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DEVELOPMENT OF EDIBLE PACKAGING MATERIAL FROM MANGO (*Mangifera indica*) SEED

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ABSTRACT
Food packaging is an important area of food research because it plays an important role in protecting and isolating food. Edible film is considered a solution to replace these synthetic plastics with naturally available biomacromolecules such as polysaccharides, proteins and lipids. A huge amount of research has been done in different parts of the world to discover its full potential. Their findings need to be confirmed to further develop this trending field of research. Consumers are increasingly demanding biodegradable food packaging that contains minimal synthetic preservatives, and at the same time they are concerned about potential contaminants, especially during a pandemic. Plant essential oils (EO) are natural compounds with significant antimicrobial properties. More research and development in the field of edible packaging is needed to promote environmentally sustainable packaging techniques that are important for both food safety and environmental protection.

Keywords:
Food safety, sustainability, edible coatings, edible packaging, and environmental contamination

INTRODUCTION
Packaging is one of the most critical post-harvest operations to preserve and extend the shelf life of fruits, vegetables and processed foods. The most important functions of food packaging are protection, communication and convenience. The development of industrialization leads to a strong increase in the use of plastic in food packaging. Global plastic production has reached up to 380 million tons and has increased dramatically in recent decades, where 40% of plastic produced is used for packaging [1]. In recent decades, consumers have also become aware of the impact of plastic on the environment. Its appearance and palatability of foods and has received much attention in recent decades as biodegradable synthetic packaging materials have been partially replaced [1]. The need has increased in recent years. to replace petroleum-based plastics such as polypropylene and polyethylene, as their non- renewability, significant carbon footprint and low biodegradability are a major environmental concern [3]. In people's daily life, single- use plastic products such as plastic bags and food packaging bags flood every corner of society and become necessary and important things. Therefore, there is a great need to develop new products rom sustainable raw materials. Starch is a common biopolymer that is abundantly available, cheap and easy to process [4]. This polymer is a potential candidate for food packaging because its films have good mechanical and thermal properties, biodegradability and renderability [5]. However, since these plastic products are non- biodegradable, they cause environmental pollution by accidentally disposing of them. This is an urgent and long-term problem, also known as "white pollution". That is why more and more countries, including China, are restricting the use of single-use plastic products. The development of biodegradable food films is increasingly important. Starch is a kind of natural polysaccharide material, which has the advantages of wide sources, good recovery, good biodegradability and low cost, especially good film- forming property. As a result, starch has gradually become the first choice in researching biodegradable food packaging materials [6].

OBJECTIVES
The main objective of the study is to develop the edible packaging from mango seed by using RSM software and evaluate the properties of edible packaging. To study the nutritional value of the foods packed with edible packaging. To evaluate the shelf life of developed edible package. Finally, perform characterization testing of

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theedible film.

ORIGIN OF EDIBLE PACKAGING

The emergence of starch-based edible packaging not only solves the problem of safe and rapid decomposition of food packaging, but also becomes an obstacle to protect food safety. Due to the differences in particle size, shape, amylopectin/amylose ratio, crystallinity, etc. of different plant starches, the properties of the films formed from these starches as matrices are quite different [7]. The main function of edible film is to control moisture loss and reduce the rate of harmful chemical reactions to improve the quality and safety of many processed and fresh foods [1] In addition, the addition of various food additives such as antimicrobial agents, antioxidants, flavors and colors to the edible film matrix further expand their applications (Tavassoli -Kafrani et al., 2016). However, the permeability and mechanical properties of edible film are not at the level of conventional synthetic plastic films [1] Edible packaging materials are natural polymers.. derived from polysaccharides, proteins (animal or vegetable proteins), lipids or combinations of these components (Khaoula et al., 2004; Galus and Kadzińska, 2015). According to Market Research Futures (MRFR), the market for edible packaging (based on proteins, lipids, polysaccharides and others) is estimated to be USD 2.14 billion by 2030 with a CAGR of 6.79 percent (2022-2030).), while in 2021 it was US$ 783.32 million. During the forecast period, North America dominates the edible packaging market, followed by the United Kingdom, Japan, Indonesia, and Israel [8]). Numerous researchers have prepared and characterized many edible films from various plant materials. Researchers have continued to work over the past three decades to develop edible films that are equivalent to conventional plastic films to enable their commercial use.

