UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF ANTIOXIDANT BILAYER FILMS BASED ON POLYETHYLENE, GELATIN AND FRUIT PEEL EXTRACTS FOR FOOD PACKAGING

NOR ADILAH BINTI ABDULLAH

FSTM 2018 20

DEVELOPMENT OF ANTIOXIDANT BILAYER FILMS BASED ON POLYETHYLENE, GELATIN AND FRUIT PEEL EXTRACTS FOR FOOD PACKAGING

By

NOR ADILAH BINTI ABDULLAH

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia in Fulfillment of the Requirements for the Degree of Master of Science.

April 2018

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

DEVELOPMENT OF ANTIOXIDANT BILAYER FILMS BASED ON POLYETHYLENE, GELATIN AND FRUIT PEEL EXTRACTS FOR FOOD PACKAGING

By

NOR ADILAH BINTI ABDULLAH

April 2018

Chairman: Nur Hanani binti Zainal Abedin, PhD
Faculty : Food Science and Technology

In this research, utilization of agricultural by-products as a source of natural antioxidant was developed for an active packaging system. In the first objective, four types of by-products namely, jackfruit peels (JPE), mango peels (MPE), pineapple peels (PPE), and papaya peels (YPE) in the form of extracts were incorporated into fish gelatin films to determine their physical and antioxidant properties. Films with three different concentrations of extracts (1, 3 and 5%) were prepared by solution casting method. Increasing concentration of extracts up to 5% produced thicker, colored, good tensile strength and less flexible films. It also showed an improvement in water permeability with less solubility. Although all films have potential to be developed into active packaging, gelatin based film with 5% MPE was more outstanding in availability of phenolic compounds and its antioxidant performances. Therefore, in the second objective, 5% MPE-gelatin based film was developed into bilayer active packaging by casting onto the PE films at 10 µm (PE/G10), 20 µm (PE/G20), 40 µm (PE/G40), and 60 µm (PE/G60). Bilayer films also showed compatibility structure without any separation between the PE and gelatin active layer. Thicker coatings influenced the reduction ($p \leq 0.05$) of the total phenolic content (TPC) values. Besides, thicker coating layer had improved the transparency and the antioxidant ability but increased ($p \leq 0.05$) the water vapor permeability. Therefore, it can be suggested that bilayer film is suitable for low water activity of food products. In the third objective, PE/G60 was used to determine the effectiveness of the bilayer films on maintaining or controlling the quality of margarine during storage at 4 °C and 25 °C. Results observed that margarine packed in PE/G60 at 4 °C able to inhibit lipid oxidation during 28 days of storage. The bilayer material affects the color changes in margarine with no significant ($p > 0.05$) differences were observed on pH of margarine for both temperatures. This concluded that 5% MPE at 60 µm was

suitable to be developed into bilayer films and had the potential as an antioxidant packaging for high lipid product.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Sarjana Sains

PEMBANGUNAN FILEM DWILAPISAN ANTIOKSIDA BERASASKAN POLIETILENA, GELATIN DAN EKSTRAK KULIT BUAH SEBAGAI PEMBUNGKUSAN MAKANAN

Oleh

NOR ADILAH BINTI ABDULLAH

April 2018

Pengerusi: Nur Hanani binti Zainal Abedin, PhD
Fakulti : Sains dan Teknologi Makanan

Dalam kajian ini, penggunaan produk sampingan pertanian sebagai sumber antioksidan semulajadi telah dibangunkan untuk sistem pembungkusan yang aktif. Dalam objektif pertama, empat jenis produk sampingan iaitu, kulit nangka (JPE), kulit mangga (MPE), kulit nanas (PPE), dan kulit betik (YPE) dalam bentuk ekstrak telah digabungkan ke dalam filem gelatin ikan untuk menentukan sifat fizikal dan antioksidan. Filem yang mempunyai tiga kepekatan ekstrak berbeza (1, 3 dan 5%) telah disediakan oleh kaedah bancuhan ke atas acuan. Peningkatan kepekatan ekstrak sehingga 5% menghasilkan filem yang tebal, berwarna, tegang dan kurang fleksibel. Ia juga menunjukkan peningkatan kebolehtelapan air dengan kurang kelarutan. Walaupun semua filem berpotensi untuk dikembangkan menjadi pembungkusan aktif, filem berasaskan gelatin dengan 5% MPE mengandungi kadar fenolik dan tahap antioksidan yang tinggi. Oleh itu, didalam objektif kedua, filem berasaskan MPE-gelatin 5% telah dibangunkan menjadi pembungkusan aktif dwilapisan dengan kaedah bancuhan ke atas PE pada 10 µm (PE/G10), 20 µm (PE/G20), 40 µm (PE/G40) dan 60 µm PE/G60). Filem dwilapisan juga menunjukkan keserasian struktur antara lapisan PE dan gelatin aktif. Lapisan tebal mempengaruhi pengurangan ($p \leq 0.05$) nilai TPC. Selain itu, lapisan tebal juga telah menambah baik ketelusan dan kebolehan antioksidan tetapi meningkatkan ($p \leq 0.05$) kebolehtelapan wap air. Oleh itu, filem dwilapisan sesuai digunakan untuk produk makanan yang kandungan airnya yang rendah. Dalam objetif ketiga, PE/G60 digunakan untuk menentukan keberkesanan filem dwilapisan dalam mengekalkan dan mengawal kualiti marjerin semasa penyimpanan pada suhu 4 ° C dan 25 ° C. Keputusan mendapati bahawa marjerin yang dibungkus dalam PE/G60 pada 4 ° C dapat menghalang pengoksidaan lipid selama 28 hari. Bahan dwilapisan mempengaruhi perubahan warna dalam marjerin, tanpa perbezaan yang signifikan ($p > 0.05$) terhadap pH marjerin untuk kedua-dua suhu. Ini menyimpulkan bahawa MPE 5% pada 60 µm sesuai untuk

dikembangkan menjadi filem dwilapisan dan mempunyai potensi sebagai pembungkusan antioksidan untuk produk berlipid tinggi.

ACKNOWLEDGEMENT

Alhamdulillah, praise to Allah S.W.T for providing me the opportunity and granting me the capability to complete this study.

I would like to express my deepest gratitude to my supervisor, Dr. Nur Hanani and my co-supervisors, Prof. Dr. Jamilah and Associate Prof. Dr. Noranizan, who have given a great deal of their time, valuable advices and continuous guidance, which helped me a lot in conducting my research. Special thanks to Mr. Amran for his help and tought me skills and techniques related to laboratory equipments used in this study. Also, I would express my deepest gratitude to all my labmates, Kak Ili, Bel, Maryam, Foong and Syida as well as my friends, Atiqah Riswan, Nina Aznan, Kak Naili and Kak Tiqah for their never ending support and help. Not to forget, to my housemates, Fk, Baiti, Iba, Yatie and Kak Pana for their motivation and as my mood booster for me to work harder.

Last but not least, a heartfelt thanks to my beloved parents for their infinite support, endless encouragement, love and care, which gave me the strength to never give up. May Allah bless us all

I certify that a Thesis Examination Committee has met on 18th April 2018 to conduct the final examination of Nor Adilah binti Abdullah on her thesis entitled "Development of antioxidant bilayer films based on polyethylene, gelatin and fruit peel extracts for food packaging" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

Chong Gun Hean, PhD
Associate Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Chairman)

Rosnita binti A. Talib, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Mohamad Yusof Maskat, PhD
Associate Professor
Faculty of Science and Technology
Universiti Kebangsaan Malaysia
(External Examiner)

____
RUSLI HAJI ABDULLAH, PhD
Professor and Deputy Dean
School of Garduate Studies
Universiti Putra Malaysia

Date: 30 July 2018

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Nur Hanani Zainal Abedin, PhD
Senior Lecturer
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Chairman)

Jamilah Bakar, PhD
Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Member)

Noranizan Mohd Adzahan, PhD
Associate Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Member)

____
ROBIAH BINTI YUNUS, PhD
Professor and Dean
School of Garduate Studies
Universiti Putra Malaysia

Date:

Declaration by graduate student

I hereby confirm that:

- this thesis is my original work;
- quotations, illustrations and citations have been duly referenced;
- this thesis has not been submitted previously or concurrently for any other degree at any other institutions;
- intellectual property from the thesis and copyright of thesis are fully-owned by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- written permission must be obtained from supervisor and the office of Deputy Vice-Chancellor (Research and Innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceedings, popular writings, seminar papers, manuscripts, posters, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- there is no plagiarism or data falsification/fabrication in the thesis, and scholarly integrity is upheld as according to the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) and the Universiti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software.

Signature: ________________ Date: ________________

Name and Matric No.: Nor Adilah binti Abdullah GS42241

Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

Signature : ______________________

Name of Chairman of Supervisory Committee : Dr. Nur Hanani bt Zainal Abedin

Signature : ______________________

Name of Member of Supervisory Committee : Prof. Dr. Jamilah bt Bakar

Signature : ______________________

Name of Member of Supervisory Committee : Assoc. Prof. Dr. Noranizan Mohd Adzahan

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

%	Percentage
°C	Degree celsius
µl	Microliter
µm	Micrometer
BHA	Butylated hydroxyanisole
BHT	Butylated hydroxytoluene
DPPH	2,2-diphenyl-1-picrylhidrazine
EAB	Elongation at break
FFS	Film forming solution
FG	Fish gelatin
GAE	Gallic acid equivalent
g	Gram
HDPE	High-density polyethylene
h	Hour
JPE	Jackfruit peel extracts
kPa	Kilopascal
LDPE	Low-density polyethylene
LLDPE	Linear low-density polyethylene
mg	miligram
ml	Milliliter
mM	miliMolar
mm	Millimeter
MPa	Milipascal
MPE	Mango peel extracts
PE	Polyethylene
PPE	Pineapple peel extracts
PV	Peroxide value
RH	Relative humidity
RSA	Radical scavenging activity
SEM	Scanning electron microscopy
TBARS	Thiobarbituric acid reactive substances
TPC	Total phenolic content
TS	Tensile strength
UV	Ultraviolet
w/v	Weight per volume
w/w	Weight per weight
WVP	Water vapor permeability
YPE	Papaya peel extracts

CHAPTER 1

INTRODUCTION

Food processing and agricultural practices produce billions of tons of agricultural by-products (Baiano, 2014). Agricultural by-products can be classified into crop residues and agro-industrial residues. Crop residues usually comprise the non-edible components of harvested plants, while agro-industrial residues are constituents like peels, hulls, pomace, corn cobs, and others which are obtained after processing of the main components (Mande, 2005). Most of these by-products are considered to be non-beneficial; hence they are disposed at landfills or utilized for feedstock and composting. However, the increase in generated waste by the year could have an impact on the limited amount of land for waste disposal and eventually cause environmental pollution. Thus, the exploitation of agricultural by-products seems to be a promising method to reduce the burden on landfills. It is said that such wastes contain valuable components such as fiber, flavor compounds, phytochemicals, polysaccharides, and proteins, all of which can be used as functional ingredients in nutritional and pharmacological products (Baiano, 2014). In the past few years, various studies have focused on agricultural wastes as renewable bioactive natural products (Lai et al., 2017; Baiano, 2014; Kammerer, Kammerer, Valet & Carle, 2014; Abdullah, Zulkifli, Abdullah, Aziman & Kamarudin, 2012; Ayala-Zavala, Vega-vega, Rosas-domínguez, Palafox-carlos & Villa-rodriguez, 2011).

