
**UNIVERSITI PUTRA MALAYSIA**

***HIGH PRESSURE PROCESSING OF JACKFRUIT (Artocarpus heterophyllus L.) BULB***

**NG SIANG KEAT**

**FSTM 2018 19**

# HIGH PRESSURE PROCESSING OF JACKFRUIT (*Artocarpus heterophyllus* L.) BULB

By

**NG SIANG KEAT**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements of the Degree of Master of Science**

**May 2018**

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

**HIGH PRESSURE PROCESSING OF JACKFRUIT (*Artocarpus heterophyllus* L.) BULB**

By

**NG SIANG KEAT**

**May 2018**

**Chairman : Professor Tan Chin Ping, PhD**
**Faculty : Food Science and Technology**

Conventional processing technology, particularly thermal processing, may extend the shelf life of fruits. However, there is always a risk of inducing negative effects to the fruits, especially in terms of colour and texture. The emergence of high pressure processing (HPP), a novel non-thermal processing technology, brings promising hope of extending the shelf life of fruits while at the same time, preserving the fresh fruit's characteristics. However, little is known or published on the effect of HPP on tropical fruits such as jackfruit. Thus, the effect of HPP on the microbiological, physicochemical and enzymatic properties of jackfruit bulbs at different pressures and holding times was studied. The pressures and holding times used in this study were 300, 400, 500 and 600 MPa at 3, 5, 10 and 15 min, respectively. The aforementioned treatments significantly ($p < 0.05$) reduced the microbial load to non-detectable level. However, the HP-treated samples exhibited no significant differences ($p > 0.05$) in terms of the proximate composition and ΔE indicator of total colour difference. HPP significantly ($p < 0.05$) increased the hardness and chewiness of the treated samples. In terms of enzymatic property, polygalacturonase (PG) and pectin esterase (PE) contents were significantly ($p < 0.05$) reduced by HPP. These results suggested that HPP had successfully inactivated the vegetative microorganisms while at the same time, retained the physicochemical properties of the jackfruit bulbs. An optimized pressure (500 MPa) and holding time (5 min) were then selected to process jackfruits bulbs packed using vacuum skin (VS) and vacuum nylon (VN) packaging. The samples were then stored at chilled temperature (4 °C) for shelf life study. HPP significantly ($p < 0.05$) increased the shelf life of VS- and VN-packed jackfruit bulbs to 60 days during chilled storage. In terms of colour stability during storage, both VS- and VN-packed HP-treated jackfruit bulbs exhibited no significant differences ($p > 0.05$) in terms of $L^*$, $a^*$, and $b^*$ values. Also, the VS- and VN-packed HP-treated samples exhibited no significant differences ($p > 0.05$) in terms of texture and enzyme activity. However, the sensory evaluation carried out among 48 panellists showed that there were significant differences ($p < 0.05$) between the untreated and HP-treated

jackfruit bulbs. The aforementioned results had proven that a HPP treatment of 500 MPa for 5 min could successfully extend the shelf life and retain the physicochemical properties of jackfruit bulbs, regardless of the types of packaging used.

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

**PEMPROSESAN TEKANAN TINGGI DARIPADA NANGKA (*Artocarpus heterophyllus* L.)**

Oleh

**NG SIANG KEAT**

**Mei 2018**

**Pengerusi : Profesor Tan Chin Ping, PhD**
**Fakulti : Sains dan Teknologi Makanan**

Teknologi pemprosesan konvensional, terutamanya pemprosesan terma, boleh memanjangkan jangka hayat buah-buahan. Walau bagaimanapun, pemprosesan sedemikian akan terdapat risiko yang membawa kepada kesan negatif ke atas buah-buahan, khususnya dari segi warna dan tekstur. Kemunculan pemprosesan tekanan tinggi (HPP) sebagai teknologi bukan terma yang baharu, membawa harapan bagi memanjangkan jangka hayat buah-buahan di samping mengekalkan ciri-ciri buah-buahan yang segar. Walau bagaimanapun, hanya sedikit sahaja yang diketahui atau dikaji mengenai kesan HPP ke atas buah-buahan tropika seperti nangka. Justeru, kesan HPP ke atas sifat-sifat mikrobiologi, fizikokimia dan enzim buah nangka pada tekanan dan masa pemprosesan yang berbeza telah dikaji. Tekanan dan masa pemprosesan yang digunakan dalam kajian ini masing-masing adalah gabungan antara 300, 400, 500 dan 600 MPa untuk 3, 5, 10, dan 15 min. Rawatan-rawatan tersebut telah berjaya mengurangkan tahap populasi mikrob dengan ketara ($p < 0.05$) ke tahap yang tidak dapat dikesan. Walau bagaimanapun, nangka yang telah dirawat dengan tekanan tinggi menunjukkan perbezaan yang tidak ketara ($p > 0.05$) dari segi komposisi proksimat dan petunjuk $\Delta E$ bagi perbezaan warna. Akan tetapi, HPP telah meningkatkan tahap kekerasan dan kekenyalan buah nangka dengan ketara ($p < 0.05$). Dari segi sifat enzim pula, aktiviti enzim *polygalacturonase* (PG) dan *pectin esterase* (PE) telah dikurangkan dengan ketara ($p < 0.05$) oleh HPP. Hasil-hasil kajian ini menunjukkan yang HPP telah berjaya menyahaktifkan mikroorganisma vegetatif dan pada masa yang sama, mengekalkan sifat-sifat fizikokimia nangka. Seterusnya, rawatan optimum iaitu pada tekanan 500 MPa dan masa pemprosesan 5 min telah dipilih untuk memproses buah nangka yang dibungkus menggunakan pembungkusan vakum kulit (VS) dan vakum nilon (VN). Sampel-sampel ini kemudiannya disimpan pada suhu dingin (4 °C) untuk kajian hayat simpan. HPP berjaya meningkatkan jangka hayat simpan buah nangka yang dibungkus dengan VS dan VN dengan ketara ($p < 0.05$), iaitu sehingga 60 hari tempoh penyimpanan. Dalam tempoh penyimpanan, kedua-dua

sampel buah nangka yang dibungkus dengan VS dan VN, dan dikenakan rawatan HPP tidak menunjukkan perbezaan yang ketara ($p > 0.05$) dari segi nilai $L^*$, $a^*$, dan $b^*$. Dari segi tekstur dan aktiviti enzim, tiada perbezaan yang ketara ($p > 0.05$) antara buah nangka yang dibungkus dengan VS dan VN selepas rawatan HPP. Namun begitu, penilaian deria oleh 48 ahli panel telah menunjukkan bahawa terdapat perbezaan yang ketara ($p < 0.05$) antara buah nangka yang tidak dirawat dengan buah nangka yang dirawat menggunakan HPP. Hasil kajian daripada kajian ini menunjukkan bahawa rawatan 500 MPa untuk 5 min berjaya memanjangkan jangka hayat simpan dan mengekalkan sifat fizikokimia buah nangka, tanpa mengira jenis pembungkusan yang digunakan.

**ACKNOWLEDGEMENTS**

I am really grateful for all the support that I have received throughout the years of my postgraduate study. I wish to express my gratitude and love to my family for their affectionate support, care and understanding.

First and foremost, I wish to express my deepest gratitude to my supervisor, Professor Dr. Tan Chin Ping. It was really my honour and pleasure to again have such opportunity to gain more knowledge and experience under his guidance. His invaluable guidance, encouragement, friendly support were crucial to me in fulfilment of this task. Without his great support, this project would not be possible. I also wish to express my thankfulness to my advisory committee, Associate Professor Dr. Chong Gun Hean, for his constructive criticism, discussions and comments on this research work.