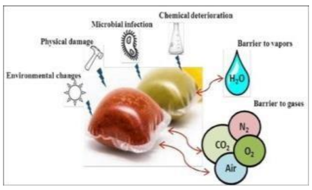
Fig.1 (V et al., Otoni et al., Gheorghita (Puscaselu) et al., & Puscaselu et al.)

CHARACTERISTICS OF EDIBLE PACKAGING

Food packaging is used for a variety of purposes including delivery, distribution and storage. Its removal and dumping causes several ecological problems, especially non-biodegradable ones. In addition, recycling the same material costs a premium [10]. Thus, in this rapidly evolving age, edible packaging is a wonderful natural substitute that prevents gas migration, slows down the ripening process, improves aesthetic appearence and extends shelf life. long life of the product in addition to functioning as packaging [11].

FUNCTIONAL PROPERTIES

Edible packaging fulfill various functional properties such as environmental barrier, water barrier, oxygen barrier, aroma barrier, oil barrier.



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ENVIRONMENTAL ASPECTS

Coatings and edible films act as an environmental barrier and are responsible for controlling mass transfer between the environment and the food [12]. Permeability is considered an important factor in the selection of edible packaging material. The effect of humidity and temperature on the membrane reflects its condition. Therefore, measurement of permeability must be done under certain conditions before it is used as a packaging material[13].

WATER BARRIER PROPERTIES

Edible packaging has been widely used for food packaging and other situations where it is desirable to avoid moisture. exchange [14]. Because the transmission of water vapor is low, the growth of microorganisms is inhibited, preventing structural changes or harmful chemical reactions. Compared to hydrocolloid-based films, edible wax and plastic films have relatively lower wate r vapor permeability (WVP) [15]. This is because the WVP of hydrophilic films increases at high relative humidity (RH) and plasticizer content. Therefore, these films can only be used to protect moisture exchange in foods with low humidity and a short shelf life. In contrast, lipid-based hydrophobic chemicals are often used to improve the water barrier properties of membranes by creatin densely organized matrices with low polarity and low abundance. [16].

OXYGEN BARRIER

Food decay or spoilage is mainly caused by oxidation of lipids and food components, enzymatic browning of fresh fruits, and staining of myoglobin pigment in freshly cut pieces of meat [17]. Oxygen-sensitive foods can be preserved for a longer shelf life by using low oxygen permeability (OP) edible packaging. In addition, it reduces the use of various expensive, rich oxygen barrier plastics, which are not recyclable. At the same time, the progress of several innovations in the production of food films can cause a changed environment [18]. These state-of-the-art methods can also help to reduce the respiration of horticultural products and the formation of ethylene in physiologically active climate products during both distribution and storage [19]. Hydrocolloid-based membranes often have excellent gas barrier properties at low relative humidity On the other hand, hydrophilic EVOH films and plasticized hydrocolloid-based films are used to achieve excellent protective properties at high relative humidity [20].

AROMA BARRIER PROPERTIES

In food packaging, aroma, i.e., volatile aroma and the movement of aromas from outside, creates a problematic situation for any food package, which must be avoided during storage and distribution [21]. In general, the barrier efficiency of the packaging material is improved when the mobile compound has a low affinity for suitable barriers, including the hydrophilicity of protein and polysaccharide-based membranes. Identification of suitable barriers Incorporating the hydrophilicity of protein- and polysaccharide-based edible films to non-polar flavor compounds. This is suggested by films based on carbohydrate and protein emulsions [22]. The main purpose of using this technique is to retain the hydrophobic organic aromatic compounds in a non-polar lipid dispersed phase, while the hydrophilic polymer matrix prevents aromatic loss to the environment or through oxidation [23]. Further research is still needed to reveal the different aspects related to aroma permeability of edible films [24].

