.2 Moisture content of edible film

S. No.	Biodegradable film	Moisture content (% by wt.)
1.	Sample A	0.13
2.	Sample B	0.21
3.	Sample C	0.46

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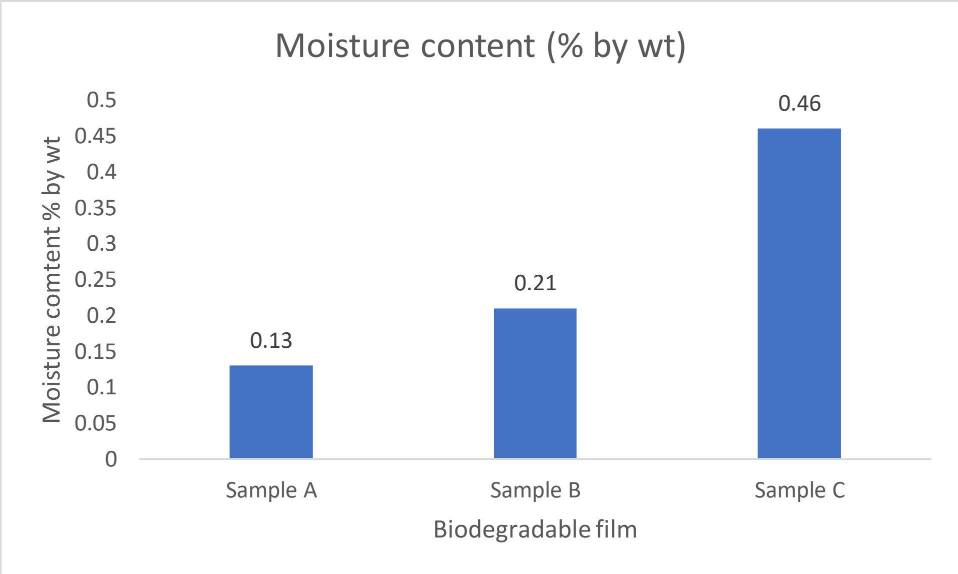
Fig: 4.2 moisture content of edible film



Moisture analysis of biodegradable film shows that sample C has highest moisture content which shows a correlation that higher the moisture content lower will be the tensile strength of the film. Sample B and sample A had much lower moisture content which results in higher tensile strength but in sample A there is much poor bond formation which has reduced the tensile strength.