I would like to take this opportunity to show my deepest appreciation to Dr. Tan Tai Boon, for his support and proofreading of my papers and research work. Also, I would like to thank my laboratory mates for all their guidance and support throughout my postgraduate study. I truly appreciate and cherish all the wonderful moments with them.

Last, I sincerely thank the Graduate School of UPM for providing graduate research fellowship to me as financial support. Also, my deepest thanks to Mr. Wong and Mr. Daniel from Duria Manufacturing Sdn. Bhd. for their support in providing research raw materials and high pressure processing facilities.

I certify that a Thesis Examination Committee has met on 24 May 2018 to conduct the final examination of Ng Siang Keat on his thesis entitled "High Pressure Processing of Jackfruit (*Artocarpus heterophyllus* L.) Bulb" 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:

**Yaya Rukayadi, PhD**
Associate Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Chairman)

**Rabiha binti Sulaiman, PhD**
Senior Lecturer
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Internal Examiner)

**Mohamed Elwathig Saeed Mirghani, PhD**
Associate Professor
International Islamic University Malaysia
Malaysia
(External Examiner)

**RUSLI HAJI ABDULLAH, PhD**
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 30 August 2018

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

**Tan Chin Ping, PhD**
Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Chairman)

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

**ROBIAH BINTI YUNUS, PhD**
Professor and Dean
School of Graduate 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.: Ng Siang Keat, GS44881

**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: Professor Dr. Tan Chin Ping

Signature: _____
Name of Member of Supervisory Committee: Associate Professor Dr. Chong Gun Hean

## TABLE OF CONTENTS


| | | Page |
|---|---|---|
| **ABSTRACT** | | i |
| ***ABSTRAK*** | | iii |
| **ACKNOWLEDGEMENTS** | | v |
| **APPROVAL** | | vi |
| **DECLARATION** | | viii |
| **LIST OF TABLES** | | xiii |
| **LIST OF FIGURES** | | xiv |
| **LIST OF ABBREVIATIONS** | | xv |
| **CHAPTER** | | |
| **1** | **INTRODUCTION** | 1 |
| **2** | **LITERATURE REVIEW** | 3 |
| | 2.1 Agriculture in Malaysia | 3 |
| | 2.2 Jackfruit | 3 |
| | 2.3 Fruit ripening | 4 |
| | 2.4 High Pressure Processing (HPP) | 6 |
| | 2.5 Applications of HPP in food industry | 8 |
| | 2.6 Effect of HPP on the inactivation of pathogen | 8 |
| | 2.7 Effect of HPP on the inactivation of enzyme | 11 |
| | 2.7.1 Polygalacturonase (PG) | 12 |
| | 2.7.2 Pectin Esterase (PE) | 14 |
| **3** | **EFFECT OF HIGH PRESSURE PROCESSING ON THE MICROBIOGICAL, PHYSICOCHEMICAL AND ENZYMATIC PROPERTIES OF JACKFRUIT BULBS** | 17 |
| | 3.1 Introduction | 17 |
| | 3.2 Materials and Methods | 18 |
| | 3.2.1 Materials | 18 |
| | 3.2.2 Sample preparation | 18 |
| | 3.2.3 HPP method | 18 |
| | 3.2.4 Microbiological analysis | 19 |
| | 3.2.5 Physicochemical analysis | 19 |
| | 3.2.5.1 Proximate analysis | 19 |
| | 3.2.5.2 Colour analysis | 19 |
| | 3.2.5.3 pH analysis | 20 |
| | 3.2.5.4 Texture analysis | 20 |
| | 3.2.6 Enzyme Activity | 20 |
| | 3.2.6.1 Sample preparation | 20 |

3.2.6.2 Polygalacturonase (PG) activity 21
3.2.6.3 Pectin esterase (PE) activity 21
3.2.6.4 Kinetic of PE inactivation 21
3.2.7 Statistical analysis 22
3.3 Results and Discussion 23
3.3.1 Effect of HPP on microbial populations of jackfruit bulbs 23
3.3.2 Effect of HPP on the proximate composition of jackfruit bulbs 24
3.3.3 Effect of HPP on the colour and pH of jackfruit bulbs 27
3.3.4 Effect of HPP on the texture of jackfruit bulbs 29
3.3.5 Effect of HPP on the PG activity in jackfruit bulbs 30
3.3.6 Effect of HPP on the PE activity in jackfruit bulbs 31
3.3.7 Kinetic of PE inactivation 32
3.4 Conclusion 34

**4 EFFECT OF OPTIMIZED HIGH PRESSURE PROCESSING PARAMETER ON THE SENSORY AND SHELF LIFE STUDIES OF JACKFRUIT BULBS PACKED USING DIFFERENT PACKAGING MATERIALS** 35
4.1 Introduction 35
4.2 Materials and methods 36
4.2.1 Materials 36
4.2.2 Sample preparation 36
4.2.3 HPP method 36
4.2.4 Sensory studies 36
4.2.5 Texture analysis 37
4.2.6 Enzyme activity 37
4.2.6.1 Sample preparation 37
4.2.6.2 PG activity 37
4.2.6.3 PE activity 37
4.2.7 Shelf life studies 37
4.2.7.1 Microbiological analysis 37
4.2.7.2 Colour analysis 38
4.2.8 Statistical analysis 38
4.3 Results and discussion 38
4.3.1 Sensory evaluation 38
4.3.2 Texture 39
4.3.3 Enzyme activity 39
4.3.4 Shelf life studies 40
4.3.4.1 Microbiological analysis 40
4.3.4.2 Colour 46
4.4 Conclusion 49

**5 CONCLUSION AND RECOMMENDATIONS** 50

**REFERENCES** 52
**APPENDICES** 67
**BIODATA OF STUDENT** 69
**LIST OF PUBLICATIONS** 70

## LIST OF TABLES


| Table | | Page |
|---|---|---|
| 2.1 | Effect of HPP on the PG enzyme in different fruits and vegetables | 13 |
| 2.2 | Effect of HPP on the PE enzyme in different fruits and vegetables | 15 |
| 3.1 | Effects of HPP treatment on the microbial populations in jackfruit bulbs | 24 |
| 3.2 | Effects of HPP at different pressures and holding times on the proximate composition of jackfruit flesh | 26 |
| 3.3 | Effects of HPP at different pressures and holding times on the colour (L*, a*, b*, h* and Δ E values) and pH of jackfruit bulbs | 28 |
| 3.4 | Different models of kinetic inactivation of PE in jackfruit bulbs | 33 |
| 4.1 | Effect of HPP at 500 MPa for 5 min on the texture of jackfruit bulbs packed using vacuum skin (VS) and vacuum nylon (VN) packaging | 39 |
| 4.2 | Effect of HPP at 500 MPa for 5 min on the PE enzyme activity and residual activity in jackfruit bulbs packed using vacuum skin (VS) and vacuum nylon (VN) packaging | 40 |
| 4.3 | Effects of HPP at 500 MPa for 5 min on the PG enzyme activity and residual activity in jackfruit bulbs packed using vacuum skin (VS) and vacuum nylon (VN) packaging | 40 |
| 4.4 | Effect of HPP at 500 MPa for 5 min on the colour (L*, a*, b* and Δ E values) of jackfruit bulbs packed using vacuum skin (VS) and vacuum nylon (VN) packaging | 48 |