OIL INHIBITOR PROPERTIES

Edible packaging can provide any type of fat resistance to lipid-containing foods [25]. Because protein-based films are hydrophilic in nature, kino and whey protein-based films have been found to be exceptionally resistant to grease [26].

FOOD SURFACE PROPERTIES

Wettability

The ability of a certain liquid to spread on a solid surface is known as the spreading coefficient or wettability (Was). The higher the moisture value, the better the covering material is suitable for use [27]. The most important factors that are considered when determining the reading coefficient are the coefficient of adhesion (Wa) and the coefficient of cohesion (Wc). The first represents the force that favors the expansion of a liquid on a solid surface, while the second represents the force that favors the contraction of a liquid on a solid surface [28].

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COMPARISON OF EDIBLE PACKAGING FILMS AND SYNTHETIC POLYMERS

When food and packaging materials come into contact, the quality of different foods changes in different ways. The government recently produced papers showing that food is vulnerable to possible leakage of chemical components from cardboard packaging used to pack food such as pizza and cereal boxes. Phthalates were once used in the production of cling film; however, they contain some dangerous substances that can be harmful to health. Despite this, phthalate-free production has made adhesive films significantly safer for use in the food industry [29]. Usually, synthetic polymers used as packaging material are not biodegradable and their production costs are very high [30]. There is an urgent need for edible films made from natural polymers or adhesive films from substances that easily decompose biologically into carbon dioxide, water and biomass under the influence of microbes.There are no environmental risks associated with these edible films. Various materials are used in the production of edible films, such aspolysaccharides, proteins, lipids, nucleic acids and composite materials [31]. Protein-based films have gained widespread recognition among all these natural films. polymers in terms of their advantages and applications compared to synthetic polymer- based films [32].


Fig. 2 (Abolfazl JS, 2017)

GENERAL CHARACTERISTICS OF EDIBLE FILMS

Food can be kept safe and fresh throughout its shelf life by using edible films and coatings that protect them from the harmful environment. The uses of edible films and coatings vary depending on what foods need to be kept fresh. In addition, the protective properties can be limited due to the way gases and moisture are transported through the inherent properties of the materials that make up the membrane. A film or coating suitable for use in foodstuffs must meet certain requirements. Ideal cover or film for food (JA, 2009).

- It should be FDA approved, safe to eat and recognized as safe for human consumption (GRAS). It must be fully digestible, non-allergenic, non-toxic and biodegradable. and must maintain stability during preparation and storage (T, 2008).
- It must be structurally sound to prevent damage during handling, storage and transportation of food materials. During production, the film-forming ingredients must dissolve and disperse easily in a solvent (such as water, alcohol, or a combination thereof) and other solvents (such as acetone). The surface of the food should have a high level of even adhesion. Due to the conditions of production and use, it must have good mechanical and rheological properties (Guilbert S, 1996).
- To maintain the appropriate humidity, the movement of water in and out of the protected food must be controlled. . Both the adhesion between the film and the flour and the cohesion between the polymer molecules forming the film must be controlled [34]. It must be able to maintain an internal balance of gases used in both anaerobic and aerobic food respiration.
- It must not adversely affect attributes such as smell, taste, taste or appearance that are necessary for consumer acceptance. However, it should provide biochemical and microbial surface stability during microbial growth and other types of damage [35]. It should act as a carrier for desired additives such as flavor, aroma, color, nutrients, antioxidants, antimicrobials and vitamins and should be readily available. produced and economically viable due to food costs and working conditions.

QUALITY PARAMETERS OF EDIBLE FILMS

In order to achieve ideal properties, edible films and coatings should be tested with a number of measurable quality parameters [36]. The most important evaluated properties of edible films and coatings are their moisture and gas barrier properties, microbiological stability, moisture adsorption capacity, adhesion, cohesion, solubility, transparency, mechanical properties, sensory and organoleptic properties [37]. Some of the parameters used to

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measure the quality of an edible film or coating are [38];

- Water vapor permeability or water vapor permeability, oxygen permeability or oxygen permeability, moisture adsorption during storage [39].Mechanical properties. such as tensile strength, percentage elongation, elongation at break, modulus of elasticity and glass transition temperature and chemical properties such as solubility in water, alcohol and mixtures and hydrophilic-hydrophobic interaction.
- Organoleptic properties such as color, taste, appearance and Odor and physical properties such as opacity and light transparency [40].

