UNIVERSITI PUTRA MALAYSIA

OPTIMISATION AND RHEOLOGICAL MODELLING OF THERMOSONICALLY EXTRACTED TROPICAL FRUIT JUICE CONCENTRATES

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By

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OPTIMISATION AND RHEOLOGICAL MODELLING OF THERMOSONICALLY EXTRACTED TROPICAL FRUIT JUICE CONCENTRATES

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This study aims to investigate the extraction of tropical fruit juice with assisted thermosonication treatment through optimisation and rheological modelling approach. Juice from the pink-fleshed guava, pink-fleshed pummelo and soursop was extracted using direct and indirect thermosonication methods by varying the intensity, time and temperature and compared to those extracted using water bath incubation. The main effects, and the 3D or 4D surface plots for each response were developed based on the factors that influenced the responses, where 3D surface plot contains of three axes for two variables and a response, while 4D surface plot explains three variables simultaneously with coloured surface to represent response values. The results indicated that the best extraction method for guava and pummelo juices were using the indirect thermosonication method with parameters of 1 kW, 55°C and 30 minutes and 2.5 kW, 54°C and 23 minutes, respectively. The direct thermosonication method at 10% amplitude and 55°C for 2 to 10 minutes was more suitable for the soursop juice.

The steady-state flow test of pink-fleshed guava, pink-fleshed pummelo and soursop was studied for combination of different temperature and concentration. All the rheological data were then superimposed into a master curve using shear rate-temperature-concentration superposition technique to predict rheological behaviour at wider range of shear rate. The final equations show shear-thinning behaviour of pink-fleshed guava, pink-fleshed pummelo and soursop with flow behaviour index of 0.2217, 0.7507 and 0.6347, respectively.

The influence of concentration on rheological behaviour of pink-fleshed guava, pink-fleshed pummelo and soursop juice concentrates was evaluated using existing models and their individual lines were shifted into a master curve using concentration-temperature principle to predict rheological parameters at wider

concentration values. A new mathematical model could be applied to describe the effect of temperature on consistency coefficient and flow behaviour index of pink-fleshed guava, pink-fleshed pummelo and soursop. An expression for new mathematical model, which combined the Arrhenius and logistic sigmoidal growth models is proposed to alleviate problems of negative region of modelling the effect of temperature on consistency coefficient and flow behaviour index using the Arrhenius model alone, and due to the improvement of curve fitting ($R^2 \geq 0.99$).

In conclusion, tropical fruit juice extraction can be done efficiently with thermosonication treatment, where the combination of mild heat and cavitation effects of ultrasound functions to reduce juice yield, ascorbic acid content and total soluble solids content loss.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENGOPTIMUMAN DAN PERMODELAN REOLOGI BAGI PATI JUS BUAH-BUAHAN TROPIKA YANG DIEKSTRAK SECARA TERMOSONIK

Oleh

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Kajian ini bertujuan untuk menyiasat pengekstrakan jus buah-buahan tropika dengan dibantu oleh rawatan termosonik melalui pendekatan pengoptimuman dan permodelan reologi. Jus daripada jambu berisi merah jambu, limau bali berisi merah jambu dan durian Belanda diekstrak menggunakan kaedah termosonik secara langsung dan tidak langsung dengan mempelbagaikan keamatan, masa dan suhu dan dibandingkan dengan yang diekstrak menggunakan pengeraman rendaman air. Plot bagi kesan-kesan utama, 3D atau 4D bagi setiap gerak balas dibangunkan berdasarkan factor-faktor yang mempengaruh gerak balas, di mana plot permukaan 3D mengandungi tiga paksi untuk dua pembolehubah dan satu response, manakala plot permukaan 4D menerangkan tiga pembolehubah secara serentak dengan permukaan berwarna untuk mewakili nilai respon. Keputusan menunjukkan bahawa kaedah pengekstrakan terbaik untuk jus-jus jambu dan limau bali menggunakan kaedah termosonik secara tidak langsung dengan parameter masing-masing ialah 1 kW, 55°C dan 30 minit,dan 2.5 kW, 54°C dan 23 minit. Kaedah termosonik secara langsung pada amplitud 10% dan 55°C selama 2 hingga 10 minit lebih sesuai untuk jus durian Belanda.

Ujian aliran keadaan mantap bagi jambu berisi merah jambu, limau bali berisi merah jambu dan limau bali dikaji untuk gabungan suhu dan kepekatan yang berbeza. Model hukumkuasa disuaikan kepada data dan semua data reologi kemudian ditindih menjadi satu lengkung induk menggunakan teknik pertindihan kadar ricihan-suhu-kepekatan sama ada dengan anjakan mendatar tunggal atau dua dimensi (mendatar-menegak) ke satu suhu rujukan dan kepekatan untuk langkah pertama dan kedua bagi penganjakan, masing-masing, untuk meramal sifat reologi pada julat kadar ricihan yang lebih luas. Persamaan-persamaan akhir menunjukkan sifat penipisan ricih bagi jambu berisi merah jambu, limau bali berisi merah jambu dan limau bali dengan indeks sifat aliranmasing-masing ialah 0.2217, 0.7507 dan 0.6347.