The demand for safer natural antioxidants to replace artificial ones is increasing. Nowadays, consumers prefer a minimal amount of synthetic additives in their food due to concerns over the adverse effects towards their health. Over the past few years, synthetic antioxidants such as butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) have been widely used in the food industry to prevent the deterioration of food products by lipid oxidation or microbial action. Therefore, natural additives in the form of extracts and essential oils are a few alternatives to be exploited. While the addition of natural antioxidants to food is non-hazardous to health, this process may alter the quality, flavor, taste, and smell of the food product. Subsequently, the consumers' preferences for the product may change. To prevent this drawback, the food packaging industry has developed new packaging systems such as active and intelligent packaging to retain the quality of the food products.

Gelatin films have been widely used in film-processing as they are an excellent barrier to volatile compounds, UV light, and gases. Gelatin is derived from a protein called collagen, and can be obtained from animal by-products through acidic or alkaline hydrolysis. The most abundant sources of gelatin are pig skin (46%), bovine hide (29.4%), as well as pig and cattle bones (23.1%) (Gómez-Guillén, Giménez, López-Caballero & Montero, 2011). Marine fish species are increasingly receiving attention from researchers as they can potentially replace the gelatin of mammalian species in light of halal, vegetarian, and kosher issues. Fish gelatin is an inexpensive major by-product of the fish-processing industry. It can be extracted from the bones and skins of the fishes. The abundance of these wastes cause pollution, so their valorization can allow them to be used as a valuable source of gelatin (Uranga, Leceta, Extabide, Huerrero & de la Caba, 2016; Hosseini, Rezaei, Zandi & Farahmandghavi, 2013; Badii & Howell, 2006). Moreover, fish gelatin has good film-forming abilities, and is also one of the first materials to be proposed as carriers of bioactive components (Gómez-Guillén et al., 2011). Furthermore, the formation of gelatin films is relatively simple and does not involve particular condition to produce (by casting method or extrusion) and for drying (Nur Hanani, Roos & Kerry, 2014). However, the drawback of gelatin film is that it has poor water vapor permeability. Therefore, several approaches like the production of bi- or multi-layers, crosslinking of chemicals, or blending of biopolymers are used to improve the properties of the films (Uranga et al., 2016).

The development of food packaging via the incorporation of active compounds into packaging materials, packed products, or their surrounding conditions - which is referred to as 'active packaging' - has been and is still ongoing (Realini & Marcos, 2014; Camo, Beltrán, & Roncalés, 2008). This innovation has generated interest among researchers due to the need to prolong the shelf life, better maintain the quality and safety, as well as enhance the organoleptic properties of food. Moreover, active packaging methods which are based on environmentally-friendliness and natural preservatives could be a better option to overcome health concerns and environmental issues (Park et al., 2012; Suppakul, Miltz, Sonneveld & Bigger, 2003; Appendini & Hotchkiss, 2002). The inclusion of natural compounds or extracts (from essential oils, plants, and agricultural wastes) as additives in biopolymer matrices has been investigated to improve the properties and provide novelty to the films (Valdés, Mellinas, Ramos, Garrigós & Jiménez, 2014). More importantly, the inclusion of these additives in polymer matrices may prolong the shelf life of the food products. The migration and slow release of antioxidants into the foodstuffs reduces their oxidation and spoilage (Manzanarez-López et al., 2011).

Plastics, which are valued over paper, cardboard, metal, glass, and other materials, are widely used as packaging materials. The most common type of polymer for plastic packaging is polyethylene (PE). PE plastics like low-density PE (LDPE), high-density PE (HDPE), and linear low-density PE (LLDPE) are generally used in food packaging. PE is the most favorable packaging material in light of its low price, ease of processing, and broad range of properties (Lokensgard, 2008). PE plastics are excellent barriers to water vapor barrier but poor barriers to gas. Therefore, these types of plastics are not suitable for oxidation-sensitive food products. The development of the barrier properties of PE films along with other materials such as gelatin-based films to form bi- or multi-layer films seems to be a promising method to enhance the properties of PE films.

An increase in 'green' consumerism - that which prefers natural ingredients over synthetic substances - is a desirable occurrence whereby valuable components from food and agricultural wastes are recovered. The wastes contain health-promoting components such as phenolic compounds, dietary fiber, and proteins (Lai et al., 2017). Active compounds are mostly used in food fortification. However, the usage of natural antioxidants releases their own odors and flavors that could alter the sensory properties of food if directly incorporated into the food. Thus, other approaches such as the development of active packaging using by-products as natural active substances in the film matrices - have been taken to help reduce this problem and at the same time maintain the quality of the food products. Besides, a combination of two different types of polymers is expected to improve the barrier properties of the films and protection of the food. In this study, agricultural waste (specifically, fruit peels) was extracted and used as a source of active compounds. The active components were added to the gelatin film-forming solution (FFS) which acted as an active compound carrier. Then, the gelatin-based film was coated on an existing PE film to produce a bilayer active packaging material. The bilayer film was expected to have antioxidant ability, lower permeability, improved light barrier and transparency. Finally, the bilayer film was applied to food products to determine the effectiveness of the film as packaging material. The objectives of this study were:

1) to study the effect of different peel extracts on the physical, mechanical and antioxidant properties of fish gelatin-based films.

2) to evaluate the effectiveness of bilayer films based on polyethylene/gelatin (PE/G) films on the physical and functional properties.

3) to determine the effect of active packaging composed of bilayer films on the quality of margarine during storage.

REFERENCES

Abbasi, A. M., Guo, X., Fu, X., Zhou, L., & Chen, Y. (2015). Comparative assessment of phenolic content and in vitro antioxidant capacity in the pulp and peel of mango cultivars. *International Journal of Molecular Sciences,16,* 13507–13527.

Abdelhedi, O., Nasri, R., Jridi, M., Kchaou, H., Nasreddine, B., Karbowiak, T., & Nasri, M. (2018). Composite bioactive films based on smooth-hound viscera proteins and gelatin: Physicochemical characterization and antioxidant properties. *Food Hydrocolloids*, *74*, 176–186.

Abdul Aziz, N. A., Wong, L. M., Bhat, R., & Cheng, L. H. (2012). Evaluation of processed green and ripe mango peel and pulp flours (*Mangifera indica* var. Chokanan) in terms of chemical composition, antioxidant compounds and functional properties. *Journal of the Science of Food and Agriculture*, *92*(3), 557–563.

Abdul Hamid, A., Shah, Z., Muse, R., & Mohamed, S. (2003). Characterization of antioxidative activities of various extracts of *Centella asiatica* (L) Urban. *Food Chemistry, 77,* 465-469.

Abdullah, N., Zulkifli, K. S., Abdullah, A., Aziman, N., & Kamarudin, W. S. S. W. (2012). Assessment on the antioxidant and antibacterial activities of selected fruit peels. *International Journal of ChemTech Research*, *4*(4), 1534–1542.

Addai, Z. R., Abdullah, A., Mutalib, S. A., & Musa, K. H. (2013). Antioxidant activity and physicochemical properties of mature papaya fruit (*Carica papaya L*. cv. Eksotika). *Advance Journal of Food Science and Technology, 5*(7), 859–865.

Aguirre-Joya, J. A., De Leon-Zapata, M., Alvarez-Perez, O. B., Torres-León, C., Nieto-Oropeza, D., Ventura-Sobrevilla, J. M., Aguilar, M. A., Ruelas-Chacón, X., Rojas, R., Ramos-Aguiña, M. E., & Aguilar, C. N. (2018). Basic and applied concepts of edible packaging for foods. In A. M.Grumezescu & A. M. Holban (Eds.), *Handbook of Food Bioengineering: Food Packaging and Preservation (Volume 9)* (pp. 1-63). Oxford, UK: Academic Press.

Ahmad, M., Hani, N. M., Nirmal, N. P., Fazial, F. F., Mohtar, N. F., & Romli, S. R. (2015). Optical and thermo-mechanical properties of composite films based on fish gelatin/rice flour fabricated by casting technique. *Progress in Organic Coatings, 84,* 115–127.

Ajila, C. M., Jaganmohan Rao, L., & Prasada Rao, U. J. S. (2010). Characterization of bioactive compounds from raw and ripe *Mangifera indica L*. peel extracts. *Food and Chemical Toxicology, 48*(12), 3406–3411.

Ajila, C. M., Naidu, K. A., Bhat, S. G., & Rao, U. J. S. P. (2007). Bioactive compounds and antioxidant potential of mango peel extract. *Food Chemistry*, *105*(3), 982–988.

Akhtar, M. J., Jacquot, M., Arab-Tehrany, E., Gaïani, C., Linder, M., & Desobry, S. (2010). Control of salmon oil photo-oxidation during storage in HPMC packaging film: Influence of film colour. *Food Chemistry*, *120*(2), 395–401.

Alemán, A., Giménez, B., Pérez-Santin, E., Gómez-Guillén, M. C., & Montero, P. (2011) Squid gelatin hydrolysates with antihypertensive, anticancer and antioxidant activity. *Food Research International*, *44*(4), 1044–1051.

Alexandre, E. M. C., Lourenço, R. V., Bittante, A. M. Q. B., Moraes, I. C. F., & Sobral, P. J. A. (2016). Gelatin-based films reinforced with montmorillonite and activated with nanoemulsion of ginger essential oil for food packaging applications. *Food Packaging and Shelf Life*, *10*, 87-96.

Ali, J., Md, S., Baboota, S., & Sahni, J. K. (2012). Polymeric Nanoparticles, Magnetic Nanoparticles and Quantum Dots: Current Future Perspectives. In E. B. Souto (Ed.), *Patenting nanomedicines* (pp. 107-110). Berlin: Springer.

Alparslan, Y., Yapici, H. H., Metin, C., Baygar, T., Günlü, A., & Baygar, T. (2016). Quality assessment of shrimps preserved with orange leaf essential oil incorporated gelatin. *LWT - Food Science and Technology*, *72*, 457–466.

American Plastic Council (1997). Understanding plastic film: its uses, benefits and waste management options. *American Plastics Council by Headly Pratt Consulting*. Retrieved 13 March 2017 from https://plastics.americanchemistry.com/Understanding-Plastic-Film/.