Antimicrobial properties; minimum inhibitory concentrations, minimum bactericidal concentrations, maximum tolerable concentrations and antimicrobial activity target organisms for edible films containing natural antimicrobials.The properties of edible films and coatings are influenced by several parameters, such as the composition of the material forming the film, the conditions of film production, e.g.; solvent type, environmental pH, temperature, and the type and concentration of additives (plasticizers, antimicrobial agents, antioxidants, crosslinking agents or emulsifiers) [41]. Hydrocolloid membranes (based on proteins and polysaccharides) have good gas barrier properties (oxygen, carbon dioxide), even weaker than plastic membranes, and sufficient lipid but not water vapor barrier properties [42]. Lipid-based edible films and coatings (such as waxes and resins) are the most effective film-forming materials to prevent moisture loss and increase due to their low water vapor permeability and hydrophobicity, but their appearance is mostly opaque and unattractive as a packaging material [43].

THE FUTURE ASPECTS OF EDIBLE PACKAGING

Ecological materials: Plant, natural and biodegradable materials are used in the production of food packaging [44]. Materials that reduce waste and its environmental impact are cling film, seaweed and vegetable starch. Sustainable development: - Edible packaging reduces the need for waste collection, processing, recycling or disposal [45]. It fulfills consumers' wishes for ecological and sustainable packaging solutions [46]. Plastic waste Problem: - There is a lot of plastic waste, because only 14% of plastic packaging is recycled [47]. Inadequate infrastructure in developing countries makes them a significant source of plastic waste. Growing convenience practices such as food packaging generate significant amounts of packaging waste. Circular economy: The goal of the circular economy paradigm shift is to minimize waste and resource consumption. There are two chains in the circular economy: the technical chain (recycling of materials) and the biological chain (returning organic materials to nature) [48]. Regional Insights: North America leads the edible packaging market due to growth in disposable income and e- commerce. Europe and Asia Pacific are promising due to environmental awareness and sustainable packaging demand.

LATEST TRENDS, CHALLENGES IN EDIBLE FILMS

The field of edible film research is constantly changing, for example regarding the creation of active packages, new raw material films, nanotechnology applications, etc. [50]. All these initiatives aimed to create biopolymers with properties comparable to those of synthetic polymers produced commercially using agricultural by-products as raw materials [51]. One of the main focus areas of packaging research in recent decades has been the creation of active films that can be used to add various antimicrobial and antioxidant components to the basic polymer matrix of perishable fruits and vegetables, thus extending their shelf life. [52]. Active edible films actively interact with the foods contained in them and promote the health of consumers [53]. In recent years, edible films made from by-products of food processing have become common. This allows industrial by-products to be valorized and edible films can be produced more economically due to their low cost [54]. Industrial by-products obtained from the processing of fruits and vegetables, crustaceans and culinary oils have a significant potential for the production of film preparations [55]. Edible films have many advantages, but as with any new technology, there are significant hurdles to overcome before they can be widely used [56]. The weak mechanical properties of the film, poor water and gas resistance, and insufficient physical properties prevent its use in various culinary applications, despite many attempts to improve its properties to the level of oil-based polymers. To solve these problems, research has been done to develop nanocomposite and composite films. This aspect must be taken into account, since the main purpose of the packaging material is to preserve food and extend the shelf life during storage [57]. The change in the properties of the edible film during aging and at different temperatures and relative humidity is also important to ensure its usability in food preservation. Consumer awareness programs and advertisements of edible films can also increase their acceptability.

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ADVANTAGES OF EDIBLE FOOD PACKAGING

Edible packaging decomposes organically and returns to the environment. It uses renewable natural resources and follows the principles of a circular economy. Its strengths are environmental friendliness and [2]biodegradability. Cost effectiveness and efficient access. Added nutritional value, customization flexibility and ease of use for the consumer.Weakness and familiarity: Consumers are either unaware of or used to edible packaging. Gaining market acceptance requires overcoming skepticism and reluctance. The need for environmentally friendly packaging is growing. Consumer awareness of environmental issues. Adoption can be accelerated through partnership, adaptation and teamwork.