Pengaruh kepekatan ke atas sifat reologi bagi pati jus jambu berisi merah jambu, limau bali berisi merah jambu dan durian Belanda dinilai menggunakan model-model sedia ada dan garis-garis individu dianjak menjadi satu lengkung induk menggunakan prinsip kepekatan-suhu untuk meramal parameter reologi pada nilai-nilai kepekatan yang lebih luas. Satu model matematik yang baru boleh digunakan untuk menjelaskan kesan suhu ke atas pekali kekonsistenan dan indeks sifat aliran bagi jambu berisi merah jambu, limau bali berisi merah jambu dan durian Belanda. Satu ungkapan untuk model matematik yang baru, yang menggabungkan model-model Arrhenius dan pertumbuhan logistik sigmoidal dicadangkan untuk mengurangkan masalah rantau negatif bagi permodelan kesan suhu ke atas pekali kekonsistenan dan indeks sifat aliran menggunakan model Arrhenius sahaja, dan disebabkan peningkatan penyuaian lengkung ($R^2 \geq 0.99$).

Kesimpulannya, pengekstrakan buah-buahan tropika boleh dilakukan secara berkesan dengan rawatan termosonik, di mana gabungan haba antara haba yang sederhana dan kesan kavitasi bagi fungsi ultrabunyi untuk mengurangkan kehilangan hasil jus, kandungan asid askorbik dan kandungan jumlah pepejal larut.

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3D	Three-dimensional
4D	Four-dimensional
σ	Shear stress
μ	Newtonian viscosity
$\dot{\gamma}$	Shear rate
K_B	Bingham consistency coefficient
σ_o	Yield stress
AA	Ascorbic acid
TSS	Total soluble solids
K	Consistency coefficient
n	Flow behaviour index
R^2	Regression coefficient
RMSE	Root mean square error
SSE	Sum of square error
SST	Total sum of squares
$\bar{y}_{\text{experimental}}$	Mean of experimental value of dependent variable
$y_{\text{experimental}}$	Experimental value of dependent variable
y_{model}	Model value of dependent variable
N	Number of data
V	Line slope
W	y_{model}-intercept
RSM	Response surface methodology

Y	Response
β_0	Constant for intercept
β_{01} to β_{09}	Constant for blocks
β_j	Linear coefficient
β_{jj}	Quadratic coefficient
β_{ij}	Interaction coefficient
x_i and x_j	Independent variables (*i* and *j* are in the range of 1 to *k*)
k	Number of independent variables (k=3).
S	Standard deviation
R^2_{adj}	Adjusted regression
ANOVA	Analysis of variance
DMRT	Duncan's multiple range tests
JY	Juice yield
g	Guava
c	Control
ds	Direct thermosonication
is	Indirect thermosonication
M	Motion frequency
t	Time
T	Temperature
A	Amplitude
P	Power
a_T	Shear rate-temperature shift factor
$\dot{\gamma}_T$	Shear rate at temperature T

$\dot{\gamma}_{T_{ref}}$	Shear rate at reference temperature
a_C	Shear rate-temperature-concentration shift factor
$\dot{\gamma}_C$	Shear rate at concentration C
$\dot{\gamma}_{C_{ref}}$	Shear rate at reference concentration
b_C	Concentration shift factor
σ_C	Shear stress at concentration C
$\sigma_{C_{ref}}$	Shear stress at reference concentration
a_T	Shift factor
C_T	Concentration at defined temperature
C_{Tref}	Concentration at reference temperature
k_T	Constant
n_T	Constant
Ea	Activation energy
R	Universal gas constant
H	Maximum value
D	Constant
r	Growth parameter
k_c	Constant
n_c	Constant
b	Constant
N	Number of population

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Fruits are perishable and some of them are seasonal. The demand for fruit juice is growing due to advantages of it being available all year round. Fruit juice is convenient for consumer without having to peel and cut fruits. People have been educated through mass media on the health benefits of fruit juice consumption. The processing of tropical fruit juice started in many countries during the last decades (Sharoba and Ramadan, 2011). Malaysia has increased by 13% in sales volume of ready-to-drink juice by litres in less than a decade (Anonymous, 2014b). The Star newspaper (Anonymous, 2014b) reported that 47% of those interviewed wanted to look cool and fashionable by drinking juice, while 65% of them love to drink juice for its goodness. Malaysians are also concerned about the taste and the quality of fruit juice. Processing into fruit juice can also help to reduce post-harvest wastage. Fruit production worldwide records over 360 million metric tons (Sharoba and Ramadan, 2011).