Anbinder, P. S., Peruzzo, P. J., Martino, M. N., & Amalvy, J. I. (2015). Effect of antioxidant active films on the oxidation of soybean oil monitored by fourier infrared spectroscopy. *Journal of Food Engineering, 151*, 43-50.

Andrea, G. D. (2015). Quercetin: A flavonol with multifaceted therapeutic applications?. *Fitoterapia*, *106,*256-271.

APAARI (2012). *Jackfruit improvement in the asia-pacific region – a status report.* Bangkok, Thailand: Asia-Pacific Association of Agricultural Research Institutions.

Appendini, P., & Hotchkiss, J. H. (2002). Review of antimicrobial food packaging. *Innovative Food Science and Emerging Technologies*, *3*(2), 113–126.

Arulmozhi, V., Pandian, K., & Mirunalini, S. (2013). Ellagic acid encapsulated chitosan nanoparticles for drug delivery system in human oral cancer cell line (KB). *Colloids and Surfaces B: Biointerfaces*, *110*, 313–320.

Arvanitoyannis, I. S., & Kotsanopoulos, K. V. (2014). Migration phenomenon in food packaging. Food package interactions, mechanisms, types of migrants, testing and relative legislation - A review. *Food and Bioprocess Technology*, *7*(1), 21–36.

Aschemann-Witzel, J., de Hooge, I., Amani, P., Bech-Larsen, & T., Oostindjer, M. (2015). Consumer related food waste: causes and potential for action. *Sustainability, 7*, 6457–6477.

Aslam, H. K. W., Raheem, M. I. U., Ramzan, R., Shakeel, A., Shoaib, M., & Sakandar, H. A. (2014). Utilization of mango waste material (peel, kernel) to enhance dietary fiber content and antioxidant properties of biscuit. *Journal of Global Innovation in Agricultural and Social Sciences, 2*(2), 76-81.

ASTM (2010). ASTM C162-05, Standard terminology of glass and glass products, ASTM International, West Conshohocken, Philadelphia. Retrieved 14 April 2017 from www.astm.org.

ASTM. (1990). Standard test methods for water vapour transmission of materials. Designation: E96-9. In *Annual Book of American Standards Testing Methods Standard* (pp. 834-841), Philadelphia.

Atarés, L., & Chiralt, A. (2016). Essential oils as additives in biodegradable films and coatings for active food packaging. *Trends in Food Science and Technology*, *48*, 51–62.

Ayala-zavala, J. F., Vega-vega, V., Rosas-domínguez, C., Palafox-carlos, H., & Villa-rodriguez, J. A. (2011). Agro-industrial potential of exotic fruit by-products as a source of food additives. *Food Research International*, *44*(7), 1866–1874.

Ayala-Zawala, J. F., Rosas-Domínguez, C., Vega-Vega, V., & González-Aguilar, G. A. (2010). Antioxidant enrichment and antimicrobial protection of fresh-cut fruits using their own by-products: looking for integral exploitation. *Journal of Food Science, 75*(8), 175-181.

Badhani B., Sharma, N., & Kakkar, R. (2015). Gallic acid: a versatile antioxidant with promising therapeutic and industrial applications. *RSC Advances, 5*, 27540–27557.

Badii, F., & Howell, N. K. (2006). Fish gelatin: structure, gelling properties and interaction with egg albumen proteins. *Food Hydrocolloids*, *20,* 630-640.

Baiano, A. (2014). Recovery of biomolecules from food wastes - a review. *Molecules*, *19*(9), 14821–14842.

Bardiya, N., Somayaji, D. & Khanna, S. (1996). Biomethanation of banana peel and pineapple waste. *Bioresources Technology. 58*, 73-76.

Barlow, C. Y., & Morgan, D. C. (2013). Polymer film packaging for food: an environmental assessment. *Resources, Conservation and Recycling*, *78*, 74–80.

Barreto, J. C., Trevisan, M. T. S., Hull, W. E., Erben, G., De Brito, E. S., & Pfundstein, B. (2008). Characterization and quantitation of polyphenolic compounds in bark, kernel, leaves, and peel of mango (*Mangifera indica* L.). *Journal of Agricultural and Food Chemistry, 56,* 5599–5610.

Bastarrachea, L., Wong, D., Roman, M., Lin, Z., & Goddard, J. (2015). Active packaging coatings. *Coatings*, *5*(4), 771–791.

Berardini, N., Knödler, M., Schieber, A., & Carle, R. (2005). Utilization of mango peels as a source of pectin and polyphenolics. *Innovative Food Science and Emerging Technologies*, *6*(4), 442–452.

Bitencourt, C. M., Fávaro-Trindade, C. S., Sobral, P. J. A., & Carvalho, R. A. (2014). Gelatin-based films additivated with curcuma ethanol extract: antioxidant activity and physical properties of films. *Food Hydrocolloids*, *40,* 145–152.

Biworo, A. (2015). Antidiabetic and antioxidant activity of jackfruit (*Artocarpus Heterophyllus*) extract. *Journal of Medical and Bioengineering*, *4*(4), 318–323.

Blanco, M., Sotelo, C. G., Chapela, M. J., & Perez-Martin, R. I. (2007). Towards sustainable and efficient use of fishery resources: present and future trends. *Trends in Food Science and Technology, 18,* 29-36.

Bolumar, T., Andersen, M. L., & Orlien, V. (2011). Antioxidant active packaging for chicken meat processed by high pressure treatment. *Food Chemistry, 129*(4), 1406–1412.

Bolumar, T., Lapeña, D., Skibsted, L. H., & Orlien, V. (2016). Rosemary and oxygen scavenger in active packaging for prevention of high-pressure induced lipid oxidation in pork patties. *Food Packaging and Shelf Life, 7*, 26–33.

Bonilla, J., & Sobral, P. J. A. (2016). Investigation of the physicochemical, antimicrobial and antioxidant properties of gelatin-chitosan edible film mixed with plant ethanolic extracts. *Food Bioscience*, *16*, 17–25.

Boulekbache-Makhlouf, L., Slimani, S., & Madani, K. (2013). Total phenolic content, antioxidant and antibacterial activities of fruits of Eucalyptus globules cultivated in Algeria. *Industrial Crops and Products, 41*, 85-89.

Brooks, D. (2000). Types of plastic materials, barrier properties and applications. In D.R. Bain & G.A. Giles (Eds.), *Materials and Development of Plastics Packaging for the Consumer Market* (pp. 16-45). Sheffield, UK: Academic Press.

Busolo, M. A., & Lagaron, J. M. (2015). Antioxidant polyethylene films based on a resveratrol containing clay of interest in food packaging applications. *Food Packaging and Shelf Life*, *6*, 30–41.

Calvache, J. N., Cueto, M., Farroni, A., de Esclada Pla, M., & Gerschenon, L. N. (2016). Antioxidant characterization of new dietary fiber concentrates from papaya pulps and peel (*Carica papaya* L.). *Journal of Functional Foods, 27,* 319-328.

Camo, J., Beltrán, J. A., & Roncalés, P. (2008). Extension of the display life of lamb with an antioxidant active packaging. *Meat Science*, *80*(4), 1086–1091.

Cao, N., Fu, Y., & He, J. (2007). Mechanical properties of gelatin films cross-linked, respectively, by ferulic acid and tannin acid. *Food Hydrocolloids*, *21*(4), 575–584.

Caroline, A., Rosemary, A. C., Tomás, G., Fernando, M., & Carlos, R. F. G. (2011). Effect of surfactants on the functional properties of gelatin-based edible films. *Journal of Food Engineering, 103*,129-136.

Carrizo, D., Taborda, G., Nerín, C., & Bosetti, O. (2016). Extension of shelf life of two fatty foods using a new antioxidant multilayer packaging containing green tea extract. Innovative *Food Science and Emerging Technologies, 33*, 534–541.

Chan, Y. K. (2009). Breeding papaya (*Carica papaya* L.). In S.M. Jain & P.M. Priyadarshan (Eds.), *Breeding Plantation Tree Crops: Tropical Species* (pp. 121-159). New York, USA: Springer.

Chan,Y. K., & Paull, R. E. (2008). *Caricaceae*. In J. Janick & R.E. Paull (Eds.), *The Encyclopaedia of Fruit & Nuts* (pp. 237-247). Wallingford, UK: CAB International.

Chang, N., Zhang, C., Zheng, F., Huang, Y., Zhu, J., Zhou, Q., & Ji, S. (2016). Migration of toluene through different plastic laminated films into food simulants. *Food Control*, *59*, 164–171.

Chen, X. Q., Zhang, Y., Zu, Y. G., Yang, L., Lu, Q., & Wang, W. (2014). Antioxidant effects of rosemary extracts on sunflower oil compared with synthetic antioxidants. *International Journal of Food Science and Technology, 49*, 385–391.

Choonpicharn, S., Jaturasitha, S., Rakariyatham, N., Suree, N., & Niamsup, H. (2014). Antioxidant and antihypertensive activity of gelatin hydrolysate from Nile tilapia skin. *Journal of Food Science and Technology*, *52*(5), 3134–3139.

Colín-Chávez, C., Soto-Valdez, H., & Peralta, E. (2014). Diffusion of carotenoids from mono- and bilayer polyethylene active packaging into soybean oil. *Food Packaging and Shelf Life*, *1*(2), 170–178.

Contini, C., Katsikogianni, M. G., O'Neill, F. T., O'Sullivan, M., Dowling, D. P., & Monahan, F. J. (2012). PET trays coated with citrus extract exhibit antioxidant activity with cooked turkey meat. *LWT – Food Science and Technology*, *47*(2), 471–477.

Contini, C., Katsikogianni, M. G., O'Neill, F. T., O'Sullivan, M., Dowling, D. P., & Monahan, F. J. (2014). Mechanism of action of an antioxidant active packaging prepared with citrus extract. *LWT – Food Science and Technology, 59, 2*, 1082–1087.

Costa, S. S., Druzian, J. I., Machado, B. A. S., De Souza, C. O., & Guimaraes, A. G. (2014). Bi-functional biobased packing of the cassava starch, glycerol, licuri nanocellulose and red propolis, *PloS ONE, 9*(11), 1-10.

Da Silva, L. M. R., De Figueiredo, E. A. T., Ricardo, N. M. P. S., Vieira, I. G. P., De Figueiredo, R. W., Brasil, I. M., & Gomes, C. L. (2014). Quantification of bioactive compounds in pulps and by-products of tropical fruits from Brazil. *Food Chemistry*, *143*, 398–404.

da Trindade Alfaro, A., Balbinot, E., Weber, A. I., Tonial, I. B., & Machado-lunkes, A. (2015). Fish gelatin: characteristics, functional properties, applications and future potentials, *Food Engineering Review, 7*, 33–44.

da Trindade Alfaro, A., Fonseca, G. G., & Prentice-Hernández, C. (2013). Enhancement of functional properties of Wami tilapia (*Oreochromis urolepis hornorum*) skin gelatin at different pH values. *Food and Bioprocess Technology*, *6*(8), 2118–2127.

da Trindade Alfaro, A., Fonseca, G. G., Balbinot, E., Machado-lunkes, A., & Prentice, C. (2013). Physical and chemical properties of Wami tilapia skin gelatin, *Food Science and Technology, 33*(3), 592–595.

