IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

ECOPACKAGING FROM POMEGRANATE, MICROBIAL SAFETY ANALYSIS

N. Vijay*, and Dr.Madan MohanGunda

Department of Microbiology, Government Degree and P.G. College (A) Siddipet, Telangana,India.

ABSTRACT

Eco packaging from pomegranate is a better replacing for the conventional plastic packaging properties. Biodegradable and active food packaging materials derived from pomegranate peel extract ,biopolymer. The present study aimed to develop a biodegradable food packaging film incorporated with pomegranate peel extract and evaluate its antimicrobial properties against selected foodborne pathogens. Pomegranate peel extract was prepared using solvent extraction and incorporated into a starch-based biodegradable film using the casting method. The antimicrobial activity of the developed films was evaluated against common foodborne bacteria including *Escherichia coli* and Staphylococcus aureus using the agar diffusion technique. The results indicated that films containing pomegranate peel extract inhibits the growth of notable microorganisms. activity compared with control films without extract. The inhibition effect increased with higher concentrations of the extract. These findings suggest that biodegradable films enriched with pomegranate peel extract may serve as promising eco-friendly packaging materials capable of enhancing food safety and extending shelf life of the products.

KEYWORDS: Biodegradable, Eco packaging, Biopolymer, Food borne, Agar diffusion, Shelf life.

INTRODUCTION

The scientific name of pomegranate is Punica granatum belongs to the family Lythraceae, subfamily Punicoideae.Food packaging plays an essential role in protecting food products from physical, chemical, and microbiological contamination during storage and transportation. However, the widespread use of petroleum-based plastic materials has created significant environmental challenges due to their persistence and limited biodegradability. As a result, the development of sustainable and biodegradable packaging materials has become an important research focus in food science and technology.

Biodegradable films produced from natural polymers such as corn starch, chitosan, and cellulose have received considerable attention as potential alternatives to synthetic plastics. In addition to environmental sustainability, modern packaging systems are increasingly designed to possess functional properties such as antimicrobial and antioxidant activity. Studies by De Moraes Crizel et al. (2017), Dai et al. (2018), and Dutta & Sit (2024) highlighted the potential of biodegradable films derived from natural polymers for sustainable food packaging.

Plant-derived bioactive compounds are widely investigated as natural additives in active packaging systems. Among these, the peel of Pomegranate is considered a valuable by-product rich in phenolic compounds, tannins, and flavonoids. These phytochemicals are known to exhibit strong antimicrobial and antioxidant activities. Several studies have demonstrated that pomegranate peel extract can inhibit the growth of various foodborne pathogens including Escherichia coli, Staphylococcus aureus, and pseudomonas aeruginosa Hanani et al. (2019) and Ismail et al. (2012) reported significant antimicrobial and antioxidant properties of pomegranate peel extracts against foodborne microorganisms.

Utilizing such natural antimicrobial agents in biodegradable films can contribute to the development of active packaging systems capable of improving food preservation and safety. Therefore, the objective of the present study was to develop a biodegradable film incorporated with pomegranate peel extract and evaluate its antimicrobial effectiveness against selected microorganisms.

METHODOLOGY

Materials and Methods

Materials pomegranates fruits were procured from the local market of Hyderabad, Telangana, India

Preparation of Pomegranate Peel Extract

Fresh pomegranate fruits were collected from a local market, and the peels were separated, washed thoroughly with water, and dried in the hot air oven at 50 to 60 degree temperature for 24 to 48 hours to obtain a same weight constantly. The dried peels were ground into a fine powder using a laboratory grinder. The powdered material was subjected to solvent extraction using distilled water. The mixture was kept under continuous agitation for 24 hours to facilitate extraction of bioactive compounds. The extract was filtered using whatman's filter paper and concentrated using a rotary evaporator to obtain a crude pomegranate peel extract.

Detection of bioactive compounds

Preliminary test

For the detection of bioactive compounds inpomegranate peel extract , add few drops of ferric chloride solution to the pomegranate peel extract, colour changes into green black. The colour changes indicates the presence of polyphenols.