The moisture content of the sample is in order sample A < sample B < sample C

- **FTIR analysis**

Sample A

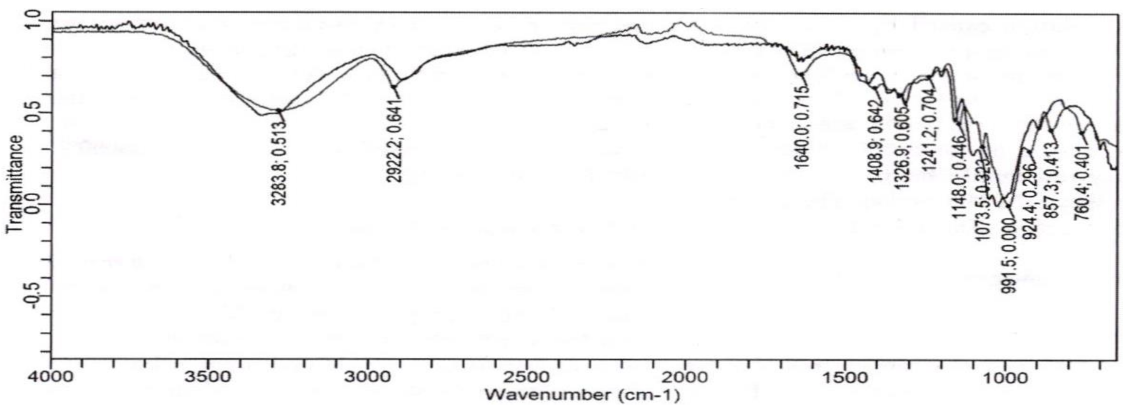


Fig 4.3.1 FTIR Spectra of Sample A

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Sample B

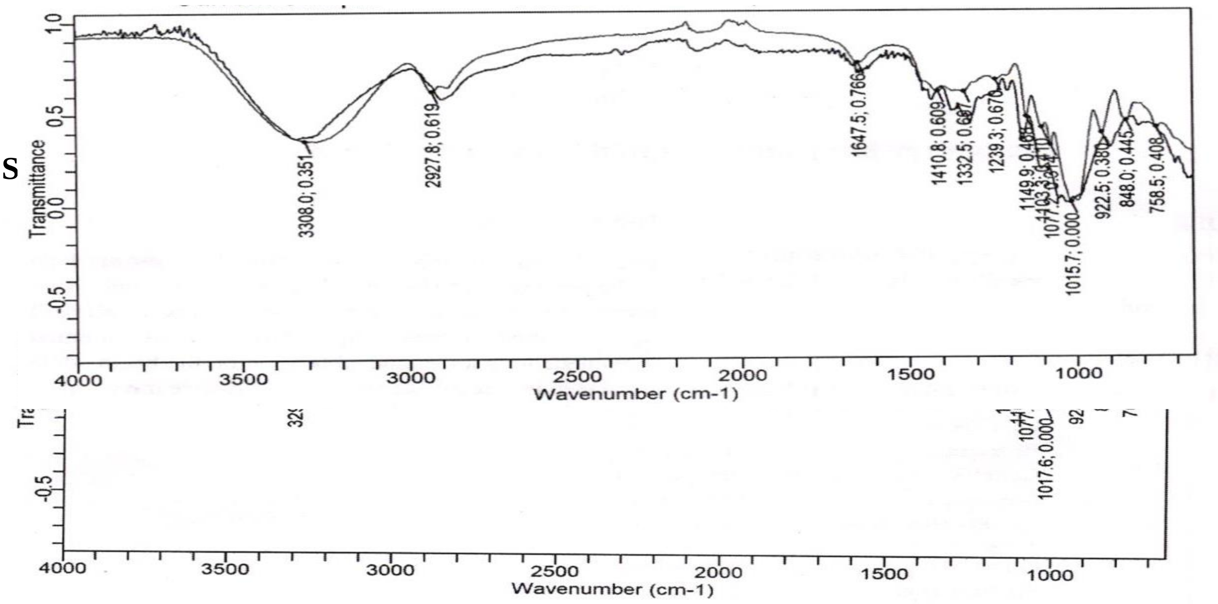

Fig 4.3.3 FTIR Spectra of Sample C

Figures show the FTIR spectra of potato starch based edible film in the wave number range of 4000 – 600 cm$^{-1.}$ The sample A, B and C film contains starch, glycerol, dry carrot powder, banana peel extract, acetic acid. The binder in this film is starch which is a homo polysaccharide mainly composed of D-glucose molecule. It is observed that the component of edible film is likely to consist of carboxylic, alcohol, methene, phenols, ketone groups among the others. In the film the starch from the peak at 2934cm^{-1} in -CH group, 1639cm^{-1}peak is seen during (-H bonding in -COOH), peak 1159cm^{-1} has appeared in (-CO group) [7]. The FTIR spectra for glycerol exhibit the C-O stretching at1110cm^{-1}, shows the bending of C-O-H group at1420cm^{-1}, the C-H stretching appear at the 2934 and 2878 cm^{-1}, O-H stretching is revealed at 3286cm^{-1} [8]. The dry carrot powder shows the (C=C) stretching around 1649cm^{-1}, (C=C) bonded with (CH_3) is seen at 1556cm^{-1}, scissoring (CH_2) bending exhibit at 1456cm^{-1}, while the asymmetrical and symmetrical bending of (CH_3) peak are observed between 1421 and 1367 cm^{-1}, the peak for oscillation of (-OH) group seen between 3000 to3600cm^{-1} [9]

The banana peel FTIR spectra show the bending of C-H of lignin and hemicellulose polymer at a peek of 1107cm^{-1}, C-H bond peak were observed 1288 and 1364cm^{-1}, O-H stretching show strong peek at 3485cm^{-1}, peak at 3365cm^{-1} suggest the presence of free (-OH) group, the free hydroxyl group of the polymeric compound show a peak rage in between 3600 to 2800cm^{-1},peak for primary amines N-H bending vibration is1609cm^{-1}, 1736cm^{-1} peak is observed due to stretching vibration of C=O, peak at 1465cm^{-1} is seen due to lignin aromatic ring vibration, C-H bending of cellulose and crystalline cellulose is observed at 1288 and 1364cm^{-1} [10]. Sample B and C has also contained chitosan, chitosan shows peak for NH out of -plane bending at 711 cm^{-1}Chitosan, C-O-C stretching was seen at 1174cm$^{-1,}$ CH_2 stretching was observed at 2865cm$^{-1, at}$ peak of 3594cm^{-1} -OH stretching was exhibit [11].