Dash, M., Chiellini, F., Ottenbrit, R. M., & Chiellini, E. (2011). Chitosan– a versatile semi-synthetic polymer in biomedical applications. *Progress in Polymer Science, 36*(8), 981–1014.

Day, B.P.F., & Potter, L. (2011). Active Packaging. In R. Coles & M. Kirwan (Eds.), *Food Beverage Packaging Technology, 2nd edition* (pp. 251-261). Oxford, UK: Wiley-Blackwell.

De Azaredo, C. M. H. (2009). Nanocomposites for food packaging applications. *Food Research International, 42,* 1240–1253.

De Faria A. F., De Rosso, V. V., & Mercadante, A. Z. (2009). Carotenoid composition of jackfruit (*Artocarpus heterophyllus*) determined by HPLC-PDA-MS/MS. *Plant Foods for Human Nutrition, 64*, 108–15.

de Moraes Crizel, T., Haas Costa, T. M., de Oliveira Rios, A., & Hickmann Flôres, S. (2016). Valorization of food-grade industrial waste in the obtaining active biodegradable films for packaging. *Industrial Crops and Products*, *87*, 218–228.

de Oliveira, J. G., & Vitória, A. P. (2011). Papaya: nutritional and pharmacological characterization, and quality loss due to physiological disorders: an overview. *Food Research International*, *44*(5), 1306–1313.

Deng, Q., & Zhao, Y. (2011). Physicochemical, nutritional, and antimicrobial properties of wine grape (cv. Merlot) pomace extract-based films. *Journal of Food Science*, *76*(3), 309–317.

Department of Agricultural Malaysia (2016). Fruit crops statistic. Retrieved: 18 March 2017 from http://www.doa.gov.my/index.

Devitt, L. C., Sawbridge, T., Holton, T. A., Mitchelson, K., & Dietzgen, R. G. (2006). Discovery of genes associated with fruit ripening in *Carica* papaya using expressed sequence tags. *Plant Science, 170*, 356−363.

Dey, T. B., Chakraborty, S., Jain, K. K., Sharma, A., & Kuhad, R. C. (2016). Antioxidant phenolics and their microbial production by submerged and solid state fermentation process: a review. *Trends in Food Science and Technology, 53,* 60-74.

Ding, P., & Darduri, K. B. (2013). Morphology of Chokanan mango flower grown in Malaysia. *African Journal of Agricultural Research*, *8*(18), 1877–1880.

Dorta, E., & Sogi, D. S. (2016). Value added processing and utilization of pineapple by-products. In M. G. Lobo & R. E. Paull (Eds.), *Pineapple Technology: Production, Postharvest Science, Processing and Nutrition* (pp. 196-220). Chichester, UK: John Wiley & Sons.

Dorta, E., González, M., Lobo, M. G., Sánchez-Moreno, C., & de Ancos, B. (2014). Screening of phenolic compounds in by-product extracts from mangoes (*Mangifera indica* L.) by HPLC-ESI-QTOF-MS and multivariate analysis for use as a food ingredient. *Food Research International*, *57,* 51–60.

Eke-Ejiofor, J., & Owuno, F. (2013) The physico-chemical and sensory properties of jackfruit (*Artocarpus Heterophilus*) Lam. *International Journal of Nutrition and Food Sciences, 2*(3), 149-152.

Elango, J., Robinson, J. S., Arumugam, V., Geevaretnama, J., & Durairaj, S. (2015). Mechanical and barrier properties of multi-composite shark catfish (*Pangasius fungaseous*) skin gelatin films with the addition of sorbitol , clay and chitosan using response surface methodology. *Jounal of Molecular and Genetic Medicine,* S4:004.

El-Shourbagy, G. A., & El-Zahar, K. M. (2014). Oxidative stability of ghee as affected by natural antioxidants extracted from food processing wastes. *Annals of Agricultural Sciences*, *59*(2), 213–220.

Esmaeilifard, N., Bahmaei, M., & Eshratabadi, P. (2016). Original article comparison of physicochemical characteristics of some margarines and butters in iranian market during storage. *Journal of Pharmaceutical and Health Sciences*, *4*(3), 181–192.

Etxabide, A., Uranga, J., Guerrero, P., & de la Caba, K. (2016). Development of active gelatin films by means of valorisation of food processing waste: a review. *Food Hydrocolloids*. *68,* 192-198.

European Comission Regulation No 450/2009. Active and intelligent materials and articles intended to come into contact with food. Retrieved May 2018.

Fagundes, G. R., & Yamanishi, O. K. (2001). Physical and chemical characteristics of fruits of papaya tree from *solo* group commercialized in 4 establishments in Brasilia-DF. *Revista Brasileira de Fruticultura, 23*(3), 541−545.

FAOSTAT (2016). Food and Agriculture Organization of the United Nations. FAO Statistic Division. Retrieved 14 April 2017 from http://www.fao.org/faostat/en/#data/QC.

Farris, S., Introzzi, L., & Piergiovanni, L. (2009). Evaluation of a biocoating as a solution to improve barrier, friction and optical properties of plastic films. *Packaging Technology and Science*, *22,* 69–83.

Food Regulations (1985). Part VIII – Standards and particular labelling requirements for food. Retrieved 27 September 2017 from http://fsq.moh.gov.my/fsq/ms/185-margerine/.

Fuggate, P., Wongs-Aree, C., Noichinda, S., & Kanlayanarat, S. (2010). Quality and volatile attributes of attached and detached *Pluk Mai Lie* papaya during fruit ripening. *Scientia Horticulturae, 126,* 120−129.

Galotto, M., & Ulloa, P. (2010). Effect of high-pressure food processing on the mass transfer properties of selected packaging materials. *Packaging and Technology and Science*, *26*, 253–266.

Ganiari, S., Choulitoudi, E., & Oreopoulou, V. (2017). Edible and active films and coatings as carriers of natural antioxidants for lipid food. *Trends in Food Science and Technology*, *68*, 70–82.

Gayosso-García Sancho, L. E., Yahia, E. M., & González-Aguilar, G. A. (2013). Contribution of major hydrophilic and lipophilic antioxidants from papaya fruit to total antioxidant capacity. *Food and Nutrition Sciences*, *4*, 93–100.

Gehring, C. K., Gigliotti, J. C., Moritza, J. S., Tou, J. C., & Jaczynski (2011). Functional and nutritional characteristics of proteins and lipids recovered by isoelectric processing of fish by-products and low-value fish: a review. *Food Chemistry, 124*, 422-431.

Giada, M. D. L. R. (2013). Food Phenolic Compounds: Main Classes, Sources And Their Antioxidant Power. In A. M. José (Ed.), *Oxidative Stress and Chronic Degenerative Diseases - A Role for Antioxidants* (pp. 87–112). Rijeka, Croatia: InTech.

Giteru, S. G., Coorey, R., Bertolatti, D., Watkin, E., Johnson, S., & Fang, Z. (2015). Physicochemical and antimicrobial properties of citral and quercetin incorporated kafirin-based bioactive films. *Food Chemistry*, *168*, 341–347.

Glass Packaging Institute (2017). Benefits of glass packaging. Retrieved 29 September 2016 from http://www.gpi.org/learn-about-glass/benefits-glass-packaging.

Gnanasaraswathi, M., Lakshmipraba, S., Rajadurai Jesudoss, R. P., Abhinayashree, M., Fathima Beevi, M., Aarthi Lakshmipriya, V., & Kamatchi, S. (2014). Potent antioxidant behaviour of citrus fruit peels and their bactericidal activity against multi drug resistant organism *Pseudomonas aeruginosa. Journal of Chemical and Pharmaceutical Sciences, 2,* 139–144.

Gómez-Estaca, J., Bravo, L., Gómez-Guillén, M. C., Alemán, A., & Montero, P. (2009). Antioxidant properties of tuna-skin and bovine-hide gelatin films induced by the addition of oregano and rosemary extracts. *Food Chemistry*, *112*(1), 18–25.

Gómez-Estaca, J., Gómez-Guillén, M. C., Fernández-Martín, F., & Montero, P. (2011). Effects of gelatin origin, bovine-hide and tuna-skin on the properties of compound gelatin-chitosan films. *Food Hydrocolloids*, *25*(6), 1461–1469.

Gómez-Estaca, J., López-de-Dicastillo, C., Hernández-Muñoz, P., Catalá, R., & Gavara, R. (2014). Advances in antioxidant active food packaging. *Trends in Food Science and Technology*, *35*(1), 42–51.

Gómez-Guillén, M. C., Giménez, B., López-Caballero, M. E., & Montero, M. P. (2011). Functional and bioactive properties of collagen and gelatin from alternative sources: a review. *Food Hydrocolloids, 25*(8), 1813–1827.

Gómez-Guillén, M. C., Ihl, M., Bifani, V., Silva, A., & Montero, P. (2007). Edible films made from tuna-fish gelatin with antioxidant extracts of two different murta ecotypes leaves (*Ugni molinae Turcz*). *Food Hydrocolloids, 21*(7), 1133–1143.

Gómez-Guillén, M. C., López-Caballero, M.E., Alemán, A., López de Lacey, A., Giménez, B., & Montero, P. (2010). Antioxidant and antimicrobial peptide fractions from squid and tuna skin gelatin. *Sea By-products as Real Material*, *661*(2), 89–115.

Gómez-Guillén, M.C., Turnay, J., Fernández-Diaz, M.D., Ulmo, N., Lizarbe, M.A., & Montero, P., (2002). Structural and physical properties of gelatin extracted from different marine species: A comparative study. *Food Hydrocolloids, 16* (1), 25– 34.

Guadipati, V. (2013). Fish Gelatin: A Versatile Ingredient For The Food and Pharmaceutical Industries. In S. K. Kim (Ed.), *Marine PROTEINS and Peptides-Biological Activities and Applications* (pp. 271-295). West Sussex, UK: John Wiley & Sons Ltd.

Gustavsson, J., Cederberg, C., Sonesson, U., van Otterdijk, R., & Meybeck, A. (2011). Global Food Losses and Food Waste. Extend, Causes and Prevention. Rome: Food and Agriculture Organization of the United Nations. Retrieved: 14 April 2017 from http://www.fao.org/fileadmin/user_upload/ ags/publications/GFL_web.pdf.