The pink-fleshed guava, pink-fleshed pummelo and soursop fruits juice are the main subject in this research because these fruits have a lot of medical benefits. There is limited and/or no information and published data found on extracting juices from these three fruits as well as preserving them into juice concentrates (Brasil *et al.*, 1995; Quek *et al.*, 2012). By consuming these fruits, cancer cells can be attacked safely and effectively naturally without causing extreme side effects like nausea and hair loss. The pink-fleshed guava (*Psidium guajava* L.) contains lycopene, which can prevent skin damage from UV rays and offer protection from prostate cancer (van Breemen and Pajkovic, 2008). It is also rich in carotene to protect from lung and oral cavity cancers. The high vitamin C content in pink-fleshed pummelo (*Citrus Maxima* M.) helps to strengthen and maintain the elasticity of arteries (Sarvamangala *et al.*, 2013). Besides good for digestive system, the pummelo can aid in weight loss process because the fat burning enzyme in pummelo can help to absorb and reduce starch and sugar in the body. The pink-fleshed pummelo is slightly sweeter and more nutritious than other pummelos because of the darker pigment. The soursop (*Annona muricata* L.) contains annonaceous acetogenins, which owns prostate cancer chemopreventive compounds (Atawodi, 2011). This fruit is good as a remedy for urethritis, haematuria and liver ailments (Badrie and Schauss, 2010) and also widely used as anticancer folk therapies in the North, Central and South America, and Southeast Asia (Ko *et al.*, 2011b).

The soursop fruit is hardly found, while the fresh pink-fleshed guava fruit cannot be found in Malaysian market. The nation's only pink guava producer is Sime Darby Beverages Sdn. Bhd. and the company does not sell the pink-fleshed guava fruits except for special request. The harvested fruits are processed into puree immediately or not more than six hours after being harvested everyday and the puree is exported. Pink-fleshed guava ready-to-drink juice and pink-fleshed guava juice concentrate, which is brandnamed GoFresh, are produced in small amount, and only sold in selected local supermarket and served in-flights by the Malaysia Airlines (Anonymous, 2015b). The pink-fleshed pummelo is only available twice a year, i.e., during Chinese New Year and Mid-Autumn Festival. Since the fruits are highly perishable and seasonal, they should be processed into juices to make their nutrition and freshness available all year around.

1.2 Statement of the Problem

Generally, fruit juice extraction is done by pressing the pulp to expel the juice. However, there are many fruit-specific ways to extract the juice (Bates *et al.*, 2001). Juice from firm and seed inedible fruits like apple is pressed mechanically, where hot press is a common process to get higher juice yield. For firm fruits with inedible skin and seeds such as citrus fruits, their fleshes are pressed mechanically to extract the juice. A tough adhering skin and seeds like soursop is hand peeled and its juice is extracted using a pulper finisher, which use heat to soften the tissue and inactivate enzymes. A steam extraction system is a current practice to extract juice from soft and readily extractable fruits such as grapes, where juice is flow out from the fruits and leave the skin empty.

The pink-fleshed guava and soursop fruits are difficult-to-juice produce and perishable almost immediately after they have ripened, while the pink-fleshed pummelo fruit is a free-run juice (Bashir and Abu-Goukh, 2003; Anonymous, 2009; Quek *et al.*, 2012; Davies and Mohammed, 2013). As the pink-fleshed guava and soursop juices are difficult to be extracted, a more advanced extraction process is needed to increase the volume of juice produced. Extraction methods which produce high quality juices will fulfil consumers' demand on nutritious, convenient and minimally processed fruit juices for health reasons. Thermosonication treatment, which is a combination of mild heat and ultrasound aids in juice extraction process through high extraction rate with minimum adverse effects of heating. Although ultrasonically assisted extraction process is known of its capability of releasing contents such as sugar, medicinal compounds and protein from biological materials by disrupting the cell walls (Mason *et al.*, 1996), it has not been used for extracting pink-fleshed guava, pink-fleshed pummelo and soursop juices. Sin *et al*. (2006)and Lee *et al*. (2006) applied hot water extraction method to extract sapodilla and banana juice, respectively, while Cendres *et al*. (2011) extracted juice from grape, plums and apricots using microwave.