- **SEM analysis**

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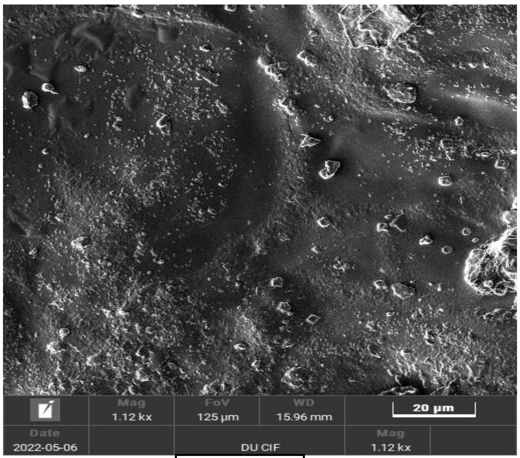
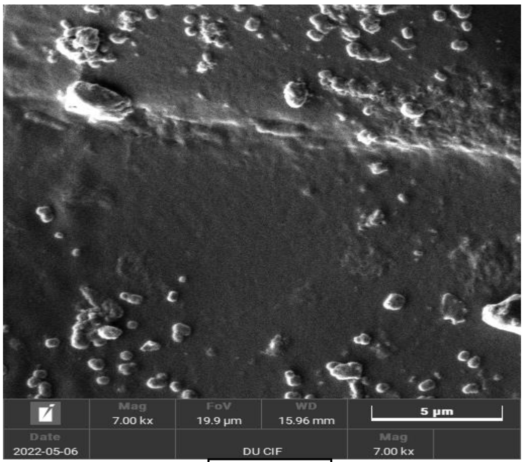
Sample A