Ha, J. W., Back, K. H., Kim, Y. H., & Kang, D. H. (2016). Efficacy of UV-C irradiation for inactivation of food-borne pathogens on sliced cheese packaged with different types and thicknesses of plastic films. *Food Microbiology*, *57*, 172–177.

Hameed, B. H. (2009). Removal of cationic dye from aqueous solution using jackfruit peel as non-conventional low-cost adsorbent, *Journal of Hazard Materials, 162*, 344-350.

Hammann, F., & Schmid, M. (2014). Determination and quantification of molecular interactions in protein films: a review. *Materials, 7*, 7975-7996.

Hannon, J. C., Kerry, J. P., Cruz-Romero, M., Azlin-Hasim, S., Morris, M., & Cummins, E. (2016). Assessment of the migration potential of nanosilver from nanoparticle-coated low-density polyethylene food packaging into food simulants. *Food Additives & Contaminants: Part A*, *33*(1), 167-178.

Hauser, C., Peñaloza, A., Guarda, A., Galotto, M. J., Bruna, J. E., & Rodríguez, F. J. (2016). Development of an active packaging film based on a methylcellulose coating containing murta (*Ugni molinae turcz)* leaf extract. *Food and Bioprocess Technology*, *9*(2), 298–307.

Hii, C. L., Ong, S. P., & Law, C. L. (2011). Drying studies of tropical fruits cultivated in Malaysia: a review. *Journal of Applied Aciences, 11*(24), 3815-3820.

Hopkins, E. J., Chang, C., Lam, R. S. H., & Nickerson, M. T. (2015). Effects of flaxseed oil concentration on the performance of a soy protein isolate-based emulsion-type film. *Food Research International, 67,* 418–425.

Hoque, M. S., Benjakul, S., & Prodpran, T. (2010). Effect of heat treatment of film forming solution on the properties of film from cuttlefish (*Sepia pharaonis*) skin gelatine. *Journal of Food Engineering*, *96*, 66-73.

Hoque, M. S., Benjakul, S., & Prodpran, T. (2011). Properties of film from cuttlefish (*Sepia pharaonis*) skin gelatin incorporated with cinnamon, clove and star anise extracts. *Food Hydrocolloids, 25*(5), 1085–1097.

Hosseini, S. F., Rezaei, M., Zandi, M., & Farahmandghavi, F. (2013). Preparation and functional properties of fish gelatin-chitosan blend edible films. *Food Chemistry*, *136*, 1490-1495.

Hosseini, S. F., Rezaei, M., Zandi, M., & Farahmandghavi, F. (2015). Fabrication of bio-nanocomposite films based on fish gelatin reinforced with chitosan nanoparticles. *Food Hydrocolloids*, *44*, 172–182.

Hu, S., Wang, H., Han, W., Ma, Y., Shao, Z., & Li, L. (2016). Development of double-layer active films containing pomegranate peel extract for the application of pork packaging. *Journal of Food Process Engineering*, *40*(2), 1-11.

Ikram, E. H. K., Stanley, R., Netzel, M., & Fanning, K. (2015). Phytochemicals of papaya and its traditional health and culinary uses - a review. *Journal of Food Composition and Analysis*, *41*, 201–211.

Inanc, T., & Maskan, M. (2012). The potential application of plant essential oils/extracts as natural preservatives in oils during processing: a review. *Journal of Food Science and Engineering, 2*, 1–9.

Iqbal, M., Saeed, A., & Zafar, S. I. (2009). FTIR spectrophotometry, kinetics and adsorption isotherms modeling, ion exchange, and EDX analysis for understanding the mechanism of Cd^{2+} and Pb^{2+} removal by mango peel waste. *Journal of Hazardous Materials*, *164*(1), 161–171.

Iqbal, S., & Bhanger, M.I. (2007). Stabilization of sunflower oil by garlic extract during accelerated storage. *Food Chemistry, 100*, 246–254.

Jahurul, M. H. A., Zaidul, I. S. M., Ghafoor, K., Al-Juhaimi, F. Y., Nyam, K. L., Norulaini, N. A. N., & Mohd Omar, A. K. (2015). Mango (*Mangifera indica L.*) by-products and their valuable components: a review. *Food Chemistry*, *183*, 173–180.

Jain, S., & Jayaram, R. V. (2007). Adsorption of phenol and substituted chlorophenols from aqueous solution by activated carbon prepared from jackfruit (*Artocarpus Heterophyllus*) peel-kinetics and equilibrium studies. *Separation Science and Technology, 42,* 2019-2032.

Janjarasskul, T., & Suppakul, P. (2018). Active and intelligent packaging: The indication of quality and safety. *Critical Reviews in Food Science and Nutrition*, *58*(5), 808–831.

Jiang, M., Liu, S., Du, X., & Wang, Y. (2010). Physical properties and internal microstructures of films made from catfish skin gelatin and triacetin mixtures. *Food Hydrocolloids*, *24,* 105–110.

Jridi, M., Hajji, S., Ayed, H. Ben, Lassoued, I., Mbarek, A., Kammoun, M., & Nasri, M. (2014). Physical, structural, antioxidant and antimicrobial properties of gelatin-chitosan composite edible films. *International Journal of Biological Macromolecules*, 67, 373–379.

Kadam, S. U., Pankaj, S. K., Tiwari, B. K., Cullen, P. J., & O'Donnell, C. P. (2015). Development of biopolymer-based gelatin and casein films incorporating brown seaweed *Ascophyllum nodosum* extract. *Food Packaging and Shelf Life*, *6*, 68–74.

Kaewprachu, P., & Rawdkuen, S. (2016). Application of active edible films as food packaging for food preservation and extending shelf life. In N. Garg, S. M. Abdel Aziz & A. Aeron (Eds.), *Microbes in food and health* (pp. 185-205). Berlin, Germany: Springer.

Kammerer, D. R., Kammerer, J., Valet, R., & Carle, R. (2014). Recovery of polyphenols from the by-products of plant food processing and application as valuable food ingredients. *Food Research International*, *65*, 2–12.

Kerry, J. (2012). Aluminium Foil Packaging. In A. Emblem & H. Emblem (Eds.), *Packaging Technology: Fundamentals, Materials and Processes* (pp. 163–177). Cambridge, UK: Woodhead Publisher.

Khanavi, M., Saghari, Z., Mohammadirad, A., Khademi, R., Hadjiakhoondi, A., & Abdollahi, M. (2009). Comparison of antioxidant activity and total phenols of some date varieties. *DARU Journal of Pharmaceutical Sciences, 17*(2), 104-108.

Khanum, R., & Thevanayagam, H. (2017). Lipid peroxidation: its effects on the formulation and use of pharmaceutical emulsions. *Asian Journal of Pharmaceutical Sciences, 12,* 401-411.

Khoddami, A., Wilkes, M. A., & Roberts, T. H. (2013). Techniques for analysis of plant phenolic compounds. *Molecules*, *18*(2), 2328–2375.

Kim, S, K., Kim Y, T., Byun, H. G., Nam, K. S., Joo, D. S., & Shahidi, F. (2001) Isolation and characterization of antioxidative peptides from gelatin hydrolysate of Alaska pollack skin. *Journal of Agricultural and Food Chemistry*, *49*(4).1984–1989.

Kim, Y. T., Min, B., & Kim, K. W. (2014). General characteristics of packaging materials for food system. In J. H. Han (Ed.), *Innovations in Food Packaging, 2nd Edition* (pp. 13-33). CA, USA: Academic Press.

Kittiphoom, S. (2012). Utilization of mango seed. *International Food Research Journal, 19, 1325*-1335.

Koczoñ, P., Gruczyñska, E., & Kowalski, B. (2008). Changes in the acid value of butter during storage at different temperatures as assessed by standard methods or by FT-IR spectroscopy. *American Journal of Food Technology, 3*(3), 154-163.

Kokoszka, S., Debeaufort, F., Lenart, A., & Voilley, A. (2010). Water vapor permeability, thermal and wetting properties of whey protein isolate based edible films. *International Dairy Journal*, *20,* 53–60.

Krinsky, N. I., Landrum, J. T., & Bone, R. A. (2003). Biologic mechanisms of the protective role of lutein and zeaxanthin in the eye. *Annual Review of Nutrition, 23*, 171–201.

Krishna, A., Nindo, I. C., & Min, C. S. (2012). Development of fish gelatin edible films using extrusion and compression molding. *Journal of Food Engineering, 108*(2), 337–344.

Krochta, J. M. (2002). Proteins as Raw Materials For Films and Coatings: Definitions, Current Status, and Opportunities. In A. Gennadios (Ed.), *Protein-based films and coatings* (pp. 1-42). New York, USA: CRC Press.

Kuorwel, K. K., Cran, M. J., Sonneveld, K., Miltz, J., & Bigger, S. W. (2011). Essential oils and their principal constituents as antimicrobial agents for synthetic packaging films. *Journal of Food Science*, *76*(9), 164-177.

Kurek, M., Ščetar, M., Voilley, A., Galić, K., & Debeaufort, F. (2012). Barrier properties of chitosan coated polyethylene. *Journal of Membrane Science*, *403–404,* 162–168.

Lacroix, M., & Vu, K. D. (2014). Edible coating and film materials: Proteins. In J. H. Han (Ed.), *Innovations in food packaging* (pp. 277-294). San Diego, USA: Academic Press.

Lai, W. T., Khong, N. M. H., Lim, S. S., Hee, Y. Y., Sim, B. I., Lau, K. Y., & Lai, O. M. (2017). A review: modified agricultural by-products for the development and fortification of food products and nutraceuticals. *Trends in Food Science and Technology*, *59*, 148–160.

Lawal D. (2013). Medicinal , pharmacological and phytochemical potentials of *Annona comosus* Linn. peel. *Bayero Journal of Pure and Applied Sciences, 6*(1), 101–104.

Lawal, D., Yunusa, & Bala, I. (2013). A study of the phytochemical properties and synergistic antibacterial activity of *Annona comosus* (linn) merr. peel and *citrus senensis* peel extracts on *aeromonas hydrophila* and *salmonella* species. *Bayero Journal of Pure and Applied Sciences*, *6*(61), 40–45.

Lee, C. H., An, D. S., Lee, S. C., Park, H. J., & Lee, D. S. (2004). A coating for use as an antimicrobial and antioxidative packaging material incorporating nisin and α-tocopherol. *Journal of Food Engineering, 62*, 323-329.

Lee, K. Y., Yang, H. J., & Song, K. B. (2016). Application of a puffer fish skin gelatin film containing *Moringa oleifera* Lam . leaf extract to the packaging of Gouda cheese. *Journal of Food Science and Technology*, *53*(11), 3876–3883

Lee, S. Y., Lee, S. J., Choi, D. S., & Hur, S. J. (2015). Current topics in active and intelligent food packaging for preservation of fresh foods. *Journal of the Science of Food and Agriculture*, *95*(14), 2799–2810.