The fruit juice industry deals with variety of temperatures and unit operations such as extraction, size reduction, fluid flow and heat transfer in its production process. The knowledge on rheological behaviour of the tropical fruit juice concentrates as affected by concentration and temperature are necessary for food and process engineerings, for scientific applications, and to evaluate juice-processing equipments. A proper design of extraction operations could help to optimise processing, prevent over-dimensioned of facilities and reduce wasteful use of economic resources (Falguera *et al.*, 2010). It also leaves less fouling thus fruit juice may flow easily without being stuck in a pipe. Optimisation and modelling approach is important in helping to design a proper tropical fruit juice extraction with a systematic and accurate approach. A better understanding of the optimisation technique and rheological behaviour of the tropical fruit juice concentrates provide opportunities of maximizing the capacity of fruit juice production without adverse effects to the nutrients content. The preservation of nutrients content is definitely apprehending the exclamation of Malaysian government urging the public to eat healthy (Anonymous, 2014a; Anonymous, 2015a).

1.3 Aims and Objectives

The aim of this study is to investigate the extraction of tropical fruit juice with assisted thermosonication treatment through modelling and optimisation approach. Tropical fruits in this context refer to the pink-fleshed guava, pink-fleshed pummelo and soursop. This research aims to provide a best and efficient thermosonic-assisted juice extraction method to increase the volume of difficult-to-juice produce with minimum adverse effects on vitamin C of the juice. Besides that, this research also provides model for correlating critical processing parameters, i.e., temperature and juice concentration with its rheological behaviour for optimisation of juice flowability during juice production process, handling and transportation.

The specific objectives are:

i. to compare the direct and indirect thermosonic-assisted extraction methods and conditions for producing higher juice yield with maximum ascorbic acid and total soluble solids levels of the tropical fruit juices,
ii. to model rheological behaviour of juice concentrates using the power law model and obtain the rheological parameters,
iii. to investigate the applicability of shear rate-temperature-concentration superposition technique for modelling rheological data,
iv. to model the effect of concentration on rheological behaviour of the tropical fruit juice concentrates using existing models, and concentration-temperature principle for developing a master curve, and
v. to develop and analyse a proposed new mathematical model, which combines the Arrhenius and logistic growth models for modelling the effect of temperature on the rheological behaviour of the tropical fruit juice concentrates.

1.4 Research Novelty

The novelties of this study are:

i. Extracting pink-fleshed guava, pink-fleshed pummelo and soursop fruit juices using thermosonication-assisted treatment.
ii. Blocked face-centered central composite design for optimised the tropical fruit juice extraction where four-dimensional (4D) surface plot has helped to explain

simultaneously the optimum juice extraction conditions affected by combination of 3 input factors.

iii. Application of vertical shift of rheological data of pink-fleshed guava to make a smooth master curve.

iv. A new mathematical model proposed from the combination of Arrhenius and logistic sigmoidal growth models to alleviate limitation of using Arrhenius model which trends to negative values of K and n due to positive value of K and low n magnitude between 0 and 1.

1.5 Scope of Thesis

The research performed in this thesis for studying fruit juice extraction and modelling of its rheological behaviour in concentrate form is meant to increase juice production capacity and improve juice processing efficiency. Chapter 2 reviews previous studies on fruit juice production and mathematical modelling. The groups of tropical fruit juice and its processing technologies are summarised. A full description about thermosonication treatment and its effects on fruit juice quality and safety are reviewed. The mathematical modelling for process optimisation, existing rheological models and superposition principle are reviewed and presented.

Chapter 3 provides the materials, set-up and experimental procedures in performing this research. Fruit juice concentrates preparation is reported and the design of each experiment is illustrated by process flow chart. The methods used for analysing each sample and the optimisation steps are described. The statistical analysis used is explained at the end of the section.

A suitable juice extraction method is necessary to minimise the adverse effects cause by overheating during juice processing. Chapter 4 offers results of the best juice extraction method for fruit type studied. The characteristics of fresh fruit pulp and mixture pulp for each materials involved are reported. The last section in Chapter 4 gave experimental verification on the precision of predicting equations on models.

Chapter 5 presents the flow behaviour of juice concentrates by the power law model fitting. This chapter shows the development of a master curve using shear rate-temperature-concentration superposition principle via single horizontal and horizontal-vertical shifting.

Chapter 6 presents the correlations between juice concentration and consistency coefficient or flow behaviour index by the power law and exponential models. The master curve was constructed to explain the effect of concentration on consistency coefficient or flow behaviour index of all rheological data in one curve line.

The Arrhenius model has been widely used to describe the effect of temperature. Chapter 7 proposes new mathematical model to predict the consistency coefficient and flow behaviour index at temperature increase. This chapter presents the discovery of a new mathematical model, a cross product of the Arrhenius and logistic sigmoidal growth models.

Finally, Chapter 8 summarises the findings and overall significance of this study. Suggestions for future work are made.

REFERENCES

Abid, M., Jabbar, S., Hu, B., Hashim, M. M., Wu, T., Lei, S., Khan, M. A., & Zeng, X. (2014). Thermosonication as a potential quality enhancement technique of apple juice. *Ultrasonics Sonochemistry*, 21(3), 984-990.