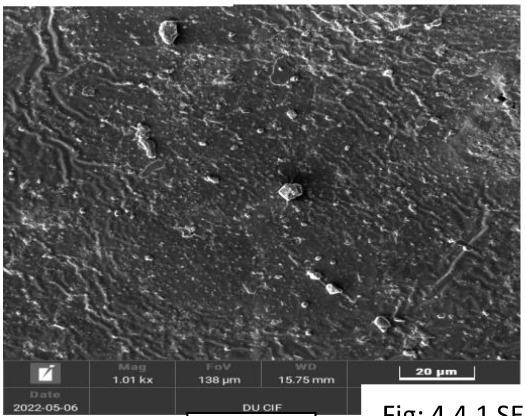


20 µm



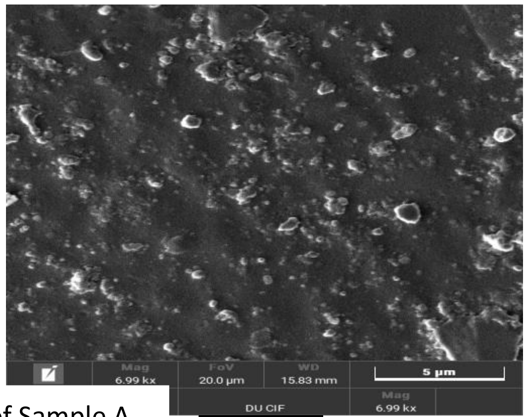
5 µm

Sample B



20 µm

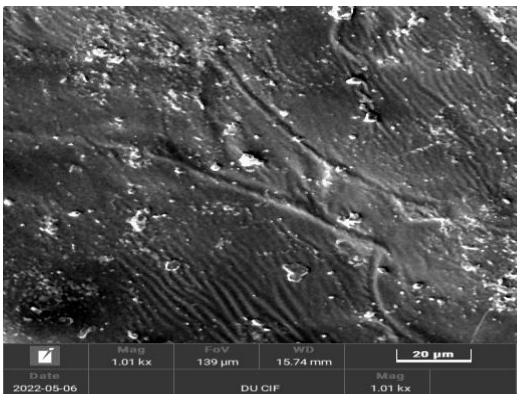
Fig: 4.4.1 SEM images of Sample A



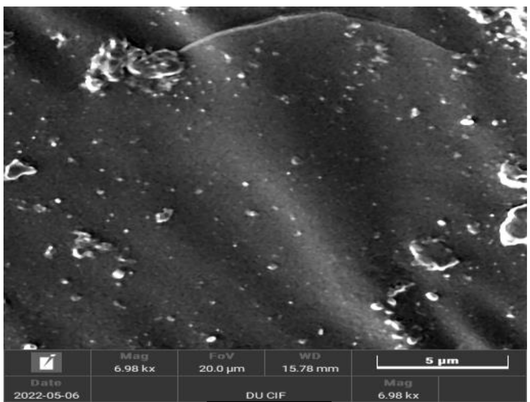
5 µm

Fig: 4.4.2 SEM images of Sample B

Sample C



20 µm



5 µm

Fig: 4.4.3 SEM images of Sample C

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SEM analysis of the different biodegradable packaging films was done to determine the microstructure and external morphology of the film samples validation the smoothness of the film material, compactness, along with equivalent dispersion of different component within film. The results represent that film (A) has a smooth surface with no fibrous mesh like formation while addition of chitosan to the film (B, C) has a rough surface with fibrous mesh like formation due to polymerization occurring by the addition of starch in it [12].

- **X-Ray diffraction analysis:**

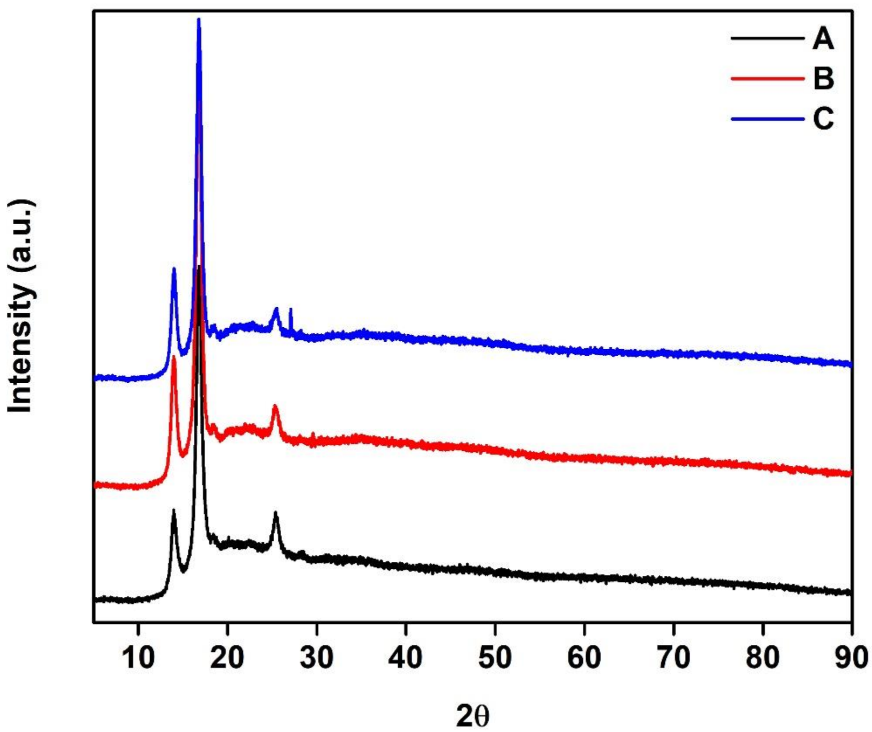

Fig: 4.5 XRD Analysis of edible film

This result suggests show that variation in the crystallization between starch sample in different films that are attribute of the difference in the amount of crystalline region which is mainly influenced by amylose and amylopectin content present in it. That can be better explained as an endothermic reaction where formation of hydrophobic interaction take place. Heating also plays an important and significant role because of conductive form that is involved in the formation of crystal structures [13]. No diffraction peak was observed in extract that was obtained from dry carrots in the 2θ range from 20-90° suggestive of amorphous nature [14,15]. Banana peel extract has peak at about 28.2° to 40°.