Li, J. H., Miao, J., Wu, J. L., Chen, S. F., & Zhang, Q. Q. (2014). Preparation and characterization of active gelatin-based films incorporated with natural antioxidants. *Food Hydrocolloids*, *37,* 166–173.

Li, T., Shen, P., Liu, W., Liu, Ciu., Liang, R., Yan, N., & Chen, J. (2014). Major phenolics in pineapple peels and their antioxidant interactions. *International Journal of Food Properties, 17*(8), 1805-1817.

Liang, C., Jia, M., Tian, D., Tang, Y., Ju, W., Ding, W., Ding, S., Tian, L., Ren, X., & Wang, X. (2017). Edible sturgeon skin gelatin films: tensile strength and UV light barrier as enhanced by blending with esculine. *Journal of Functional Foods, 37,* 219-228.

Licciardello, F., Wittenauer, J., Saengerlaub, S., Reinelt, M., & Stramm, C. (2015). Rapid assessment of the effectiveness of antioxidant active packaging – study with grape pomace and olive leaf extracts. *Food Packaging and Shelf Life, 6*, 1–6.

Liu, Z., Ge, X., Lu, Y., Dong, S., Zhao, Y., & Zeng, M. (2012). Effects of chitosan molecular weight and degree of deacetylation on the properties of gelatine-based films. *Food Hydrocolloid, 26*(1), 311–317.

Lokensgard, E. (2008*). Industrial plastics: Theory and Applications, 6th Edn* (pp. 15-36). New York, USA: Cengage Learning.

López de Dicastillo, C., Bustos, F., Guarda, A., & Galotto, M. J. (2016). Cross-linked methyl cellulose films with murta fruit extract for antioxidant and antimicrobial active food packaging. *Food Hydrocolloids*, *60*, 335–344.

López, D., Márquez, A., Gutiérrez-Cutiño, M., Venegas-Yazigi, D., Bustos, R., & Matiacevich, S. (2017). Edible film with antioxidant capacity based on salmon gelatin and boldine. *LWT - Food Science and Technology*, *77*, 160–169.

López-Gómez, A., Fernández, P., Palop, A., Periago, P.,Martinez-López, A., & Marin-Iniesta, F. (2009). Food safety engineering: an emergent perspective. *Food Engineering Reviews, 1,* 84–104.

Lorenzo, J. M., Batlle, R., & Gómez, M. (2014). Extension of the shelf-life of foal meat with two antioxidant active packaging systems. *LWT - Food Science and Technology*, *59*(1), 181–188.

Ma, Q., Ren, Y., & Wang, L. (2017). Investigation of antioxidant activity and release kinetics of curcumin from tara gum/polyvinyl alcohol active film. *Food Hydrocolloids*, *70*, 286–292.

Maalihan, R. D., & Pajarito, B. B. (2016). Effect of colorant, thickness, and pro-oxidant loading on degradation of low-density polyethylene films during thermal aging. *Journal of Plastic Film and Sheeting*, *32*(2), 124–139.

Mahdi, Y., Bassiri, A. R., & Branch, V. (2015). Evaluation of the antioxidant potential of fennel seed extract as compared to the synthetic antioxidants in margarine under accelerated storage condition. *Journal of Food Biosciences and Technology, 5*(1), 63–68.

Malaysia Pineapple Industry Board (2016). Origin of pineapple. Retrieved: 19 May 2017 from http://mpib.gov.my/en/asal-usul-nanas.

Malhotra, B., Keshwani, A., & Kharkwal, H. (2015). Antimicrobial food packaging: potential and pitfalls. *Frontiers in Microbiology, 6*(611), 1-9.

Mande, S. (2005). Biomass Gasifier-Based Power Plants: Potential, Problems, and Research Needs for Decentralized Rural Electrification. In B. Lal & M.R.V.P. Reddy (Eds.), *Wealth from Waste: Trends and Technologies* (pp. 1-28). New Delhi, India: The Energy and Resources Institute.

Manzanarez-López, F., Soto-Valdez, H., Auras, R., & Peralta, E. (2011). Release of α-tocopherol from poly(lactic acid) films, and its effect on the oxidative stability of soybean oil. *Journal of Food Engineering, 104*(4), 508–517.

Marcos, B., Sárraga, C., Castellari, M., Kappen, F., Schennink, G., & Arnau, J. (2014). Development of biodegradable films with antioxidant properties based on polyesters containing α-tocopherol and olive leaf extract for food packaging applications. *Food Packaging and Shelf Life, 1*, 140–150

Marina, Z., & Noriham, A. (2014). Quantification of total phenolic compound and in vitro antioxidant potential of fruit peel extracts. *International Food Research Journal*, *21*(5), 1925–1929.

Marsh, K., & Bugusu, B. (2007). Food packaging - roles, materials, and environmental issues: scientific status summary. *Journal of Food Science*, *72*(3), 39-55.

Martins, J.T., Cerqueira, M.A., Vicente, A.A. (2012). Influence of α-tocopherol on physicochemical properties of chitosan-based films. *Food Hydrocolloids*, *27*, 220–227.

Martucci, J. F., & Ruseckaite, R. A. (2010). Biodegradable three-layer film derived from bovine gelatin. *Journal of Food Engineering*, *99*(3), 377–383.

Maryam Adilah, Z. A. & Nur Hanani, Z. A. (2016). Active packaging of fish gelatin films with *Morinda citrifolia* oil. *Food Bioscience, 16,* 66-71.

Maryam Adilah, Z. A., Jamilah, B., & Nur Hanani, Z. A. (2017). Functional and antioxidant properties of protein-based films incorporated with mango kernel extract for active packaging. *Food Hydrocolloids*, *74*, 207-218.

Matkowski, A., Ku, P., Góralska, E., & Wo, D. (2013). Mangiferin – a bioactive xanthonoid , not only from mango and not just antioxidant, *Mini-Reviews in Medicinal Chemistry, 13*,439–455.

Matumoto-Pintro, P. T., Murakami, A. E., Vital, A. C. P., Croge, C., da Silva, D. F., Ospina-Roja, I. C., & Guerra, A. F. Q. G. (2017). Effects of storage time and temperature on lipid oxidation of egg powders enriched with natural antioxidants. *Food Chemistry, 228*, 463–468.

McKeen, L. W. (2013). Introduction to Use of Plastics in Food Packaging. In E. Sina (Ed.), *Plastic Films in Food Packaging – Materials, Technology and Applications* (pp 1-15). Oxford, GB: Elsevier Inc.

Mendes, E., Rajapakse, N., & Kim, S. K. (2005). Antioxidant properties of a radical-scavenging peptide purified from enzymatically prepared fish skin gelatin hydrolysate. *Journal of Agricultural and Food Chemistry, 53*(3), 581–587.

Miao, L., Zhang, Y., Yang, X., Xiao, J., Zhang, H., Zhang, Z., & Jiang, G. (2016). Colored light-quality selective plastic films affect anthocyanin content, enzyme activities, and the expression of flavonoid genes in strawberry (*Fragaria* × *ananassa*) fruit. *Food Chemistry*, *207*, 93–100.

Mihaly Cozmuta, A., Turila, A., Apjok, R., Ciocian, A., Mihaly Cozmuta, L., Peter, A., & Benković, T. (2015). Preparation and characterization of improved gelatin films incorporating hemp and sage oils. *Food Hydrocolloids*, *49*, 144–155.

Mlalila, N., Kadam, D. M., Swai, H., & Hilonga, A. (2016). Transformation of food packaging from passive to innovative via nanotechnology: concepts and critiques. *Journal of Food Science and Technology*, *53*(9), 3395–3407.

Mohajer, S., Rezaei, M., & Hosseini, S. F. (2017). Physico-chemical and microstructural properties of fish gelatin/agar bio-based blend films. *Carbohydrate Polymers*, *157*, 784–793.

Mostafa, U. E. (2013). Phenolic Compounds and antioxidant potential of mango peels and kernels (*Mangifera indica* L.) on the frying oil stability, lipid profile and activity of some antioxidant serum enzymes in rats. *Journal of American Science, 9*(11), 3761-378.

Munteanu, B., Paslaru, E., Zemljic, L., Sdrobis, A., Pricope, G., & Vasile, C. (2014). Chitosan coatings applied to poylethylene surface to obtain food-packaging materials. *Cellulose Chemistry and Thechnology*, *48*, 565–575.

Musso, Y. S., Salgado, P. R., & Mauri, A. N. (2016). Smart edible films based on gelatin and curcumin. *Food Hydrocolloids*, *66*, 8–15.

Nadeem, M., Imran, M., Iqbal, Z., Abbas, N., & Mahmud, A. (2017). Enhancement of the oxidative stability of butter oil by blending with mango (*Mangifera indica* L.) kernel oil in ambient and accelerated oxidation. *Journal of Food Processing and Preservation, 41*(3), 1–10.

Nerín, C. (2010). Antioxidant Active Food Packaging and Antioxidant Edible Films. In E. Decker, R. Elias & D. J. McClements (Eds.), *Oxidation in Foods and Beverages and Antioxidant Applications* (pp. 496–515). Cambridge, UK: Woodhead Publishing Limited.

Nerín, C., Tovar, L., & Salafranca, J. (2008). Behaviour of a new antioxidant active film versus oxidizable model compounds. *Journal of Food Engineering, 84*, 313–320.

Nerín, C., Tovar, L., Djenane, D., Camo, J., Salafranca, J., Beltrán, J. A., & Roncalés, P. (2006). Stabilization of beef meat by new active packaging containing natural antioxidants. *Journal of Agricultural and Food Chemistry, 54*(20), 7840–7846.

Nur Fatin Nazurah, R., & Nur Hanani, Z. A. (2017). Physicochemical characterization of kappa-carrageenan (*Euchema cottoni*) based films incorporated with various plant oils. *Carbohydrate Polymers*, *157*, 1479–1487.

Nur Hanani, Z. A. (2016). Gelatin. *Encyclopedia of Food and Health*, *3*, 191–195.

Nur Hanani, Z. A., Roos, Y. H., & Kerry, J. P. (2012). Use of beef, pork and fish gelatin sources in the manufacture of films and assessment of their composition and mechanical properties. *Food Hydrocolloids, 29*(1), 144–151.

Nur Hanani, Z. A., Roos, Y. H., & Kerry, J. P. (2014). Use and application of gelatin as potential biodegradable packaging materials for food products. *International Journal of Biological Macromolecules, 71*, 94–102.

O'Callaghan, K. (2016). Technologies for the utilisation of biogenic waste in the bioeconomy. *Food Chemistry, 198*, 2–11.

Oreopoulou, V. & Tzia, C. (2007). Utilization of Plant By-products for the Recovery of Proteins, Dietary Fibers, Antioxidants, and Colorants. In V. Oreopoulou & W. Russ

(Eds.), *Utilization of By-Products and Treatment of Waste in the Food Industry* (pp. 209-232). New York, USA: Springer.