## LIST OF FIGURES


| Figure | | Page |
|---|---|---|
| 2.1 | Classification of climacteric and non-climacteric fruits at different stage of growth.[Adapted from Wills *et al.* (1999)] | 5 |
| 2.2 | Proposed model of high pressure effect on enzyme conformational structure. [Adapted from Chakraborty *et al.* (2014)] | 11 |
| 3.1 | Effects of HPP at different pressure and holding times on hardness of jackfruit bulbs | 29 |
| 3.2 | Effects of HPP at different pressure and holding times on chewiness of jackfruit bulbs | 30 |
| 3.3 | Residual PG enzyme activity in HP-treated jackfruit bulbs at: 3min; 5min; 10min; 15min | 31 |
| 3.4 | Residual PE activity in HP-treated jackfruit bulbs at: 3min; 5min; 10min; 15min | 32 |
| 3.5 | Effect of pressure on PE inactivation rates in jackfruit bulbs | 33 |
| 4.1 | Total plate count for jackfruit bulbs with treatments of: ◇ VS packaging only; △ VN packaging only; ○ VS packaging + HPP; × VN packaging + HPP | 42 |
| 4.2 | Coliform bacteria count in jackfruit bulbs with treatments of: ◇VS packaging only; △ VN packaging only; ○ VS packaging + HPP; × VN packaging + HPP | 43 |
| 4.3 | Yeast and mold count in jackfruit bulbs with treatments of: ◇VS packaging only; △ VN packaging only; ○ VS packaging + HPP; × VN packaging + HPP | 44 |
| 4.4 | Total presumptive *E. coli* in jackfruit bulbs with treatments of: ◇VS packaging only; △ VN packaging only; ○ VS packaging + HPP; × VN packaging + HPP | 45 |
| 4.5 | *L. monocytogenes* count in jackfruit bulbs with treatments of: ◇VS packaging only; △ VN packaging only; ○ VS packaging + HPP; × VN packaging + HPP | 46 |

## LIST OF ABBREVIATIONS

| | |
|---|---|
| *et al.* | *et alia* (and others) |
| h | hour |
| min | minute |
| s | second |
| L | litre |
| mL | millilitre |
| µL | microlitre |
| kg | kilogram |
| g | gram |
| mg | milligram |
| µm | micrometre |
| mm | millimetre |
| °C | Celsius |
| % | percent |
| ALP | Aluminium Laminated Packaging |
| *E. coli* | *Escherichia coli* |
| EMB | Eosin Methylene Blue |
| EVA | Ethylene-vinyl Acetate |
| HPP | High Pressure Processing |
| HP-treated | High Pressure Treated |
| *L. monocytogenes* | *Listeria monocytogenens* |
| LDPE | Low Density Polyehthylene |
| LLDPE | Linear Low-density Polyethylene |
| MAP | Modified Atmosphere Packaging |
| MPa | megapascal |
| N | Newton |
| PP | Polypropylene |
| PE | Polyethylene |
| PET | Polyethylene terephthalate |
| PG | Polygalacturonase |
| PE | Pectin Esterase |
| PCA | Plate Count Agar |
| PDA | Potato Dextrose Agar |
| TPC | Total Plate Count |
| VS | Vacuum Skin |
| VN | Vacuum Nylon |
| VS-HPP | Vacuum Skin packaging with High Pressure Processing |
| VN-HPP | Vacuum Nylon packaging with High Pressure Processing |

# CHAPTER 1

## INTRODUCTION

The shelf life of fresh fruit and vegetable products are relatively short and may vary from a few days to a few weeks. The shelf life of the products is greatly dependent on the types of fruit, vegetables and storage conditions. Thus, various preservation techniques or post-harvest technologies have been introduced to extend the shelf life of the products. For instances, the use of chemical sanitizers such as chlorine and organic acid, physical preservation techniques such as heating, modified atmosphere packaging (MAP), irradiation, ultraviolet light and ultrasound Ramos *et al.* (2013). Notably, conventional processing methods, such as thermal pasteurization and sterilization, are used to destroy the pathogenic microorganisms and reduce the water activity in food system, thus inhibiting the growth of microorganisms and secure the safety of the food. However, conventional preservation techniques can induce negative impacts on the food in terms of colour, texture and nutritional properties (Fernandes *et al.*, 2015). Therefore, new preservation techniques are being explored and developed to overcome the limitations of conventional technology. A novel technology, high pressure processing (HPP), was developed and became a major technology used in the preservation of different types of food.

Jackfruit (*Artocarpus heterophyllus*), is also known as nangka (Javan and Malay), jacquier (French), khnaor (Cambodia), langka (Philippine), and khanum (Thailand). It is one of the local non-seasonal tropical fruits that are increasingly gaining popularity and is cultivated throughout the Southeast Asia tropics region (Rajendran, 1992). Jackfruit is extensively planted for local and export markets. It is rich in carbohydrate, fiber, potassium and carotene. Certain jackfruit pulp has fibrous, thin, soft and musky flesh and emits a strong aroma when ripe (Saxena *et al.*, 2011b). Jackfruit from Malaysia is mainly exported to Singapore, Thailand, Hong Kong and Brunei. In recent years, the Department of Agriculture has identified jackfruit as one of the six high-value non-seasonal tropical fruits marked for the Entry Point Project (EPP). The EPP was launched under the Agriculture National Key Economic Area (NKEA) and PEMANDU's Economic Transformation Programme (ETP) with the aim to increase the export of local premium fruits and vegetables to the Middle East and Europe. The Ministry of Agriculture has targeted an increase in the total export value of Malaysian premium fruits and vegetables to RM400 million (www.doa.gov.my). Therefore, research on postharvest treatment and minimal processing are essential to improve the overall quality and shelf life of local tropical fruits for export markets. Minimally-processed fruits will boost the fruit's potential internationally.

With the recent shift in consumer's lifestyle towards healthy living and healthier food, the consumption of fresh fruits has become popular. As mentioned earlier, traditional processing technologies, particularly those that involves heat, can instigate damaging

effects on the products, especially in terms of color and texture. Thus, there has been an increasing interest in minimal processing technologies, such as HPP, irradiation and pulsed electric field, to prolong the shelf life of fruits. By comparing the effects of HPP and other non-thermal processing technologies, such as irradiation and pulsed electric field, on the processing of food, it is clear that HPP provides much more reliability and feasibility in large scale of processing of food products. Thus, HPP was chosen as the non-thermal processing method to be used in this study. Also, there have been various studies on the effect of HPP on the physicochemical characteristics of different fruit and vegetable juices (Houška *et al.*, 2006). However, there are limited studies on the effect of HPP on tropical fruits such as jackfruit. Thus, the primary aim of this research was to investigate the effect of HPP in prolonging the shelf life of jackfruit while at the same time, preserving the fresh fruit's characteristics.

Basically, the importance of this research was to preserve and enhance the shelf life of tropical fruits using HPP, and without the application of any thermal treatment. It is hoped that HPP could be an alternative processing technology to be used by the food industry to commercialize tropical fruits and expand their market globally to potential countries such as China. The outcomes of this project are expected to bring a significant commercial value to our local food industry.

Specifically, the objectives mentioned above can be further refined into following sub-objectives:

1. To evaluate the effect of HPP on the microbiological, physicochemical and enzymatic properties of jackfruit bulbs at different pressures and holding times.
2. To determine the effect of optimized HPP parameters on the sensory evaluation and shelf life study of jackfruit bulbs packed using selected packaging materials.

## REFERENCES


Abee, T., & Wouters, J. A. 1999. Microbial stress response in minimal processing. *International Journal of Food Microbiology*, 50(1–2), 65-91.

Abeles, F. B., & Takeda, F. 1990. Cellulase activity and ethylene in ripening strawberry and apple fruits. *Scientia Horticulturae*, 42(4), 269-275.

Ahmed, J., Ramaswamy, H. S., & Hiremath, N. 2005. The effect of high pressure treatment on rheological characteristics and colour of mango pulp. *International journal of food science & technology*, 40(8), 885-895.