SUMMARY AND CONCLUSION

This research was focused on developing biodegradable edible film. There were three samples of biodegradable film that was synthesized, namely sample A, sample B and sample

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C which were prepared using different amount of fruit and vegetable waste that was incorporated in the samples. The film was prepared using starch, glycerol, acetic acid, fruit and vegetable waste. The film samples were analyzed on various parameter such as tensile strength, moisture analysis, FTIR analysis, SEM analysis, XRD analysis and Kirby Bauer analysis. Through analysis it was found that sample B has highest tensile strength which indicate that is has better bond formation, the tensile strength of the sample is as follow sample C < sample A < sample B. the moisture analysis shows that the sample C has highest moisture content that can be correlated in decreasing the tensile strength of the film. FTIR analysis depict the various peaks of the starch, glycerol, dry carrot peel extract and banana peel. The SEM analysis showed the surface structure of the film sample in which sample A more smother surface and sample B and sample C are meshier and more fibrous. The XRD analysis describe the peak of the starch and banana peel extract

It can be concluded that sample B film was best formed in against sample A and C. The film synthesized can be used in packaging of dry bakery product.

The future trend in edible packaging can be to focus more on food safety, development of film has feature like stable on high temperature and pressure, formation of multilayer structure, more use of biopolymer, prolonging the shelf life and edible film should have cost competitiveness with petroleum-based packaging materials.

REFERENCES:

1. da Rocha, M., de Souza, M. M., & Prentice, C. (2018). Biodegradable Films: An alternative food packaging. In *Food Packaging and Preservation* (pp. 307-342). Academic Press.
2. Menezes, J., & Athmaselvi, K. A. (2018). Report on edible films and coatings. In *Food packaging and preservation* (pp. 177-212). Academic Press.
3. Ivonkovic, A., Zeljko, K., Talic, S., & Lasic, M. (2017). Biodegradable packaging in the food industry. *J. Food Saf. Food Qual*, *68*, 26-38.
4. Shaikh, S., Yaqoob, M., & Aggarwal, P. (2021). An overview of biodegradable packaging in food industry. *Current Research in Food Science*, *4*, 503-520.
5. Chaurasia, S., & Lal, A. (2016). Development of biodegradable packaging film using potato starch. *International Journal of Current Engineering and Technology*, *6*(3), 915-925.
6. Kadzińska, J., Janowicz, M., Kalisz, S., Bryś, J., & Lenart, A. (2019). An overview of fruit and vegetable edible packaging materials. *Packaging Technology and Science*, *32*(10), 483-495.
7. Hebeish, A., Aly, A. A., El-Shafei, A., & Zaghloul, S. (2009). Synthesis and characterization of cationized starches for application in flocculation, finishing and sizing. *J. Chem*, *52*, 73-89.
8. Danish, M., Mumtaz, M. W., Fakhar, M., & Rashid, U. (2016). Response surface methodology: an imperative tool for the optimized purification of the residual glycerol from biodiesel production process. *Chiang Mai J. Sci*, *43*, 1-13.
9. Joda, B. A., Abed Al-Kadhim, Z. M., Ahmed, H. J., & Al-Khalaf, A. K. (2022). A convenient green method to synthesize β-carotene from edible carrot and nanoparticle formation. *Karbala International Journal of Modern Science*, *8*(1), 20-27.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper **© 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 11, Iss 8, Dec 2022**

10. Application of kepok banana peel activated carbon prepared by conventional and microwave heating for malachite green adsorption

11. Varma, R., & Vasudevan, S. (2020). Extraction, characterization, and antimicrobial activity of chitosan from horse mussel Modiolus. *ACS omega*, *5*(32), 20224-20230.

12. Tulamandi, S., Rangarajan, V., Rizvi, S. S., Singhal, R. S., Chattopadhyay, S. K., & Saha, N. C. (2016). A biodegradable and edible packaging film based on papaya puree, gelatin, and defatted soy protein. *Food Packaging and Shelf Life*, *10*, 60-71.

13. Dome, K., Podgorbunskikh, E., Bychkov, A., & Lomovsky, O. (2020). Changes in the crystallinity degree of starch having different types of crystal structure after mechanical pretreatment. *Polymers*, *12*(3), 641.

14. Afonso, B. S., Azevedo, A. G., Gonçalves, C., Amado, I. R., Ferreira, E. C., Pastrana, L. M., & Cerqueira, M. A. (2020). Bio-based nanoparticles as a carrier of β-carotene: production, characterisation and in vitro gastrointestinal digestion. *Molecules*, *25*(19), 4497.

15. Yusuf, M., Khan, R. A., Khan, M., & Ahmed, B. (2012). Plausible antioxidant biomechanics and anticonvulsant pharmacological activity of brain-targeted β-carotene nanoparticles. *International Journal of Nanomedicine*, *7*, 4311.