UV visible spectrophotometer

To detect compounds presence scan the extract from 200-400nm range.

Peaks at around 250-290nm and 320 -370nm indicates the presence of polyphenols compound.

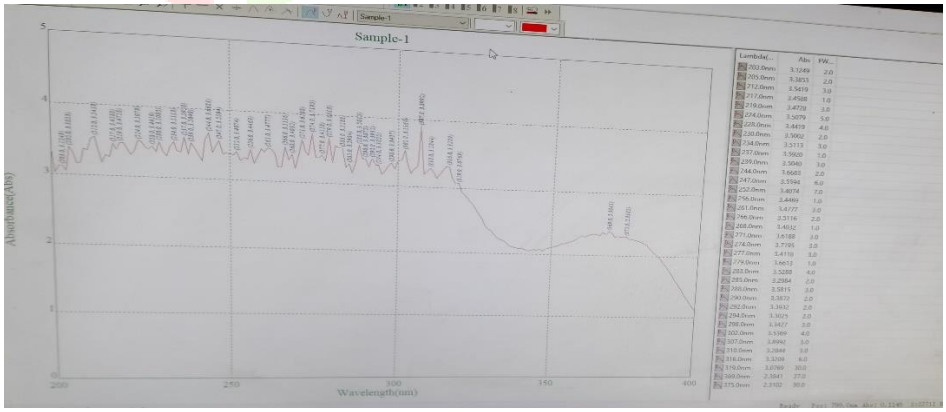

Figure1. UV graph of pomegranate fruit peel extract

Preparation of Biodegradable Film

Biodegradable films were prepared using a corn starch through the solvent casting technique. Corn Starch 4 to 5 grams was dissolved in distilled water and heated with constant stirring to obtain a uniform solution. Glycerol 1.5 ml was added as a plasticizing agent to improve film flexibility. Heat stearic acid 0.25 g at 60 to 70 degrees temperature and add the lecithin 0.10g to stearic acid stir the solution for 5 to 10 minutes., and this molten stearic acid mixture into the hot starch solution slowly

with constant stirring at 2000 rpm for 15 to 20 minutes to uniform dispersion of stearic acid. Pomegranate peel extract 5 percent to the weight of biopolymer incorporated into the film-forming solution at different concentrations. The resulting mixture was poured onto clean glass petri plates and dried at 40 degree temperature for 12 to 24 hours to form thin films, after getting the thin layers collected the layers from the petriplates.

Test Cultures

The antimicrobial activity of the films was tested against selected foodborne microorganisms including:

- *Escherichia coli*
- *Staphylococcus aureus*
- *Bacillus*
- *Pseudomonas*spp

These bacterial strains were selected due to their frequent association with food contamination and foodborne illnesses.

Evaluation of Antimicrobial Activity

The antimicrobial effectiveness of the developed films as determined using the agar diffusion method. Nutrient agar plates were inoculated with bacterial cultures using sterile swabs. Circular pieces of the biodegradable film were carefully placed on the agar surface. The plates were incubated at 37°C for 24 hours. Following incubation, the diameter of the inhibition zones surrounding the film samples was measured to evaluate antimicrobial activity.

Statistical Analysis

All experiments were conducted in triplicate to ensure reliability of the results. The obtained data were expressed as mean values with standard deviation. Statistical comparisons were performed to assess differences between control and treated samples.

RESULTS

The biodegradable films incorporated with pomegranate peel extract demonstrated clear antimicrobial activity against the tested microorganisms. In contrast, control films without the extract showed no inhibitory effect.