Ahn, J., Balasubramaniam Vm Fau - Yousef, A. E., & Yousef, A. E. 2007. Inactivation kinetics of selected aerobic and anaerobic bacterial spores by pressure-assisted thermal processing. (0168-1605 (Print)).

Alexandrakis, Z., Katsaros, G., Stavros, P., Katapodis, P., Nounesis, G., & Taoukis, P. 2014. Comparative Structural Changes and Inactivation Kinetics of Pectin Methylesterases from Different Orange Cultivars Processed by High Pressure. *Food and Bioprocess Technology*, 7(3), 853-867.

Alpas, H., Kalchayanand N Fau - Bozoglu, F., Bozoglu F Fau - Sikes, A., Sikes A Fau - Dunne, C. P., Dunne Cp Fau - Ray, B., & Ray, B. 1999. Variation in resistance to hydrostatic pressure among strains of food-borne pathogens. (0099-2240 (Print)).

Andreou, V., Dimopoulos, G., Katsaros, G., & Taoukis, P. 2016. Comparison of the application of high pressure and pulsed electric fields technologies on the selective inactivation of endogenous enzymes in tomato products. *Innovative Food Science & Emerging Technologies*, 38(Part B), 349-355.

Andrés, V., Villanueva, M.-J., & Tenorio, M.-D. 2016a. Influence of high pressure processing on microbial shelf life, sensory profile, soluble sugars, organic acids, and mineral content of milk- and soy-smoothies. *LWT - Food Science and Technology*, 65, 98-105.

Andrés, V., Villanueva, M., & Tenorio, M. 2016b. The effect of high-pressure processing on colour, bioactive compounds, and antioxidant activity in smoothies during refrigerated storage. *Food Chemistry*, 192(Supplement C), 328-335.

AOAC. 1995. Official methods of analysis of AOAC International. *Official methods of analysis of AOAC International*.

Arkroyd, W., Gopalan, C., & Balasubramanuyam, S. 1966. The nutritive value of Indian food and the planning of satisfaction diet. Sept. Rep. Ser, 42.

Asaka, M., Aoyama, Y., Nakanishi, R., & Hayashi, R. 1994. Purification of a Latent Form of Polyphenoloxidase from La France Pear Fruit and Its Pressure-activation. *Bioscience, Biotechnology, and Biochemistry*, 58(8), 1486-1489.

Balasubramaniam, V. M., & Farkas, D. 2008. High-pressure food processing. *Food Science and Technology International*, 14(5), 413-418.

Baliga, M. S., Shivashankara, A. R., Haniadka, R., Dsouza, J., & Bhat, H. P. 2011. Phytochemistry, nutritional and pharmacological properties of Artocarpus heterophyllus Lam (jackfruit): A review. *Food Research International*, 44(7), 1800-1811.

Balogh, T., Smout, C., Nguyen, B. L., Van Loey, A. M., & Hendrickx, M. E. 2004. Thermal and high-pressure inactivation kinetics of carrot pectinmethylesterase: from model system to real foods. *Innovative Food Science & Emerging Technologies*, 5(4), 429-436.

Barba, F. J., Esteve, M. J., & Frigola, A. 2013. Physicochemical and nutritional characteristics of blueberry juice after high pressure processing. *Food Research International*, 50(2), 545-549.

Barbosa-Cánovas, G. V., & Rodríguez, J. J. 2005. Thermodynamic aspects of high hydrostatic pressure food processing *Food Science and Technology Series* 141 (pp. 183-205). Boca Raton: CRC Press Inc.

Basak, S., & Ramaswamy, H. 1996. Ultra high pressure treatment of orange juice: a kinetic study on inactivation of pectin methyl esterase. *Food Research International*, 29(7), 601-607.

Benito, A., Ventoura G Fau - Casadei, M., Casadei M Fau - Robinson, T., Robinson T Fau - Mackey, B., & Mackey, B. 1999. Variation in resistance of natural isolates of Escherichia coli O157 to high hydrostatic pressure, mild heat, and other stresses. (0099-2240 (Print)).

Bermejo-Prada, A., Van Buggenhout, S., Otero, L., Houben, K., Van Loey, A., & Hendrickx, M. E. 2014. Kinetics of thermal and high-pressure inactivation of avocado polygalacturonase. *Innovative Food Science & Emerging Technologies*, 26, 51-58.

Bermúdez-Aguirre, D., Guerrero-Beltrán, J. Á., Barbosa-Cánovas, G. V., & Welti-Chanes, J. 2011. Study of the inactivation of Escherichia coli and pectin methylesterase in mango nectar under selected high hydrostatic pressure treatments. *Food Science and Technology International*, 17(6), 541-547.

Biale, J. B. 1964. Growth, maturation and senescence in fruits. *Science*, 146(3646), 880-888.

Black, E. P., Koziol-Dube K Fau - Guan, D., Guan D Fau - Wei, J., Wei J Fau - Setlow, B., Setlow B Fau - Cortezzo, D. E., Cortezzo De Fau - Hoover, D. G., Setlow, P. 2005. Factors influencing germination of Bacillus subtilis spores via activation of nutrient receptors by high pressure. (0099-2240 (Print)).

Błaszczak, W., Amarowicz, R., & Górecki, A. R. 2017. Antioxidant capacity, phenolic composition and microbial stability of aronia juice subjected to high hydrostatic pressure processing. *Innovative Food Science & Emerging Technologies*, 39, 141-147.

Brecht, J., Ritenour, M., Haard, N., & Chism, G. 2008. Postharvest physiology of edible plant tissues. *Food Science and Technology-New York-Marcel Dekker-*, 169, 975.

Bridgman, P. 1914. The coagulation of albumen by pressure. *Journal of Biological Chemistry*, 19(4), 511-512.

Bull, M. K., Zerdin, K., Howe, E., Goicoechea, D., Paramanandhan, P., Stockman, R., Stewart, C. M. 2004. The effect of high pressure processing on the microbial, physical and chemical properties of Valencia and Navel orange juice. *Innovative Food Science & Emerging Technologies*, 5(2), 135-149.

Caner, C., Aday, M. S., & Demir, M. 2008. Extending the quality of fresh strawberries by equilibrium modified atmosphere packaging. *European Food Research and Technology*, 227(6), 1575-1583.

Caner, C., Hernandez, R. J., Pascall, M., Balasubramaniam, V. M., & Horte, B. R. 2004. The effect of high-pressure food processing on the sorption behaviour of selected packaging materials. *Packaging Technology and Science*, 17(3), 139-153.

Chai, C., Lee, J., Lee, Y., Na, S., & Park, J. 2014. A combination of TiO2–UV photocatalysis and high hydrostatic pressure to inactivate Bacillus cereus in freshly squeezed Angelica keiskei juice. *LWT - Food Science and Technology*, 55(1), 104-109.

Chakraborty, S., Baier, D., Knorr, D., & Mishra, H. N. 2015. High pressure inactivation of polygalacturonase, pectinmethylesterase and polyphenoloxidase in strawberry puree mixed with sugar. *Food and Bioproducts Processing*, 95, 281-291.

Chakraborty, S., Kaushik, N., Rao, P. S., & Mishra, H. N. 2014. High-Pressure Inactivation of Enzymes: A Review on Its Recent Applications on Fruit Purees and Juices. *Comprehensive Reviews in Food Science and Food Safety*, 13(4), 578-596.

Chapman, B., Winley, E., Fong, A. S. W., Hocking, A. D., Stewart, C. M., & Buckle, K. A. 2007. Ascospore inactivation and germination by high pressure processing is affected by ascospore age. *Innovative Food Science & Emerging Technologies*, 8(4), 531-534.