Adekunte, A., Tiwari, B. K., Scannell, A., Cullen, P. J., & O'donnell, C. (2010a). Modelling of yeast inactivation in sonicated tomato juice. *International Journal of Food Microbiology*, 137(1), 116-120.

Adekunte, A. O., Tiwari, B. K., Cullen, P. J., Scannell, A. G. M., & O'donnell, C. P. (2010b). Effect of sonication on colour, ascorbic acid and yeast inactivation in tomato juice. *Food Chemistry*, 122(3), 500-507.

Alissandrakis, E., Mantziaras, E., Tarantilis, P. A., Harizanis, P. C., & Polissiou, M. (2010). Generation of linalool derivatives in an artificial honey produced from bees fed with linalool-enriched sugar syrup. *European Food Research and Technology*, 231(1), 21-25.

Anonymous (2009). Panduan Menanam Limau Bali. Retrieved 15 May 2015, from http://pertanianmjg.perak.gov.my/bahasa/panduan_limaubali.htm.

Anonymous (2014a). Helping Malaysians fight the flab. The Star online Retrieved 16 May 2015, from http://www.thestar.com.my/Lifestyle/Health/2014/04/27/Helping-Malaysians-fight-the-flab/.

Anonymous (2014b). Popularity of fruit juices growing well in Malaysia. The Star online Retrieved 12 December 2014, from http://www.thestar.com.my/Business/SME/2014/09/25/Juicing-things-up-Popularity-of-fruit-juices-growing-well-in-Malaysia/?style=biz.

Anonymous (2015a). Nutrition Month Malaysia: Change your lifestyle to prevent diabetes. The Star online Retrieved 16 May 2015, from http://www.thestar.com.my/Lifestyle/Health/2015/04/09/Sweet-changes-needed/.

Anonymous (2015b). Sime Darby Beverages Sdn Bhd. Retrieved 16 May 2015, from http://www.simedarbyplantation.com/Sime_Darby_Beverages_Sdn_Bhd.aspx.

Atawodi, S. (2011). Nigerian foodstuffs with prostate cancer chemopreventive polyphenols. *Infectious Agents and Cancer*, 6(SUPPL. 2).

Augusto, P. E. D., Falguera, V., Cristianini, M., & Ibarz, A. (2012a). Rheological Behavior of Tomato Juice: Steady-State Shear and Time-Dependent Modeling. *Food and Bioprocess Technology*, 5(5), 1715-1723.

Augusto, P. E. D., Soares, B. M. C., Chiu, M. C., & Gonçalves, L. a. G. (2012b). Modelling the effect of temperature on the lipid solid fat content (SFC). *Food Research International*, 45(1), 132-135.

Badrie, N., & Schauss, A. G. (2010). Soursop (Annona muricata L.): Composition, nutritional value, medicinal uses, and toxicology, in Bioactive Foods in Promoting Health. pp.621-643.

Bagamboula, C. F., Uyttendaele, M., & Debevere, J. (2002). Acid tolerance of *Shigella sonnei* and *Shigella flexneri*. *Journal of Applied Microbiology*, 93(3), 479-486.

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.

Barbana, C., & El-Omri, A. (2012). Viscometric behavior of reconstituted tomato concentrate. *Food and Bioprocess Technology*, 5(1), 209-215.

Bashir, H. A., & Abu-Goukh, A.-B. A. (2003). Compositional changes during guava fruit ripening. *Food Chemistry*, 80(4), 557-563.

Bates, R. P., Morris, J. R., & Crandall, P. G. (2001). Principles and practices of small- and medium-scale fruit juice processing. Food and Agriculture Organization of the United Nations, Rome, Italy.

Bazzano, L. A., Serdula, M. K., & Liu, S. (2003). Dietary intake of fruits and vegetables and risk of cardiovascular disease. *Current Atherosclerosis Reports*, 5(6), 492-499.

Bermúdez-Aguirre, D., Mawson, R., & Barbosa-Cánovas, G. V. (2011). Study of possible mechanisms of inactivation of *Listeria innocua* in thermo-sonicated milk using scanning electron microscopy and transmission electron microscopy. *Journal of Food Processing and Preservation*, 35(6), 767-777.

Bezbaruah, B. J., & Hazarika, M. K. (2014). Generalization of temperature and thickness effects in kinetic studies of turmeric (Curcuma longa) slices drying. *International Food Research Journal*, 21(4), 1529-1532.

Bhat, R., Kamaruddin, N. S. B. C., Min-Tze, L., & Karim, A. A. (2011). Sonication improves kasturi lime (Citrus microcarpa) juice quality. *Ultrasonics Sonochemistry*, 18(6), 1295-1300.

Bhattacharya, S., & Rastogi, N. K. (1998). Rheological properties of enzyme-treated mango pulp. *Journal of Food Engineering*, 36(3), 249-262.