CONCLUSION

Edible films have been recognized as healthy sources to protect food from various elements because they are naturally occurring, inexpensive and renewable. The ability to add functional ingredients and excellent biodegradability further increase its appeal. Extensive research has been done to determine the best result and minimize the damage of new concepts such as the composite membrane approach and the application of nanotechnology. Its successful dissemination requires further research on important aspects such as property improvement, implementation of safety and regulation, finding new and economic sources, and commercial scale through continuous production .They can be used as individual packaging materials, food coating material. and carriers of active ingredients and separate sections of heterogeneous ingredients in foods.

REFERENCES

[1] ed), R. M. (2007). Handbook of food preservation.*CRC Press.*
[2] Abolfazl JS, A. R. (2017). Bioplastics and the environment. *Electron J Biol 13(3)*, :274–279.
Ahn WS, P. S. (2001). Production of poly(3- hydroxybutyrate) from whey by cell recycle fed-batch culture of recombinant Escherichia coli. *Biotechnol Lett 23(3):*, 235–240.
[3] al., A. e. (2017). EFFECTS OF AMADUMBLE STARCH NANOCRYSTALS ON THE PHYSICOCHEMICAL PROPETIES OF STARCH BASED BOCOMPOSITE
[4] al., K. W. (2019). Mechanism properties and solubility in water of corn starch collagen composite films;effect of starch type and concentration. *food chem*.
[5]B. Ebrahimi, R. M.-A. (2018). Survival of probiotic bacteria in carboxymethyl cellulose-based edible film and assessment of quality parameters. *LWT, 87* , pp. 54-60.
[6]C, D. M.-J. (1997). Edible and biodegradable polymer films: challenges and opportunities. *Food Technol 51(2):*, 61-73.
[7]C. Soukoulis, S. B.-J. (2017). Stability of Lactobacillus rhamnosus GG incorporated in edible films: Impact of anionic biopolymers and whey protein concentrate. *Food Hydrocolloids, 70* ,pp. 345-355,.
[8] Cazón et al. (2017). Polysaccharide-based films and coatings fpr food packaging:A review. *Food Hydrocollids*, 136-148.
[9] Debeaufort F, Q.-G. J. (1998). Edible films and coatings: Tomorrow's packagings: A review. . *Crit Rev Food Sci Nutr 38:*, 299-313.
[10] Debeaufort F, Q.-G. J. (1998). Edible films and coatings: tomorrow's packaging:a review. *Crit Rev Food Sci 38(4)*, 219-313.
[11] Erkmen O, B. T. (2016). Food Microbiology: Principles into Practice. *John Wiley and Sons Ltd, Chichester, UK.p.* , 458.
[12] Fabra MJ, H. A. (2009). Influence ofinteractions on water and aroma permeabilities of ι- carrageenan–oleic acid–beeswax films used for flavour encapsulation. *Carbohyd Polym 76(2),* 325-332.
[13] Falguera V, Q. J. (2011). Edible films and coatings: Structures, active functions and trends in their use. *Trends Food Sci Technol 22,* : 292-303.
[14]G.K. Shroti, C. S. (2022). Development of edible films from protein of brewer's spent grain: Effect of pH and protein concentration on physical, mechanical and barrier properties of films. *Applied Food Research, 100043* .
[15] Galus S, K. J. (2016). Whey protein edible films modified with almond and walnut oils. . *Food hydrocol 52:*, 76-88.
[16] Guilbert S, G. N. (1996). Prolongation of the shelf-life of perishable food products using biodegradable films and coatings. *LWT-Food Sci Technol 29*, 10-17.