Cheftel, J. C. 1995. Review : High-pressure, microbial inactivation and food preservation / Revisión: Alta-presión, inactivación microbiológica y conservación de alimentos. *Food Science and Technology International*, 1(2-3), 75-90.

Chen, D., Xi, H., Guo, X., Qin, Z., Pang, X., Hu, X., . . . Wu, J. 2013. Comparative study of quality of cloudy pomegranate juice treated by high hydrostatic pressure and high temperature short time. *Innovative Food Science & Emerging Technologies*, 19, 85-94.

Chew, T. A., & Ghazali Mohayidin, M. 1995. Plantation agriculture: Its genesis, management, and role in the Malaysian economy. *Agribusiness*, 11(2), 139-145.

Daoudi, L., Quevedo, J., Trujillo, A.-J., Capdevila, F., Bartra, E., Mínguez, S., & Guamis, B. 2002. Effects of High-Pressure Treatment on the Sensory Quality of White Grape Juice (Vol. 22).

Daryaei, H., & Balasubramaniam, V. M. 2012. 13 - Microbial decontamination of food by high pressure processing. In A. Demirci & M. O. Ngadi (Eds.), *Microbial Decontamination in the Food Industry* (pp. 370-406): Woodhead Publishing.

De Faria, De Rosso, V., & Mercadante, A. 2009. Carotenoid composition of jackfruit (Artocarpus heterophyllus), determined by HPLC-PDA-MS/MS. *Plant foods for human nutrition*, 64(2), 108-115.

de Faria, A. F., de Rosso Vv Fau - Mercadante, A. Z., & Mercadante, A. Z. 2009. Carotenoid composition of jackfruit (Artocarpus heterophyllus), determined by HPLC-PDA-MS/MS. (1573-9104 (Electronic)).

Denoya, G. I., Vaudagna, S. R., & Polenta, G. 2015. Effect of high pressure processing and vacuum packaging on the preservation of fresh-cut peaches. *LWT - Food Science and Technology*, 62(1), 801-806.

Fachin, D., Loey, A. v., VanLoeyIndrawati, A., Ludikhuyze, L., & Hendrickx, M. 2002. Thermal and High- Pressure Inactivation of Tomato Polygalacturonase: A Kinetic Study. *Journal of food science*, 67(5), 1610-1615.

Fachin, D., Smout, C., Verlent, I., Ly Nguyen, B., Van Loey, A. M., & Hendrickx, M. E. 2004. Inactivation kinetics of purified tomato polygalacturonase by thermal and high-pressure processing. *Journal Agricultural Food Chemistry*, 52(9), 2697-2703.

Farheen, T., Ranganna, B., & Munishamanna, K. B. 2014. Vacuum packaging of minimally processed jackfruit bulbs for long distance transportation. Mysore *Journal of Agricultural Sciences*, 48(3), 351-357.

Feng, P., Weagant, S. D., Grant, M. A., Burkhardt, W., Shellfish, M., & Water, B. 2002. BAM: Enumeration of Escherichia coli and the Coliform Bacteria. *Bacteriological analytical manual*, 13-19.

Fernandes, P. A. R., Moreira, S. A., Fidalgo, L. G., Santos, M. D., Queirós, R. P., Delgadillo, I., & Saraiva, J. A. 2015. Food Preservation Under Pressure (Hyperbaric Storage) as a Possible Improvement/Alternative to Refrigeration. *Food Engineering Reviews*, 7(1), 1-10.

Fernández García, A., Butz, P., Bognàr, A., & Tauscher, B. 2001. Antioxidative capacity, nutrient content and sensory quality of orange juice and an orange-lemon-carrot juice product after high pressure treatment and storage in different packaging. *European Food Research and Technology*, 213(4), 290-296.

Garriga, M., Grèbol, N., Aymerich, M. T., Monfort, J. M., & Hugas, M. 2004. Microbial inactivation after high-pressure processing at 600 MPa in commercial meat products over its shelf life. *Innovative Food Science & Emerging Technologies*, 5(4), 451-457.

Goswami, C., Hossain, M., Kader, H., & Islam, R. 2011. Assessment of physicochemical properties of jackfruits'(Artocarpus heterophyllus Lam) pulps. *Journal of Horticulture, Forestry and Biotechnology*, 15(3), 26-31.

Gross, K. C. 1982. A rapid and sensitive spectrophotometric method for assaying polygalacturonase using 2-cyanoacetamide. *HortScience*, 17, 933-934.

Gunasena, H., Ariyadasa, K., Wikramasinghe, A., Herath, H., Wikramasinghe, P., & Rajakaruna, S. 1996. Manual of jack cultivation in Sri Lanka. *Forest Information Service, Forest Department*, 48.

Hagerman, A. E., & Austin, P. J. 1986. Continuous spectrophotometric assay for plant pectin methyl esterase. *J Agric Food Chem*, 34(3), 440-444.

Hayakawa, I., Kanno, T., Yoshiyama, K., & Fujio, Y. 1994. Oscillatory Compared with Continuous High Pressure Sterilization on Bacillus stearothermophilus Spores. *Journal of food science*, 59(1), 164-167.

Hayashi, R. 1995. Chapter 9 - Advances in high pressure food processing technology in Japan. In A. G. Gaonkar (Ed.), *Food Processing* (pp. 185-195). Amsterdam: Elsevier Science B.V.

Heiman, K. E., Mody, R. K., Johnson, S. D., Griffin, P. M., & Gould, L. H. 2015. Escherichia coli O157 Outbreaks in the United States, 2003–2012. *Emerging Infectious Diseases*, 21(8), 1293-1301.

Heinz, V., & Knorr, D. 2001. Effects of High Pressure on Spores. In M. G. Hendrickx, D. Knorr, L. Ludikhuyze, A. Van Loey & V. Heinz (Eds.), Ultra High Pressure Treatments of Foods (pp. 77-113): *Springer US*.

Hiremath, N., & Ramaswamy, H. 2012. High-pressure destruction kinetics of spoilage and pathogenic microorganisms in mango juice (Vol. 36).

Hite, B. H. 1899. The effect of pressure in the preservation of milk : a preliminary report. Morgantown, W.V.: *West Virginia Agricultural Experiment Station*.

Hite, B. H., Giddings, N. J., & Weakly, C. E. 1914. The Effect of Pressure on Certain Micro-Organisms Encountered in the Preservation of Fruits and Vegetables. Morgantown, W.V.: *West Virginia Agricultural Experiment Station*.

Hogan, E., Kelly, A. L., & Sun, D.-W. 2005. 1 - High Pressure Processing of Foods: An Overview. In D.-W. Sun (Ed.), *Emerging Technologies for Food Processing* (pp. 3-32). London: Academic Press.

Houben, K., Jamsazzadeh Kermani, Z., Van Buggenhout, S., Jolie, R., Van Loey, A., & Hendrickx, M. 2013. Thermal and High-Pressure Stability of Pectinmethylesterase, Polygalacturonase, β-Galactosidase and α-Arabinofuranosidase in a Tomato Matrix: Towards the Creation of Specific Endogenous Enzyme Populations Through Processing. *Food and Bioprocess Technology*, 6(12), 3368-3380.

Houben, K., Jamsazzadeh Kermani, Z., Van Buggenhout, S., Jolie, R. P., Van Loey, A. M., & Hendrickx, M. E. 2012. Thermal and High-Pressure Stability of Pectinmethylesterase, Polygalacturonase, β-Galactosidase and α-Arabinofuranosidase in a Tomato Matrix: Towards the Creation of Specific Endogenous Enzyme Populations Through Processing. *Food and Bioprocess Technology*, 6(12), 3368-3380.