Bhattacherjee, A. K., Tandon, D. K., Dikshit, A., & Kumar, S. (2011). Effect of pasteurization temperature on quality of aonla juice during storage. *Journal of Food Science and Technology*, 48(3), 269-273.

Bosiljkov, T., Brnčic, M., Tripalo, B., Karlović, S., Ukrainczyk, M., Ježek, D., & Brnčić, S. R. (2009). Impact of ultrasound-enhanced homogenization on physical properties of soybean milk. *Chemical Engineering Transactions*, 17), 1029-1034.

Brasil, I. M., Maia, G. A., & De Figueiredo, R. W. (1995). Physical-chemical changes during extraction and clarification of guava juice. *Food Chemistry*, 54(4), 383-386.

Brennan, J. G. (2006). Food Processing Handbook. 177-224, Wiley-VCH, Weinheim, Germany.

Burdurlu, H. S., Koca, N., & Karadeniz, F. (2006). Degradation of vitamin C in citrus juice concentrates during storage. *Journal of Food Engineering*, 74(2), 211-216.

Butz, P., & Tauscher, B. (2002). Emerging technologies: Chemical aspects. *Food Research International*, 35(2-3), 279-284.

Cabral, R. a. F., Telis, V. R. N., Park, K. J., & Telis-Romero, J. (2011). Friction losses in valves and fittings for liquid food products. *Food and Bioproducts Processing*, 89(4), 375-382.

Cai, H., Nakada, M., & Miyano, Y. (2013). Simplified determination of long-term viscoelastic behavior of amorphous resin. *Mechanics of Time-Dependent Materials*, 17(1), 137-146.

Carley, K. M., Kamneva, N. Y., & Reminga, J. (2004). Response Surface Methodology. CASOS Technical Report.

Cendres, A., Chemat, F., Maingonnat, J. F., & Renard, C. M. G. C. (2011). An innovative process for extraction of fruit juice using microwave heating. *LWT - Food Science and Technology*, 44(4), 1035-1041.

Chambial, S., Dwivedi, S., Shukla, K. K., John, P. J., & Sharma, P. (2013). Vitamin C in disease prevention and cure: An overview. *Indian Journal of Clinical Biochemistry*, 28(4), 314-328.

Chang, F.-C., Lam, F., & Kadla, J. (2013). Application of time–temperature–stress superposition on creep of wood–plastic composites. *Mechanics of Time-Dependent Materials*, 17(3), 427-437.

Chek Zaini, H., Zaiton, H., Zanariah, C. W., & Sakinah, N. (2012). High fiber cookies made from pink guava (Psidium Guajava) decanter/agro waste. Retrieved 7 October 2012, from http://www.ifr.ac.uk/totalfood2009/Oral%20presentations%20(approved)/Presentation%20-%20Chek%20Zaini%20H.pdf.

Chemat, F., Zill, E. H., & Khan, M. K. (2011). Applications of ultrasound in food technology: Processing, preservation and extraction. *Ultrasonics Sonochemistry*, 18(4), 813-835.

Cheng, L. H., Soh, C. Y., Liew, S. C., & Teh, F. F. (2007). Effects of sonication and carbonation on guava juice quality. *Food Chemistry*, 104(4), 1396-1401.

Chevali, V. S., Dean, D. R., & Janowski, G. M. (2009). Flexural creep behavior of discontinuous thermoplastic composites: Non-linear viscoelastic modeling and time–temperature–stress superposition. *Composites Part A: Applied Science and Manufacturing*, 40(6–7), 870-877.

Chin, N. L., Chan, S. M., Yusof, Y. A., Chuah, T. G., & Talib, R. A. (2009). Modelling of rheological behaviour of pummelo juice concentrates using master-curve. *Journal of Food Engineering*, 93(2), 134-140.

Chin, N. L., Tan, M. C., Che Pa, N. F., & Yusof, Y. A. (2013). Method and apparatus for high intensity ultrasonic treatment of baking materials, Google Patents.

Chisari, M., Barbagallo, R. N., & Spagna, G. (2007). Characterization of polyphenol oxidase and peroxidase and influence on browning of cold stored strawberry fruit. *Journal of Agricultural and Food Chemistry*, 55(9), 3469-3476.

Codex, 2005. Codex General Standard for Fruit Juices and Nectars. Codex Stan 247-2005, 1 - 19.

Dak, M., Verma, R. C., & Jaaffrey, S. N. A. (2007). Effect of temperature and concentration on rheological properties of "Kesar" mango juice. *Journal of Food Engineering*, 80(4), 1011-1015.

Dak, M., Verma, R. C., & Sharma, G. P. (2006). Flow characteristics of juice of “Totapuri” mangoes. *Journal of Food Engineering*, 76(4), 557-561.