Palmeira, S. M. V., Gois, L. M., & Souza, L. D. (2012). Extraction of phenolic compounds from mango peels. *Latin American Applied Research, 42*, 77-81.

Pande, G., Akoh, C. C., & Shewfelt, R. L. (2013). Utilization of enzymatically interesterified cottonseed oil and palm stearin-based structured lipid in the production of trans-free margarine. *Biocatalysis and Agricultural Biotechnology, 2*(1), 76–84.

Parfitt, J., Barthel, M., & Macnaughton, S. (2010). Food waste within food supply chains: quantification and potential for change to 2050. *Philosophical Transactions of the Royal Society B*, *465*, 3065-3081.

Parisi, S. (2013). *Food industry and packaging materials : performance oriented guidelines for users* (pp. 53-79). Shawsbury, UK: Smithers Rapra Technology Ltd.

Park, H. Y., Kim, S. J., Kim, K. M., You, Y. S., Kim, S. Y., & Han, J. (2012). Development of antioxidant packaging material by applying corn-zein to LLDPE film in combination with phenolic compounds. *Journal of Food Science*, *77*(10), 273–279.

Pawar, N., Gandhi, K., Purohit, A., Arora, S., & Singh, R. R. B. (2012). Effect of added herb extracts on oxidative stability of ghee (butter oil) during accelerated oxidation condition. *Journal of Food Science and Technology*, *51*(10), 2727–2733.

Peacock, A. J. (2000). *Handbook of Polyethylene: structures, properties and applications* (pp. 1-25). New York, USA: Marcel Dekker Inc.

Peng, Y., Wu, Y., & Li, Y. (2013). Development of tea extracts and chitosan composite films for active packaging materials. *International Journal of Biological Macromolecules*, *59*, 282–289.

Pereira, D. M., Valentão, P., Pereira, J. A., & Andrade, P. B. (2009). Phenolics: from chemistry to biology. *Molecules*, *14*(6), 2202–2211.

Pérez-Gago, M. B. (2012). Protein-Based Films and Coatings. In E. A. Baldwin, R. D. Hagenmaier & J. Bai (Eds.), *Edible Coatings and Films To Improve Food Quality* (pp. 13–78). Boca Raton, Florida: CRC Press.

Piergiovanni, L., & Limbo, S. (2013). Metal Packaging Materials. In S. Parisi (Ed.), *Food Packaging : Principles and Practice* (pp. 13-21). New York, USA: Springer.

Prakash Maran, J., & Arun Prakash, K. (2015). Process variables influence on microwave assisted extraction of pectin from waste *Carcia papaya* L. peel. *International Journal of Biological Macromolecules, 73,* 202-206.

Prakash, O., Kumar, R., Mishra, A. & Gupta, R. (2009). *Artocarpus heterophyllus* (Jackfruit): an overview. *Pharmacognosy Reviews, 3*(6), 353-358.

Praveena, J., & Estherlydia, D. (2014). Comparative study of phytochemical screening and antixodant capacities of vinegar made from peel and fruit of pineapple (*Ananas Comosus* L.). *International Journal of Pharma and Bio Sciences, 6*(2), 36-52.

Puligundla, P., Obulam, V. S. R., Oh, S. E., & Mok, C. (2014). Biotechnological potentialities and valorization of mango peel waste: a review. *Sains Malaysiana*, *43*(12), 1901–1906.

Qian, Z. J., Jung, W. K., & Kim, S. K. (2008). Free radical scavenging activity of a novel antioxidative peptide purified from hydrolysate of bullfrog skin, *Rana catesbeiana Shaw*. *Bioresource Technology*, *99*(6), 1690–1698.

Raheem, D. (2012). Application of plastics and paper as food packaging materials - an overview. *Emirates Journal of Food and Agriculture*, *25*(3), 177–188.

Rahmani, B., Hosseini, H., Khani, M., Farhoodi, M., Honarvar, Z., Feizollahi, E., & Shojaee-Aliabadi, S. (2017). Development and characterisation of chitosan or alginate-coated low density polyethylene films containing *Satureja hortensis* extract. *International Journal of Biological Macromolecules*. *105*(1), 121-130.

Ramirez, J.E., Zambrano, R., Sepúlveda, B., & Simirgiotis, M.J. (2014). Antioxidant properties and hyphenated HPLC-PDA-MS profiling of Chilean Pica mango fruits (*Mangifera indica* L. cv. piqueño). *Molecules, 19*, 438–458.

Ramos, M., Valdés, A., Beltrán, A., & Garrigós, M. (2016). Gelatin-Based Films and Coatings for Food Packaging Applications. *Coatings*, *6*(4), 41.

Rattaya, S., Benjakul, S., & Prodpran, T. (2009). Properties of fish skin gelatin film incorporated with seaweed extract. *Journal of Food Engineering*, *95*(1), 151–157.

Ravindran, R., & Jaiswal, A. (2016). Exploitation of food industry waste for high- value products. *Trends in Biotechnology, 34*, 58-69.

Rawdkuen, S., Suthiluk, P., Kamhangwong, D., & Benjakul, S. (2012). Mechanical, physicochemical, and antimicrobial properties of gelatin-based film incorporated with catechin-lysozyme. *Chemistry Central Journal*, *6*(1), 1–10.

Realini, C. E., & Marcos, B. (2014). Active and intelligent packaging systems for a modern society. *Meat Science*, *98*(3), 404–419.

Ribeiro, S. M. R., & Schieber, A. (2010). Bioactive compounds in mango (*Mangifera indica* L.). In R. R. Watson & V. R. Preedy (Eds.). *Bioactive Foods in Promoting Health* (pp. 507–523). San Diego, CA, USA: Academic Press.

Roda, A., De Faveri, D. M., Giacosa, A., Dordoni, R., & Lambri, M. (2016). Effect of pre-treatments on saccharification of pineapple waste as apotential source for vinegar production. *Journal of Cleaner Production, 112*(5), 4477-4484.

Rossi-Marquéz, G., Han, J. H., García-Almendárez, B., Castaño-Tostado, E., & Regalado-González, C. (2009). Effect of temperature, pH and film thickness on nisin release from antimicrobial whey protein isolate edible films. *Journal of the Science of Food and Agriculture, 89,* 2492–2497. .

Rubilar, J. F., Cruz, R. M. S., Silva, H. D., Vicente, A. A., Khmelinskii, I., & Vieira, M. C. (2013). Physico-mechanical properties of chitosan films with carvacrol and grape seed extract. *Journal of Food Engineering, 115*(4), 466–474.

Rudra, S. G., Nishad, J., Jakhar, N., & Kaur, C. (2015). Food industry waste: Mine of nutraceuticals. *International Journal of Science, Enviroment and Technology*, *4*(1), 205–229.

Rudzińska, M., Przybylski, R., & Wąsowicz, E. (2014). Degradation of phytosterols during storage of enriched margarines. *Food Chemistry*, *142*, 294–298.

Ruiz-Montañez, G., Ragazzo-Sáanchez, J.A., Calderón-Santoyo, M., Cruz, G.V., Ramírez de León, J.A., & Navarro-Ocaña, A. (2014). Evaluation of extraction methods for preparative scale obtention of mangiferin and lupeol from mango peels (*Mangifera indica* L.). *Food Chemistry, 159,* 267-272.

Ruiz-Navajas, Y., Viuda-Martos, M., Sendra, E., Perez-Alvarez, J. A., & Fernández-López, J. (2013). In vitro antibacterial and antioxidant properties of chitosan edible films incorporated with *Thymus moroderi* or *Thymus piperella* essential oils. *Food Control*, *30*(2), 386–392.

Russ, W., & Schnappinger, M. (2007). Waste related to the food industry: A challenge in material loops. In V. Oreopoulou and W. Russ (Eds.), *Utilization of by-products and Treatment of Waste in the Food Industry* (pp. 1–13). New York, USA: Springer.

Sabaghi, M., Maghsoudlou, Y., Khomeiri, M., & Ziaiifar, A. M. (2015). Active edible coating from chitosan incorporating green tea extract as an antioxidant and antifungal on fresh walnut kernel. *Postharvest Biology and Technology*, *110*, 224–228.

Salgado, P. R., López-Caballero, M. E., Gómez-Guillén, M. C., Mauri, A. N., & Montero, M. P. (2013). Sunflower protein films incorporated with clove essential oil have potential application for the preservation of fish patties. *Food Hydrocolloids*, *33*(1), 74–84.

Salhofer, S., Obersteiner, G., Schneider, & F., Lebersorger, S. (2008). Potentials for the prevention of municipal solid waste. *Waste Manage, 28*, 245–259.

Sanches-Silva, A., Costa, D., Albuquerque, T. G., Buonocore, G. G., Ramos, F., Castilho, M. C., & Costa, H. S. (2014). Trends in the use of natural antioxidants in active food packaging: a review. *Food Additives & Contaminants: Part A*, *31*(3), 374–395.

Santos, J. P., Esquerdo, V. M., Moura, C. M., & Pinto, L. A. A. (2018). Crosslinking agents effect on gelatins from carp and tilapia skins and in their biopolymeric films. *Colloids and Surfaces A*, *539*, 184–191.

Santos, R. D., Shetty, K., & da Silva Miglioranza, L. H. (2014). Oxidative stability of butter with added phenolics from Lamiaceae herbs and in vitro evaluation of potential cytotoxicity of rosemary (*Rosmarinus officinalis* L.) extract. *International Journal of Food Science and Technology, 49*(3), 768–775.

Sarabia, A. L., Gómez-Guillén, M. C., & Montero, P. (2000). The effect of added salts on the viscoelastic properties of fish skin gelatin. *Food Chemistry, 70*, 71-76.

Saxena A., Bawa A. S., & Raju, P. S. (2009). Optimization of a multitarget preservation technique for jackfruit (*Artocarpus heterophyllus* L.) bulbs. *Journal of Food Engineering, 91*(1), 18-28.

Saxena, A., Bawa, A.S. and Raju, P.S. (2011). Jackfruit (*Artocarpus heterophyllus* Lam.). In Yahia, E. M. (Ed.) *Postharvest Biology and Technology of Tropical and Subtropical Fruits, Volume 3.* (pp. 275-298). Cambridge, UK: Woodhead Publishing Limited.

Schrieber, R., & Gareis, H. (2007). From collagen to gelatin. *Gelatin handbook. Theory and industrial practice* (pp. 45-117). Germany: Wiley-VCH Verlag GmbH & Co.

Shahbazi, Y. (2017). The properties of chitosan and gelatin films incorporated with ethanolic red grape seed extract and *Ziziphora clinopodioides* essential oil as biodegradable materials for active food packaging. *International Journal of Biological Macromolecules*, *99*, 746–753.