Houška, M., Strohalm, J., Kocurová, K., Totušek, J., Lefnerová, D., Tříska, J., Paulíčková, I. 2006. High pressure and foods—fruit/vegetable juices. *Journal of Food Engineering*, 77(3), 386-398.

Hsu, H., Sheen, S., Sites, J., Huang, L., & Wu, J. S.-B. 2014. Effect of high pressure treatment on the survival of Shiga toxin-producing Escherichia coli in strawberry puree. *Food Microbiology*, 40(Supplement C), 25-30.

Huang, H.-W., Chang, Y. H., & Wang, C.-Y. 2015. High pressure pasteurization of sugarcane juice: evaluation of microbiological shelf life and quality evolution during refrigerated storage. *Food and Bioprocess Technology*, 8(12), 2483-2494.

Hugas, M., Garriga M Fau - Monfort, J. M., & Monfort, J. M. 2002. New mild technologies in meat processing: high pressure as a model technology. (0309-1740 (Print)).

Irwe, S., & Olsson, I. 1994. Reduction of pectinesterase activity in orange juice by high pressure treatment (pp. 35-42): CRC Press, Boca Raton, FL.

Jayachandran, L. E., Chakraborty, S., & Rao, P. S. 2015. Effect of high pressure processing on physicochemical properties and bioactive compounds in litchi based mixed fruit beverage. *Innovative Food Science & Emerging Technologies*, 28, 1-9.

Jung, S., Ghoul, M., & de Lamballerie-Anton, M. 2003. Influence of high pressure on the color and microbial quality of beef meat. *LWT - Food Science and Technology*, 36(6), 625-631.

Kader, A., & Barrett, D. 1996. Classification, composition of fruits, and postharvest maintenance of quality. *Processing fruits: Science and technology*, 1, 1-24.

Kader, A. A. (2001). A summary of CA requirements and recommendations for fruits other than apples and pears. Paper presented at the VIII International Controlled Atmosphere Research Conference 600.

Kader, A. A., & Rolle, R. S. 2004. The role of post-harvest management in assuring the quality and safety of horticultural produce (Vol. 152): *Food & Agriculture Org.*

Kameník, J., Saláková, A., Pavlík, Z., Bořilová, G., Hulanková, R., & Steinhauserová, I. 2014. Vacuum skin packaging and its effect on selected properties of beef and pork meat. *European Food Research and Technology*, 239(3), 395-402.

Katsaros, G., Alexandrakis, Z., & Taoukis, P. 2017. Kinetic Assessment of High Pressure Inactivation of Different Plant Origin Pectinmethylesterase Enzymes. *Food Engineering Reviews*, 1-20.

Kaushik, N., Kaur, B. P., & Rao, P. S. 2014. Application of high pressure processing for shelf life extension of litchi fruits (Litchi chinensis cv. Bombai) during refrigerated storage. *Revista de Agaroquimica y Tecnologia de Alimentos*, 20(7), 527-541.

Kaushik, N., Kaur, B. P., Rao, P. S., & Mishra, H. N. 2014. Effect of high pressure processing on color, biochemical and microbiological characteristics of mango pulp (Mangifera indica cv. Amrapali). *Innovative Food Science & Emerging Technologies*, 22(Supplement C), 40-50.

Kaushik, N., Rao, P. S., & Mishra, H. N. 2017. Comparative analysis of thermal-assisted high pressure and thermally processed mango pulp: Influence of processing, packaging, and storage. *Food Science and Technology International*, 1082013217724578.

Kays, S. J. 1991. Metabolic processes in harvested products Postharvest physiology of perishable plant products (pp. 75-142): *Springer*.

Knorr, D. 1993. Effects of high-hydrostatic-pressure processes on food safety and quality. *Food technology* (USA).

Knorr, D. 1999. Novel approaches in food-processing technology: new technologies for preserving foods and modifying function. *Current opinion in biotechnology*, 10(5), 485-491.

Knorr, D., Heinz, V., & Buckow, R. 2006. High pressure application for food biopolymers. *Biochimica et Biophysica Acta (BBA) - Proteins and Proteomics*, 1764(3), 619-631.

Krebbers, B., Matser, A. M., Hoogerwerf, S. W., Moezelaar, R., Tomassen, M. M. M., & van den Berg, R. W. 2003. Combined high-pressure and thermal treatments for processing of tomato puree: evaluation of microbial inactivation and quality parameters. *Innovative Food Science & Emerging Technologies*, 4(4), 377-385.

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(1), 171-201.

Kunugi, S., & Tanaka, N. 2002. Cold denaturation of proteins under high pressure. *Biochimica et Biophysica Acta (BBA) - Protein Structure and Molecular Enzymology*, 1595(1), 329-344.

Kusumaningrum, D., Lee, S.-H., Lee, W.-H., Mo, C., & Cho, B.-K. 2015. A Review of Technologies to Prolong the Shelf Life of Fresh Tropical Fruits in Southeast Asia (Vol. 40).

Lambert, Y., Demazeau, G., Largeteau, A., Bouvier, J. M., Laborde-Croubit, S., & Cabannes, M. 2000. Packaging for high-pressure treatments in the food industry. *Packaging Technology and Science*, 13(2), 63-71.

LeChevallier, M. W., Shaw, N. J., & Smith, D. B. 1996. Factors limiting microbial growth in distribution systems: full-scale experiments: *American Water Works Association*.

Lelievre, J.-M., Tichit, L., Dao, P., Fillion, L., Nam, Y.-W., Pech, J.-C., & Latché, A. 1997. Effects of chilling on the expression of ethylene biosynthetic genes in Passe-Crassane pear (Pyrus communis L.) fruits. *Plant molecular biology*, 33(5), 847-855.

Lima Tribst, A. A., de Souza Sant'Ana, A., & de Massaguer, P. R. 2009. Microbiological quality and safety of fruit juices—past, present and future perspectives. *Critical Reviews in Microbiology*, 35(4), 310-339.

Linton, M., & Patterson, M. F. 2000. High pressure processing of foods for microbiological safety and quality (a short review). (1217-8950 (Print)).

Liu, F., Wang, Y., Li, R., Bi, X., & Liao, X. 2014. Effects of high hydrostatic pressure and high temperature short time on antioxidant activity, antioxidant compounds and color of mango nectars. *Innovative Food Science & Emerging Technologies*, 21(Supplement C), 35-43.

Ludikhuyze, L., Van Loey, A., Denys, I. S., & Hendrickx, M. E. 2001. Effects of high pressure on enzymes related to food quality Ultra high pressure treatments of foods (pp. 115-166): *Springer*.

Ludwig, H., & Schreck, C. 1997. The inactivation of vegetative bacteria by pressure. *High pressure research in the biosciences and biotechnology*, 221-224.

Ly- Nguyen, B., Loey, A. v., Smout, C., ErenÖzcan, S., Fachin, D., Verlent, I., Hendrickx, M. 2003. Mild- Heat and High- Pressure Inactivation of Carrot Pectin Methylesterase: A Kinetic Study. *Journal of food science*, 68(4), 1377-1383.

Ma, H. J., & Ledward, D. A. 2004. High pressure/thermal treatment effects on the texture of beef muscle. *Meat Sci*, 68(3), 347-355.

Macé, S., Joffraud, J.-J., Cardinal, M., Malcheva, M., Cornet, J., Lalanne, V., Dousset, X. 2013. Evaluation of the spoilage potential of bacteria isolated from spoiled raw salmon (Salmo salar) fillets stored under modified atmosphere packaging. *International Journal of Food Microbiology*, 160(3), 227-238.

Malaysia, International Law Book, S., & Legal Research, B. 1994. Food Act 1983 (Act 281) ; & Food Regulations 1985 : as at 25th July 1994. Kuala Lumpur: *International Law Book Services*.