Dasgupta, S., & Sarkar, B. (2012). Membrane Applications in Fruit Processing Technologies, in Advances in Fruit Processing Technologies. In: Rodrigues, S. & Fernandes, F. a. N. CRC Press, Boca Raton, pp.101.

Davies, R. M., & Mohammed, U. S. (2013). Physical and Mechanical Properties of Soursop (Annona muricata).

De Carvalho, J. M., Maia, G. A., Da Fonseca, A. V. V., De Sousa, P. H. M., & Rodrigues, S. (2013). Effect of processing on physicochemical composition, bioactive compounds and enzymatic activity of yellow mombin (*Spondias mombin* L.) tropical juice. *Journal of Food Science and Technology*), 1-6.

Dealy, J. M., & Wang, J. (2013). Viscosity and Normal Stress Differences, in Melt Rheology and its Applications in the Plastics Industry. Springer, pp.19-47.

Deshmukh, P. S., Manjunatha, S. S., & Raju, P. S. (2013). Rheological behaviour of enzyme clarified sapota (Achras sapota L) juice at different concentration and temperatures. *Journal of Food Science and Technology*), 1-15.

Dong, Y. J., Wang, Y. L., & Feng, J. (2011). Rheological and fractal characteristics of unconditioned and conditioned water treatment residuals. *Water Research,* 45(13), 3871-3882.

Dubrović, I., Herceg, Z., Jambrak, A. R., Badanjak, M., & Dragović-Uzelac, V. (2011). Effect of high intensity ultrasound and pasteurization on anthocyanin content in strawberry juice. *Food Technology and Biotechnology*, 49(2), 196-204.

Economos, C., & Clay, W. D. (1999). Food, Nutrition and Agriculture: Nutritional and Health Benefits of Citrus Fruits. Retrieved 15 October 2012, from http://www.fao.org/docrep/x2650T/x2650t03.htm.

Enríquez-Fernández, B. E., Camarillo-Rojas, C. R., & Vélez-Ruiz, J. F. (2013). Physical properties of concentrated milk and its influence on powder milk characteristics and spray dryer design parameters. *Journal of Food Process Engineering*, 36(1), 87-94.

Ercan, S. Ş., & Soysal, Ç. (2011). Effect of ultrasound and temperature on tomato peroxidase. *Ultrasonics Sonochemistry*, 18(2), 689-695.

Fachin, D., Van Loey, A. M., Ly Nguyen, B., Verlent, I., Indrawati, A., & Hendrickx, M. E. (2003). Inactivation kinetics of polygalacturonase in tomato juice. *Innovative Food Science and Emerging Technologies,* 4(2), 135-142.

Falguera, V., Vélez-Ruiz, J. F., Alins, V., & Ibarz, A. (2010). Rheological behaviour of concentrated mandarin juice at low temperatures. *International Journal of Food Science and Technology*, 45(10), 2194-2200.

Falguera, V., Vicente, M., Garvín, A., & Ibarz, A. (2013). Flow behavior of clarified pear and apple juices at subzero temperatures. *Journal of Food Processing and Preservation*, 37(2), 133-138.

Fonteles, T. V., Costa, M. G. M., De Jesus, A. L. T., De Miranda, M. R. A., Fernandes, F. a. N., & Rodrigues, S. (2012). Power ultrasound processing of cantaloupe melon juice: Effects on quality parameters. *Food Research International*, 48(1), 41-48.

Fraiha, M., Biagi, J. D., & Ferraz, A. C. O. (2011). Rheological behavior of corn and soy mix as feed ingredients. *Ciencia e Tecnologia de Alimentos*, 31(1), 129-134.

Gamboa-Santos, J., Montilla, A., Soria, A. C., & Villamiel, M. (2012). Effects of conventional and ultrasound blanching on enzyme inactivation and carbohydrate content of carrots. *European Food Research and Technology*, 234(6), 1071-1079.

Gao, S., Lewis, G. D., Ashokkumar, M., & Hemar, Y. (2014). Inactivation of microorganisms by low-frequency high-power ultrasound: 2. A simple model for the inactivation mechanism. *Ultrasonics Sonochemistry*, 21(1), 454-460.

Gastélum, G. G., Avila-Sosa, R., López-Malo, A., & Palou, E. (2012). *Listeria innocua* multi-target inactivation by thermo-sonication and vanillin. *Food and Bioprocess Technology*, 5(2), 665-671.

Ghosh, S., & Das, M. K. (2014). Optimization of the effect of gamma radiation on textural properties of different varieties of potato (Kufri Chandramukhi and Kufri Jyoti) and mango (Langra and Fazli) during storage by response surface methodology. *Innovative Food Science and Emerging Technologies*, 2(6), 257-264.

Giner, J., Ibarz, A., Garza, S., & Xhian-Quan, S. (1996). Rheology of clarified cherry juices. *Journal of Food Engineering*, 30(1-2), 147-154.