Shakila J. R., Jeevithan, E., Varatharajakumar, A., Jeyasekaran, G., & Sukumar, D. (2012) Functional characterization of gelatin extracted from bones of red snapper and grouper in comparison with mammalian gelatin. *LWT-Food Science and Technology, 48*(1), 30–36.

Shojaee-Aliabadi, S., Hosseini, H., Mohammadifar, M.A., Mohammadi, A., Ghasemlou, M., Ojagh, S.M., Hosseini, S.M., & Khaksar, R. (2013). Characterization of antioxidant- antimicrobial k-carrageenan films containing *Satureja hortensis* essential oil. *International Journal of Biological Macromolecules, 52,* 116–124.

Singh, S. P., & Sudhakar Rao, D. V. (2011). Papaya *(Carica papaya L.)*. In Yahia, E. M. (Ed.), *Postharvest Biology and Technology of Tropical and Subtropical Fruits* (pp. 86-126), Cambridge, UK: Woodhead Publishing Limited.

Siracusa, V. (2012). Food packaging permeability behavior: a report. *International Journal of Polymer Science,302029,*1-11.

Siracusa, V., Rocculi, P., Romani, S., & Rosa,M.D. (2008). Biodegradable polymers for food packaging: a review. *Trends in Food Science and Technology, 19*, 634-643.

Siripatrawan, U., & Harte, B. R. (2010). Physical properties and antioxidant activity of an active film from chitosan incorporated with green tea extract. *Food Hydrocolloids*, *24*(8), 770–775.

Sogi, D. S., Siddiq, M., Greiby, I., & Dolan, K. D. (2013). Total phenolics, antioxidant activity, and functional properties of "Tommy Atkins" mango peel and kernel as affected by drying methods. *Food Chemistry*, *141*(3), 2649–2655.

Stahl, W, & Sies, H. (2005). Bioactivity and protective effects of natural carotenoids. *Biochimica et Biophysica Acta, 1740*, 101–7.

Stejskal, V., Bostlova, M., Nesvorna, M., Volek, V., Dolezal, V., & Hubert, J. (2017). Comparison of the resistance of mono- and multilayer packaging films to stored-product insects in a laboratory test. *Food Control*, *73*, 566–573.

Su, Q. Z., Lin, Q. B., Chen, C. F., Wu, Y. M., Wu, L. B., Chen, X. Q., & Wang, Z. W. (2015). Effect of antioxidants and light stabilisers on silver migration from nanosilver-polyethylene composite packaging films into food simulants. *Food Additives and Contaminants - Part A Chemistry, Analysis, Control, Exposure and Risk Assessment*, *32*(9), 1561–1566.

Sui Chin, S., Han Lyn, F., & Nur Hanani, Z. A. (2017). Effect of Aloe vera (*Aloe barbadensis* Miller) gel on the physical and functional properties of fish gelatin films as active packaging. *Food Packaging and Shelf Life*, *12*, 128–134.

Sultana, B., Hussain, Z., Asif, M., & Munir, A. (2012). Investigation on the antioxidant activity of leaves, peels, stems bark, and kernel of mango (*Mangifera indica* L.). *Journal of Food Science*, *77*(8), 849–852.

Suppakul, P., Miltz, J., Sonneveld, K., & Bigger, S. W. (2003). Active packaging technologies with an emphasis on antimicrobial packaging and its applications. *Journal of Food Science, 68*(2), 408–420.

Swami, S. B., Thakor, N. J., Haldankar, P. M., & Kalse, S. B. (2012). Jackfruit and its many functional components as related to human health: a review. *Comprehensive Reviews in Food Science and Food Safety*, *11*(6), 565–576.

Tananuwong, K., & Tewaruth, W. (2010). Extraction and application of antioxidants from black glutinous rice. *LWT - Food Science and Technology, 43*(3), 476–481.

Tankhiwale, R., & Bajpai, S. K. (2012). Preparation, characterization and antibacterial applications of ZnO-nanoparticles coated polyethylene films for food packaging. *Colloids and Surfaces B: Biointerfaces, 90*(1), 16–20.

Tharanathan, R. N. (2003). Biodegradable films and composite coatings: past, present and future. *Trends in Food Science and Technology, 14*(3), 71-78.

Tharanathan, R. N., Yashoda, H. M., & Prabha, T. N. (2006). Mango (*Mangifera indica* L.), 'The king of fruits' – a review. *Food Reviews International, 22*, 95–123.

Theapsak, S., Watthanaphanit, A., & Rujiravanit, R. (2012). Preparation of chitosan-coated polyethylene packaging films by DBD plasma treatment. *ACS Applied Materials and Interfaces*, *4*(5), 2474–2482.

Thi, L., Thuy, M., Dat, N. T., Quynh, N. Do, & Osako, K. (2015). The effects of preparation conditions on the properties of gelatin film from horse mackerel (*trachurus japonicus*) scale. *Can Tho University Journal of Science*, *1*, 39–46.

Tian, F., Decker, E. A., & Goddard, J. M. (2013). Controlling lipid oxidation of food by active packaging technologies. *Food & Function, 4*, 669-680.

Tongnuanchan, P., Benjakul, S., & Prodpran, T. (2014). Comparative studies on properties and antioxidative activity of fish skin gelatin films incorporated with essential oils from various sources. *International Aquatic Research*, *6*(2), 1–12.

Tornuk, F., Hancer, M., Sagdic, O., & Yetim, H. (2015). LLDPE based food packaging incorporated with nanoclays grafted with bioactive compounds to extend shelf life of some meat products. *LWT - Food Science and Technology*, *64*(2), 540–546.

Tovar, L., Salafranca, J., Sanchez, C., & Nerin, C. (2005). Migration studies to assess the safety in use of a new antioxidant active packaging. *Journal of Agricultural and Food Chemistry, 53,* 5270-5275.

Uranga, J., Leceta, I., Etxabide, A., Guerrero, P., & de la Caba, K. (2016). Cross-linking of fish gelatin films to develop sustainable films with enhanced properties. *European Polymer Journal*, *78*, 82-90.

Valdés, A., Mellinas, A. C., Ramos, M., Garrigós, M. C., & Jiménez, A. (2014). Natural additives and agricultural wastes in biopolymer formulations for food packaging. *Frontiers in Chemistry*, *2*(6), 1-10.

Van der Sluis, A. A., Dekker, M., De Jager, A., & Jongen, W. M. F. (2001). Activity and concentration of polyphenolic antioxidants in apple: effect of cultivar, harvest year, and storage conditions. *Journal of Agricultural Food Chemistry, 49*, 3606–3613.

Vega-Vega, V., Silva-Espinoza, B., Cruz-Valenzuela, M., Bernal-Mercado, a., González-Aguilar, G., Ruíz-Cruz, S., & Ayala-Zavala, J. (2013). Antimicrobial and antioxidant properties of byproduct extracts of mango fruit. *Journal of Applied Botany and Food Quality*, *86*, 205–211.

Vuong, Q. V., Hirun, S., Roach, P. D., Bowyer, M. C., Phillips, P. A., & Scarlett, C. J. (2013). Effect of extraction conditions on total phenolic compounds and antioxidant activities of Carica papaya leaf aqueous extracts. *Journal of Herbal Medicine*, *3*(3), 104–111.

Waldron, K. (2009). *Handbook of waste management and co-product recovery in food processing* (pp. 3-33). Cambridge, UK : Woodhead Publishing.

Wang, L. F., & Rhim, J. W. (2015). Preparation and application of agar/alginate/collagen ternary blend functional food packaging films. *International Journal of Biological Macromolecules*, *80,* 460–468.

Wang, L., Liu, L., Holmes, J., Kerry, J. F., & Kerry, J. P. (2007). Assessment of film-forming potential and properties of protein and polysaccharide-based biopolymer films. *International Journal of Food Science and Technology*, *42*, 1128-1138.

Wang, L.Y., Dong, Y., Men, H.T., Tong, J., & Zhou, J. (2013). Preparation and characterization of active films based on chitosan incorporated tea polyphenols. *Food Hydrocolloids*. *32*, 35–41.

World Packaging Organization (2009). Market Statistics and Future Trends in Global Packaging. Retrieved 29 September 2016 from http://www.worldpackaging.org/i4a/doclibrary/index.cfm?category_id=4.

Wu, J., Chen, S., Ge, S., Miao, J., Li, J., & Zhang, Q. (2013). Preparation, properties and antioxidant activity of an active film from silver carp (*Hypophthalmichthys molitrix*) skin gelatin incorporated with green tea extract. *Food Hydrocolloids, 32*(1), 42–51.

Wu, J., Ge, S., Liu, H., Wang, S., Chen, S., Wang, J., & Zhang, Q. (2014). Properties and antimicrobial activity of silver carp (*Hypophthalmichthys molitrix*) skin gelatin-chitosan films incorporated with oregano essential oil for fish preservation. *Food Packaging and Shelf Life*, *2*(1), 7–16.

Yang, H. J., Lee, J. H., Won, M., & Song, K. B. (2016). Antioxidant activities of distiller dried grains with solubles as protein films containing tea extracts and their application in the packaging of pork meat. *Food Chemistry*, *196*, 174–179.

Ylidirim, S., Rōcker, B., Pettersen, M. K., Nilsen-Nygaard, J., Ayhan, Z., Rutkaite, R., Radusin, T., Suminska, P., Marcos, B., & Coma, V. (2018). Active packaging applications for food. *Comprehensive Reviews in Food Science and Technology, 17,* 165-199.

Yogiraj, V., Goyal, P. K., & Chauhan, C. S. (2014). Carica papaya Linn : an overview. *International Journal of Herbal Medicine*, *2*(5), 1–8.

Yuan, G., Lv, H., Yang, B., Chen, X., & Sun, H. (2015). Physical properties, antioxidant and antimicrobial activity of chitosan films containing carvacrol and pomegranate peel extract. *Molecules*, *20*(6), 11034–11045.

Zaeroomali, M., Maghsoudlou, Y., & Aryaey, P. (2014). Investigation of physicochemical properties of table margarine during storage time in ambient temperature. *Pelagia Reasearch Library, 4*(3), 188-190.

Zhang, L., Tu, Z. Cai, Xie, X., Wang, H., Wang, H., Wang, Z., Sha, X., & Lu, Y. (2017). Jackfruit (*Artocarpus heterophyllus* Lam.) peel: A better source of antioxidants and a-glucosidase inhibitors than pulp, flake and seed, and phytochemical profile by HPLC-QTOF-MS/MS. *Food Chemistry*, *234*, 303–313.

Zhu, X., Schaich, K., Chen, X., & Yam, K. (2013). Antioxidant effects of sesamol released from polymeric films on lipid oxidation in linoleic acid and oat cereal. *Packaging Technology and Science, 26*, 31–38.