iJETRM
International Journal of Engineering Technology Research & Management

[17]H. Aloui, K. B. (2019). Development and characterization of novel composite glycerol- plasticized films based on sodium caseinate and lipid fraction of tomato pomace by- product. *International Journal of Biological Macromolecules, 139* , pp. 128-138.
[18] Hambleton A, D. F. (2009). Influence of alginate emulsion-basedfilms structure on its barrier properties and on the protection of microencapsulated aroma compounds. *Food Hydrocol 23(8):*, 2116-2124.
[19] Han JH, K. J. (2001). Physical properties and oil absorption of whey-protein-coated paper. *JFood Sci 66(2):*, 294-299.
[20] Hong SI, K. J. (2003). Oxygen barrier properties of whey protein isolate coatings on polypropylene films. *J Food Sci 68(1)*, 224-248.
[21]J. Orozco-Parra, C. M. (2020). Development of a bioactive synbiotic edible film based on cassava starch,inulin, and Lactobacillus casei. *Food Hydrocolloids, Article 105754*, 104-110.
[22]J. Orozco-Parra, C. M. (2020). Development of a bioactive synbiotic edible film based on cassava starch, inulin, and Lactobacillus casei. *Food Hydrocolloids*.
[23]J. Orozco-Parra, C. M. (2020). Development of a bioactive synbiotic edible film based on cassava starch, inulin, and Lactobacillus casei. *Food Hydrocolloids, 104* .
[24]J.J. Jeevahan, M. C. (2020). Scaling up difficulties and commercial aspects of edible films forfood packaging: A review. *Trends in Food Science & Technology, 100* , pp. 210-222.
[25]J.J. Jeevahan, M. C. (2020). Scaling up difficulties and commercial aspects of edible films forfood packaging: A review. *Trends in Food Science & Technology,*, pp. 210-222.
[26] JA, Q.-G. (2009). Delivery of food additives and antimicrobials using edible films and coatings.In Embuscado ME, Huber KC (eds.).Edible films and coatings for food applications. *Springer, New York.pp:* , 315-333.
[27] JA, Q.-G. (2009). Delivery of food additives and antimicrobials using edible films and coatings.In: Embuscado ME, Huber KC (eds.)Edible films and coatings for food applications. *Springer, New York.pp*, 315-333.
[28] Janjarasskul T, K. J. (2010). Edible packaging materialS.*Ann Rev Food Sci Technol*, 415-448.
[29]Janjarasskul T, K. J. (2010). Edible packaging materials. *Annual Rev Food SciTechnol 1:*, 415-448.
[30] JH, H. (2014). Innovation in food packaging. In: Han JH, Edible Films and Coatings: A Review. *Academic Press,London.pp*, 213-255.
[31] JM, K. (2002). Proteins as raw materials for films and coatings: definitions, current status, and opportunities. *protein based film coat 1:*, 1-40.
[32] Krochta JM, D. M.-J. (1997). Edible and biodegradable polymer films: challenges andopportunities. *Food Technol 51(2)*, 61–73.
[33] Kumar, A. (2022). Trends in Edible Packaging FAILMS and its Prospective Future in Food.
[34]L. Deng, X. L. (2020). Development of Disulfide Bond Crosslinked Gelatin/ε-Polylysine Active Edible Film with Antibacterial and Antioxidant Activities. *Food and Bioprocess Technology, 13(4)* ,pp. 577-588.
[35] Li, Y. (2021). Comprehensive review of polysaccharide- based materials in edible pacakaging: A Susutainable approach. *Foods 2021 10(8)*.
[36] Lima ÁM, C. M. (2010). New edible coatings composed of galactomannans and collagenblends to improve the posthar-vest quality of fruits– Influence on fruits gas transfer rate. *J Food Eng 97(1)*, 101-109.
[38]M. Moradi, J. G. (2021). Current applications of exopolysaccharides from lactic acid bacteria inthe development of food active edible packaging. *Current Opinion in Food Science, 40*, pp. 33-39,.
[39]M. Moradi, J. G. (2021). Current applications of exopolysaccharides from lactic acid bacteria inthe development of food active edible packaging. *Current Opinion in Food Science*,pp. 33-39.
[40]M.S. Nair, M. T.-K. (2020). Enhancing the functionality of chitosan-and alginate-based active edible coatings/films for the preservation of fruits and vegetables: A review. *International Journalof Biological Macromolecules*, pp. 304- 320,.
[41]M.S. Nair, M. T.-K. (2020). Enhancing the functionality of chitosan-and alginate-based active edible coatings/films for the preservation of fruits and vegetables: A review. *International Journalof Biological Macromolecules*, pp. 304- 320.
[42] Malhotra B, K. A. (2015). Natural polymer based cling films for food packaging. *Int J PharmPharm*