Mañas, P., & Mackey, B. M. 2004. Morphological and Physiological Changes Induced by High Hydrostatic Pressure in Exponential- and Stationary-Phase Cells of Escherichia coli: Relationship with Cell Death. *Applied and Environmental Microbiology*, 70(3), 1545-1554.

Marangoni, A. G., Jackman, R. L., & Stanley, D. W. 1995. Chilling-Associated Softening of Tomato Fruit is Related to Increased Pectinmethylesterase Activity. *Journal of food science*, 60(6), 1277-1281.

Mertens, B. 1995. Hydrostatic pressure treatment of food: equipment and processing. In G. W. Gould (Ed.), *New Methods of Food Preservation* (pp. 135-158): Springer US.

Mozhaev, V. V., Heremans, K., Frank, J., Masson, P., & Balny, C. 1994. Exploiting the effects of high hydrostatic pressure in biotechnological applications. *Trends in Biotechnology*, 12(12), 493-501.

Mukhopadhyay, S., Sokorai, K., Ukuku, D., Fan, X., Juneja, V., Sites, J., & Cassidy, J. 2016. Inactivation of Salmonella enterica and Listeria monocytogenes in cantaloupe puree by high hydrostatic pressure with/without added ascorbic acid. *International Journal of Food Microbiology*, 235(Supplement C), 77-84.

Nakasone, H. Y., & Paull, R. E. 1998. Tropical fruits: Cab International.

Narasimham, P. 1990. Breadfruit and jackfruit. Fruits of Tropical and Subtropical Origin. Composition, Properties and Uses (S. Nagy, PE Shaw and WF Wardowski, eds.). *Florida Science Source*, Inc. Lake Alfred, Florida, 193-259.

Nienaber, U., & Shellhammer, T. 2001. High- pressure processing of orange juice: combination treatments and a shelf life study. *Journal of food science*, 66(2), 332-336.

Noichinda, S. 2000. Respiration rate and ethylene production of lime fruit. *Natl J King Mongkut's Inst Tech (North Bangkok)*, 7, 27-31.

O'Hare, T. 1995. Postharvest physiology and storage of rambutan. *Postharvest Biology and Technology*, 6(3-4), 189-199.

O'Reilly, C. E., O'Connor, P. M., Kelly, A. L., Beresford, T. P., & Murphy, P. M. 2000. Use of Hydrostatic Pressure for Inactivation of Microbial Contaminants in Cheese. *Applied and Environmental Microbiology*, 66(11), 4890-4896.

Oey, I., Lille, M., Van Loey, A., & Hendrickx, M. 2008a. Effect of high-pressure processing on colour, texture and flavour of fruit- and vegetable-based food products: a review. *Trends in Food Science & Technology*, 19(6), 320-328.

Oey, I., Lille, M., Van Loey, A., & Hendrickx, M. 2008b. Effect of high-pressure processing on colour, texture and flavour of fruit-and vegetable-based food products: a review. *Trends in Food Science & Technology*, 19(6), 320-328.

Oey, I., Van der Plancken, I., Van Loey, A., & Hendrickx, M. 2008. Does high pressure processing influence nutritional aspects of plant based food systems? *Trends in Food Science & Technology*, 19(6), 300-308.

Ogawa, H., Fukuhisa, K., Kubo, Y., & Fukumoto, H. 1990. Pressure inactivation of yeasts, molds, and pectinesterase in Satsuma mandarin juice: effects of juice concentration, pH, and organic acids, and comparison with heat sanitation. *Agricultural and Biological Chemistry*, 54(5), 1219-1225.

Okazaki, T., Kakugawa, K., Yoneda, T., & Suzuki, K. 2000. Inactivation Behavior of Heat-Resistant Bacterial Spores by Thermal Treatments Combined with High Hydrostatic Pressure. *Food Science and Technology Research*, 6(3), 204-207.

Paciulli, M., Medina-Meza, I. G., Chiavaro, E., & Barbosa-Cánovas, G. V. 2016. Impact of thermal and high pressure processing on quality parameters of beetroot (Beta vulgaris L.). *LWT - Food Science and Technology*, 68(Supplement C), 98-104.

Pagán, R., & Mackey, B. 2000. Relationship between Membrane Damage and Cell Death in Pressure-Treated Escherichia coli Cells: Differences between Exponential- and Stationary-Phase Cells and Variation among Strains. *Applied and Environmental Microbiology*, 66(7), 2829-2834.

Pagán, R., Mañas, P., Raso, J., & Condón, S. 1999. Bacterial Resistance to Ultrasonic Waves under Pressure at Nonlethal (Manosonication) and Lethal (Manothermosonication) Temperatures. *Applied and Environmental Microbiology*, 65(1), 297-300.

Patterson, M. F. 2005. Microbiology of pressure-treated foods. *Journal of Applied Microbiology*, 98(6), 1400-1409.

Paul, V., Pandey, R., & Srivastava, G. C. 2012. The fading distinctions between classical patterns of ripening in climacteric and non-climacteric fruit and the ubiquity of ethylene—An overview. *Journal of food science and technology*, 49(1), 1-21.

Pereda, J., Ferragut, V., Quevedo, J. M., Guamis, B., & Trujillo, A. J. 2007. Effects of Ultra-High Pressure Homogenization on Microbial and Physicochemical Shelf Life of Milk. *Journal of Dairy Science*, 90(3), 1081-1093.

Polydera, A., Galanou, E., Stoforos, N., & Taoukis, P. 2004. Inactivation kinetics of pectin methylesterase of greek Navel orange juice as a function of high hydrostatic pressure and temperature process conditions. *Journal of Food Engineering*, 62(3), 291-298.

Pua, C. K., Hamid, N. S. A., Tan, C. P., Mirhosseini, H., Rahman, R. B. A., & Rusul, G. 2010. Optimization of drum drying processing parameters for production of jackfruit (Artocarpus heterophyllus) powder using response surface methodology. *LWT-Food Science and Technology*, 43(2), 343-349.

Pua, C. K., Sheikh Abd. Hamid, N., Tan, C. P., Mirhosseini, H., Abd. Rahman, R., & Rusul, G. 2008. Storage stability of jackfruit (Artocarpus heterophyllus) powder packaged in aluminium laminated polyethylene and metallized co-extruded biaxially oriented polypropylene during storage. *Journal of Food Engineering*, 89(4), 419-428.

Ramos, B., Miller, F. A., Brandão, T. R. S., Teixeira, P., & Silva, C. L. M. 2013. Fresh fruits and vegetables—An overview on applied methodologies to improve its quality and safety. *Innovative Food Science & Emerging Technologies*, 20(Supplement C), 1-15.

Rao, L., Guo, X., Pang, X., Tan, X., Liao, X., & Wu, J. 2014. Enzyme activity and nutritional quality of peach (Prunus persica) juice: effect of high hydrostatic pressure. *International Journal of Food Properties*, 17(6), 1406-1417.

Reddy, N. R., Solomon, H. M., Fingerhut, G. A., Rhodehamel, E. J., Balasubramaniam, V. M., & Palaniappan, S. 1999. Inactivation of clostridium botulinum type e spores by high pressure processing. *Journal of Food Safety*, 19(4), 277-288.

Riahi, E., & Ramaswamy, H. S. 2003. High- Pressure Processing of Apple Juice: Kinetics of Pectin Methyl Esterase Inactivation. *Biotechnology progress*, 19(3), 908-914.

Ritz, M., Pilet, M. F., Jugiau, F., Rama, F., & Federighi, M. 2006. Inactivation of Salmonella Typhimurium and Listeria monocytogenes using high-pressure treatments: destruction or sublethal stress? *Letters in Applied Microbiology*, 42(4), 357-362.