The diameter of inhibition zones increased with increasing concentrations of pomegranate peel extract in the film matrix. The antimicrobial activity was more pronounced against the Gram-positive bacterium *Staphylococcus aureus* compared to the Gram-negative bacterium *Escherichia coli.*

Table1. Function of pomegranate film against bacterial pathogens

Bacterial pathogen	**zone of inhibition**	
	pomegranate film	**Synthetic film**
S aureus	10mm	0
Bacillus subtilis	9.5mm	0
E coli	11.5mm	0
Pseudomonas aeruginosa	13mm	0

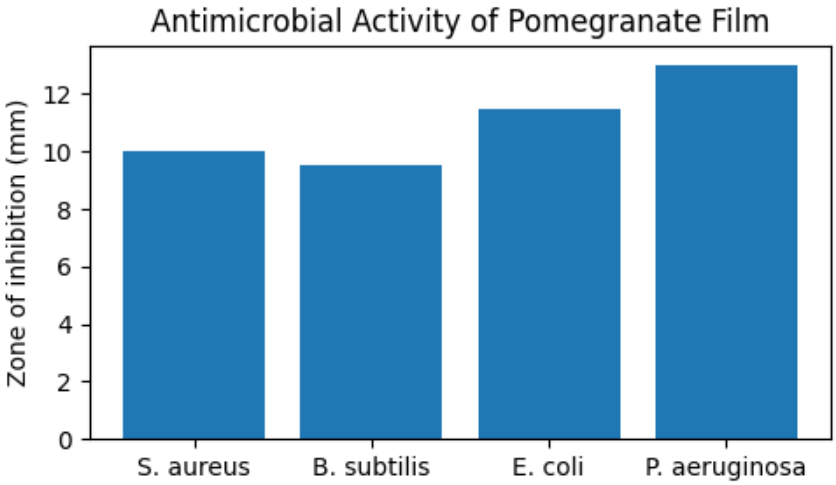

Figure 2. Antimicrobial activity based on zone of inhibition.

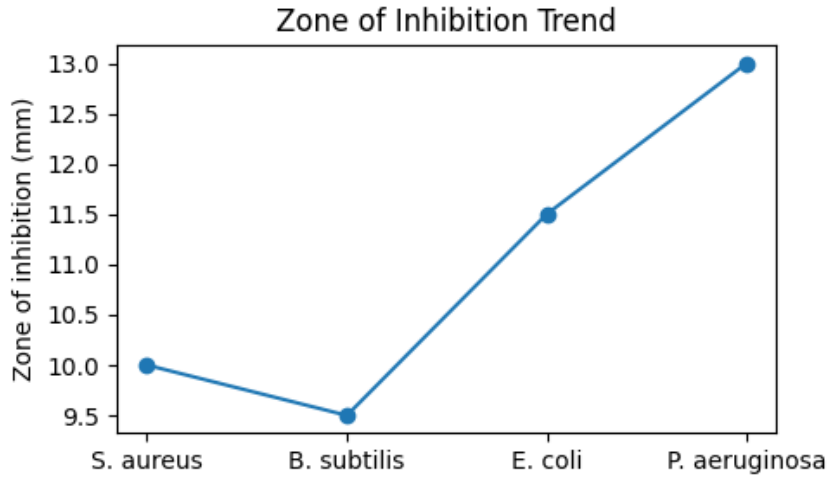

Figure 3. Trend of zone of inhibition among tested microorganisms.

These observations indicate that the presence of pomegranate peel extract significantly enhances the antimicrobial performance of biodegradable packaging films, the synthetic films doesn't shown any antimicrobial activity.

Thickness

The thickness of the food packaging film measured using verniercaliperit is recorded as 0.20mm(20 microns) thickness.

Tensile test

The tensile strength of the film determined by using universal testing machine recorded as 09 MPa

DISCUSSION

The findings of this study confirm that incorporation of pomegranate peel extract into biodegradable films provides effective antimicrobial properties. The antimicrobial activity can be attributed to the high content of phenolic compounds and tannins present in pomegranate peel. Similar observations were reported by Hanani et al. (2019) and De Araújo et al. (2015), who demonstrated enhanced antimicrobial performance in bioactive starch- and gelatin-based films containing natural extracts.

Phenolic compounds are known to disrupt microbial cell membranes, interfere with enzyme activity, and inhibit essential metabolic processes in bacteria. Such mechanisms contribute to the suppression of microbial growth and proliferation.

The stronger inhibitory effect observed against Staphylococcus aureus may be associated with structural differences between Gram-positive and Gram-negative bacterial cell walls. Gram-negative bacteria such as Escherichia coli possess an outer membrane that can act as a barrier to certain antimicrobial compounds.