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International Journal of Engineering Technology Research & Management

Sci 7(4), 10-18.
[43] Martín-Belloso O, R.-G. M.-F. (2009). Delivery of flavor and active ingredients using ediblefilms and coatings. In: Embuscado ME, Huber KC (eds.).Edible films and coatings for food applications. *Springer, New York.pp:*, 295-313.
[44] MB, N. (2009). Structure and function of polysaccharide gum-based edible films and coatings. In: Edible Films and Coatings for Food Applications. *Springer, New York.pp*, 57- 112.
[45] Medeiros BGDS, P. A.-d.-C. (2012). Development andcharacterization of a nanomultilayercoating of pectin and chitosan–evaluation of its gas barrier properties and application on 'Tommy Atkins' mangoes. *J Food Eng 110(3)*, 457-464.
[46] MF, Á. (2000). Revisión: Envasado activo de los alimentos/review: active food packaging. *Food SciTechnol Int 6(2):*, 97-108.
[47] Muzaffer hassan, A. k. (2020). Biodegradable and edible film:A counter to plastic pollution.
[48] O, A. (2017). Making a case for the use of vegetable leaf and other sustainable packaging materials in food packaging as against modern food packaging; Society of Environmental Toxicologyand Chemistry (SETAC) Book of Abstracts, at the 8th Biennial Conference; Theme th. *Siloam Publications Ltd – Nigeria,*, p 35–36.
[49] Pegg RB, S. F. (2007). Encapsulation, stabilization, and controlled release of food ingredients and bioactives In: Handbook of food preservation. *CRC Press,pp*, 527–586.
[50] Ramírez C, G. I. (2012). Study of contact angle, wettability and water vaporpermeability in carboxymethylcellulose (CMC) based film with murta leaves (Ugni molinae Turez) extract. *J Food Eng109(3):*, 424–429.
[51] Ramos ÓL, R. I. (2013). Effectof whey protein purity and glycerol content upon physical propertiesof edible films manufacture there from. *Food Hydrocol 30(1)*, 110-122.
[52] Salgado PR, e. a. (2015). ScienceDirect Edible films and coatings containing bioactive deterioration,*Current opinion in food science*, 86-92.
[53] Silva-Weiss A, I. M.-G. (2013). Natural additives inbioactive edible films and coatings: functionality and applications in foods. *Food Eng Rev 5(4)*, 200-216.
[54] Souza BW, C. M. (2010). Effect of chitosan based coaatings on the shelf life of salmon(Salmonsalar). *J Agric Food Chem*, 11456–11462.
[55] T, B. (2008). Review article edible films and coatings: characteristics and properties. *Int FoodRes J 15*, 237-248.
[56] T, B. (2008). Review article edible films and coatings: characteristics and properties. *Int FoodRes J 15:* , 237-248.
[57] Tang CH, J. Y. (2007). Modulation of mechanical and surface hydrophobic properties of foodprotein films by transglutaminase treatment. *Food Res Int 40(4)*, 504-509.
[58]V et al., 2., Otoni et al., 2., Gheorghita (Puscaselu) et al., 2., & Puscaselu et al., 2. (n.d.).
[59]V et al., 2., Otoni et al., 2., Gheorghita (Puscaselu) et al., 2., & Puscaselu et al., 2. (n.d.).
[60] Valencia, N. (2021). Starch based films enriched with nanocellulose- stabilized pickering emulsions containing different essential oils for posssible applications in food packaging. *Food packaging and shelf life, 27.*
[61] Zhou, Y. &. (2019). Recent trends in edible packging for food applications - perspective for thefuture. *Food engineering reviews*, 718-747.