Ritz, M., Tholozan, J. L., Federighi, M., & Pilet, M. F. 2001. Morphological and Physiological Characterization ofListeria monocytogenes Subjected to High Hydrostatic Pressure. *Applied and Environmental Microbiology*, 67(5), 2240-2247.

Rovere, P., Lonnerborg, N., Gola, S., Miglioli, L., Scaramuzza, N., & Squarcina, N. 1999. Advances in bacterial spores inactivation in thermal treatments under pressure *Advances in high pressure bioscience and biotechnology* (pp. 113-120): Springer.

Samborska, K., Guiavarc'h, Y., Van Loey, A., & Hendrickx, M. 2005. The influence of moisture content on the thermostability of Aspergillus oryzae α-amylase. *Enzyme and microbial technology*, 37(2), 167-174.

Saxena, A., Bawa, A. S., & Raju, P. S. 2008. Use of modified atmosphere packaging to extend shelf-life of minimally processed jackfruit (Artocarpus heterophyllus L.) bulbs. *Journal of Food Engineering*, 87(4), 455-466.

Saxena, A., Bawa, A. S., & Raju, P. S. 2011a. 12 - Jackfruit (Artocarpus heterophyllus Lam.) A2 - Yahia, Elhadi M Postharvest Biology and Technology of Tropical and Subtropical Fruits (pp. 275-299e): *Woodhead Publishing*.

Saxena, A., Bawa, A. S., & Raju, P. S. 2011b. Jackfruit (Artocarpus heterophyllus Lam.) Postharvest Biology and Technology of Tropical and Subtropical Fruits: Cocona to Mango (pp. 275-298).

Saxena, A., Saxena, T. M., Raju, P., & Bawa, A. 2013. Effect of controlled atmosphere storage and chitosan coating on quality of fresh-cut jackfruit bulbs. *Food and Bioprocess Technology*, 6(8), 2182-2189.

Serment-Moreno, V., Jacobo-Velázquez, D. A., Torres, J. A., & Welti-Chanes, J. 2017. Microstructural and Physiological Changes in Plant Cell Induced by Pressure: Their Role on the Availability and Pressure-Temperature Stability of Phytochemicals. *Food Engineering Reviews*, 1-21.

Shook, C. M., Shellhammer Th Fau - Schwartz, S. J., & Schwartz, S. J. 2001. Polygalacturonase, pectinesterase, and lipoxygenase activities in high-pressure-processed diced tomatoes. (0021-8561 (Print)).

Simonin, H., Duranton, F., & de Lamballerie, M. 2012. New Insights into the High-Pressure Processing of Meat and Meat Products. Comprehensive Reviews in *Food Science and Food Safety*, 11(3), 285-306.

Singh, A., Kumar, S., & Singh, I. 1991. Functional properties of jack fruit seed flour. Lebensmittel-Wissenschaft+ Technologie, 24(4), 373-374.

Smelt, J. P. 1998. Recent advances in the microbiology of high pressure processing. *Trends in Food Science & Technology*, 9(4), 152-158.

Smelt, J. P., Hellemons, J. C., & Patterson, M. 2001. Effects of high pressure on vegetative microorganisms. *Ultra high pressure treatments of foods* (pp. 55-76): Springer.

Stahl, W., & Sies, H. 2005. Bioactivity and protective effects of natural carotenoids. *Biochimica et Biophysica Acta (BBA) - Molecular Basis of Disease*, 1740(2), 101-107.

Standard, B., & ISO, B. 2004. Sensory Analysis–Methodology–Triangle test. BS ISO, 4120, 2004.

Stratakos, A. C., Linton, M., Tessema, G. T., Skjerdal, T., Patterson, M. F., & Koidis, A. 2016. Effect of high pressure processing in combination with Weissella viridescens as a protective culture against Listeria monocytogenes in ready-to-eat salads of different pH. *Food Control*, 61(Supplement C), 6-12.

Swami, S. B., Thakor, N., Haldankar, P., & Kalse, S. 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.

Taib, M., Muhamad, I., Ngo, C., & Ng, P. 2013. Drying kinetics, rehydration characteristics and sensory evaluation of microwave vacuum and convective hot air dehydrated jackfruit bulbs. *Jurnal Teknologi*, 65(1).

Tangwongchai, R., Ledward, D. A., & Ames, J. M. 2000. Effect of high-pressure treatment on the texture of cherry tomato. *J Agric Food Chem*, 48(5), 1434-1441.

Tauscher, B. 1995. Pasteurization of food by hydrostatic high pressure: chemical aspects. *Zeitschrift für Lebensmittel-Untersuchung und Forschung*, 200(1), 3-13.

Terefe, N. S., Gamage, M., Vilkhu, K., Simons, L., Mawson, R., & Versteeg, C. 2009. The kinetics of inactivation of pectin methylesterase and polygalacturonase in tomato juice by thermosonication. *Food Chemistry*, 117(1), 20-27.

Thakur, B. R., & Nelson, P. E. 1998. High- pressure processing and preservation of food. *Food Reviews International*, 14(4), 427-447.

Ting, E., & Marshall, R. 2002. Production issues related to UHP food (pp. 727-738): *Food Preservation Technology Series< Boca Raton: CRC Press*.

Tournas, V., Stack, M., Mislivec, P., Koch, H., & Bandler, R. 1998. Yeasts, molds and mycotoxins (Chapter 18), Bacteriological Analytical Manual (BAM, ). *Food and Drug Administration*, Gaithersburg, MD, USA, 227-234.

Tsou, C.-L. 1986. Location of the active sites of some enzymes in limited and flexible molecular regions. *Trends in Biochemical Sciences*, 11(10), 427-429.

Van den Broeck, I., Ludikhuyze Lr Fau - Van Loey, A. M., Van Loey Am Fau - Hendrickx, M. E., & Hendrickx, M. E. 2000. Inactivation of orange pectinesterase by combined high-pressure and -temperature treatments: a kinetic study. (0021-8561 (Print)).

Varela-Santos, E., Ochoa-Martinez, A., Tabilo-Munizaga, G., Reyes, J. E., Pérez-Won, M., Briones-Labarca, V., & Morales-Castro, J. 2012. Effect of high hydrostatic pressure (HHP) processing on physicochemical properties, bioactive compounds and shelf-life of pomegranate juice. *Innovative Food Science & Emerging Technologies*, 13, 13-22.

Vázquez-Gutiérrez, J., Quiles, A., Hernando, I., & Pérez-Munuera, I. 2011. Changes in the microstructure and location of some bioactive compounds in persimmons treated by high hydrostatic pressure. *Postharvest Biology and Technology*, 61(2), 137-144.

Vojdani, J. D., Beuchat Lr Fau - Tauxe, R. V., & Tauxe, R. V. 2008. Juice-associated outbreaks of human illness in the United States, 1995 through 2005. (0362-028X (Print)).

Wills, R., McGlasson, B., Graham, D., Joyce, D., & Rushing, J. W. 1999. Postharvest: An introduction to the physiology and handling of fruit, vegetables and ornamentals. *Journal of vegetable crop production*, 4(2), 83-84.

Wuytack, E. Y., Boven S Fau - Michiels, C. W., & Michiels, C. W. 1998. Comparative study of pressure-induced germination of Bacillus subtilis spores at low and high pressures. (0099-2240 (Print)).

Wuytack, E. Y., Soons J Fau - Poschet, F., Poschet F Fau - Michiels, C. W., & Michiels, C. W. 2000. Comparative study of pressure- and nutrient-induced germination of Bacillus subtilis spores. (0099-2240 (Print)).