The incorporation of natural extracts into biodegradable polymer matrices not only improves the functional properties of packaging materials but also contributes to the development of environmentally friendly food preservation technologies. Findings by Hanapiah et al. (2024), De Moraes Crizel et al. (2017), and Dai et al. (2018) further support the use of natural bioactive additives to improve packaging functionality and sustainability.

CONCLUSION

This study demonstrated the successful development of a biodegradable food packaging film incorporated with pomegranate peel extract. The prepared films exhibited significant antimicrobial activity against selected foodborne pathogens including Escherichia coli and Staphylococcus aureus. The results indicate that pomegranate peel extract can be effectively utilized as a natural antimicrobial agent in biodegradable packaging materials. The developed film has potential applications in sustainable food packaging systems aimed at improving food safety while reducing environmental pollution associated with conventional plastics.

ACKNOWLEDGMENT

The author likes to acknowledge all the researchers who have reported the data of biodegradable food packaging film, who have been quoted in this article. And the author is gratefully acknowledge The Principal Professor G. Sunitha madam, Government Degree and P.G. College(A), Siddipet ,Dr. G. Madanmohan Sir Head of Department, Department of Microbiology, of Government Degree and P.G. College(A), Siddipet, and Dr. Md.Sadikali sir, assistant professor, dept of pharmaceutical engineering of BVRIT college,Narsapur.

CONFLICTS OF INTEREST

The author declares no conflict of interest.

REFERENCES

1.De Moraes Crizel, T., De Oliveira Rios, A., Alves, V. D., Bandarra, N., Moldão-Martins, M., &Flôres, S. H. (2017). Biodegradable films based on gelatin and papaya peel microparticles with antioxidant properties. Food and Bioprocess Technology, 11(3), 536-550. https://doi.org/10.1007/s11947-017-2030-0

2.Dai, H., Ou, S., Huang, Y., & Huang, H. (2018). Utilization of pineapple peel for production of nanocellulose and film application. Cellulose, 25(3), 1743-1756. https://doi.org/10.1007/s10570-018-1671-0

3.De Araújo, G. K. P., De Souza, S. J., Da Silva, M. V., Yamashita, F., Gonçalves, O. H., Leimann, F. V., & Shirai, M. A. (2015). Physical, antimicrobial and antioxidant properties of starch-based film containing ethanolic propolis extract. International Journal of Food Science and Technology, 50(9), 2080-2087. https://doi.org/10.1111/ijfs.12869

4. De Moraes Crizel, T., De Oliveira Rios, A., Alves, V. D., Bandarra, N., Moldão-Martins, M., &Flôres, S. H. (2017). Biodegradable films based on gelatin and papaya peel microparticles with antioxidant properties. Food and Bioprocess Technology, 11(3), 536-550. https://doi.org/10.1007/s11947-017-2030-0

5.Dutta, D., & Sit, N. (2024). Comprehensive review on developments in starch-based films along with active ingredients for sustainable food packaging. Sustainable Chemistry and Pharmacy, 39, Article 101534. https://doi.org/10.1016/j.scp.2024.101534
6.Hanani, Z. A. N., Yee, F. C., & Nor-Khaizura, M. A. R. (2019). Effect of pomegranate (Punica granatum L.) peel powder on the antioxidant and antimicrobial properties of fish gelatin films as active packaging. Food Hydrocolloids, 89, 253-259. https://doi.org/10.1016/j.foodhyd.2018.10.007
7.Hanapiah, N. A. M., Salleh, S. N. A. S., Johari, W. L. W., Adzahan, N. M., Halimoon, N., & Osman, N. H. (2024). Biodegradable films incorporating Malaysian stingless bee propolis: development, characterization, and potential for food packaging. Applied Food Research, 4(2), Article 100594. https://doi.org/10.1016/j.afres.2024.100594
8.Ismail, T., Sestili, P., & Akhtar, S. (2012). Pomegranate peel and fruit extracts: A review of potential anti-inflammatory and anti-infective effects. Journal of Ethnopharmacology, 143(2), 397-405. https://doi.org/10.1016/j.jep.2012.07.00