Giner, M. J., Hizarci, Õ., Martí, N., Saura, D., & Valero, M. (2013). Novel approaches to reduce brown pigment formation and color changes in thermal pasteurized tomato juice. *European Food Research and Technology*, 236(3), 507-515.

Goula, A. M., & Adamopoulos, K. G. (2011). Rheological models of kiwifruit juice for processing applications. *Journal of Food Processing and Technology*, 2(1), 1 - 7.

Guedes, R. M. (2011). A viscoelastic model for a biomedical ultra-high molecular weight polyethylene using the time-temperature superposition principle. *Polymer Testing*, 30(3), 294-302.

Gupta, R., Baldewa, B., & Joshi, Y. M. (2012). Time temperature superposition in soft glassy materials. *Soft Matter*, 8(15), 4171-4176.

He, F. J., Nowson, C. A., Lucas, M., & Macgregor, G. A. (2007). Increased consumption of fruit and vegetables is related to a reduced risk of coronary heart disease: Meta-analysis of cohort studies. *Journal of Human Hypertension*, 21(9), 717-728.

Holtung, L., Grimmer, S., & Aaby, K. (2011). Effect of processing of black currant press-residue on polyphenol composition and cell proliferation. *Journal of Agricultural and Food Chemistry*, 59(8), 3632-3640.

Hui, Y. H. (2006). Handbook of Fruits and Fruit Processing. Blackwell Publishing, Iowa, USA.

Ibarz, A., Giner, J., Pagan, J., Gimeno, V., & Garza, S. (1995). Rheological behaviour of kiwi fruit juice concentrates. *Journal of Texture Studies*, 26(2), 137-145.

Ibarz, A., & Miguelsanz, R. (1989). Variation with temperature and soluble solids concentration of the density of a depectinised and clarified pear juice. *Journal of Food Engineering*, 10(4), 319-323.

Jha, S. N., & Gunasekaran, S. (2010). Authentication of sweetness of mango juice using Fourier transform infrared-attenuated total reflection spectroscopy. *Journal of Food Engineering*, 101(3), 337-342.

Kaci, M., Meziani, S., Arab-Tehrany, E., Gillet, G., Desjardins-Lavisse, I., & Desobry, S. (2014). Emulsification by high frequency ultrasound using piezoelectric transducer: Formation and stability of emulsifier free emulsion. *Ultrasonics Sonochemistry*, 21(3), 1010-1017.

Kaya, A., & Sözer, N. (2005). Rheological behaviour of sour pomegranate juice concentrates (Punica granatum L.). *International Journal of Food Science and Technology*, 40(2), 223-227.

Kek, S. P., Chin, N. L., & Yusof, Y. A. (2013). Simultaneous time-temperature-thickness superposition theoretical and statistical modelling of convective drying of guava. *Journal of Food Science and Technology*, 51(12), 3609-3622.

Keshani, S., Chuah, A. L., & Russly, A. R. (2012). Effect of temperature and concentration on rheological properties pomelo juice concentrates. *International Food Research Journal*, 19(2), 553-562.

Khazaei, J., Chegini, G.-R., & Bakhshiani, M. (2008). A novel alternative method for modeling the effects of air temperature and slice thickness on quality and drying kinetics of tomato slices: superposition technique. *Drying technology*, 26(6), 759-775.

Khuri, A. I., & Mukhopadhyay, S. (2010). Response surface methodology. *Wiley Interdisciplinary Reviews: Computational Statistics*, 2(2), 128-149.

Ko, Y.-M., Wu, T.-Y., Wu, Y.-C., Chang, F.-R., Guh, J.-Y., & Chuang, L.-Y. (2011a). Annonacin induces cell cycle-dependent growth arrest and apoptosis in estrogen receptor-Î±-related pathways in MCF-7 cells. *Journal of Ethnopharmacology*, 137(3), 1283-1290.

Ko, Y. M., Wu, T. Y., Wu, Y. C., Chang, F. R., Guh, J. Y., & Chuang, L. Y. (2011b). Annonacin induces cell cycle-dependent growth arrest and apoptosis in estrogen receptor-α-related pathways in MCF-7 cells. *Journal of Ethnopharmacology*, 137(3), 1283-1290.

Kok, M. V. (2010). Statistical approach of two-three parameters rheological models for polymer type drilling fluid analysis. *Energy Sources, Part A: Recovery, Utilization and Environmental Effects*, 32(4), 336-345.

Koshani, R., Ziaee, E., Niakousari, M., & Golmakani, M. T. (2014). Optimization of thermal and thermosonication treatments on pectin methyl esterase inactivation of sour orange juice (*citrus aurantium*). *Journal of Food Processing and Preservation*.

Kozusko, F., & Bourdeau, M. (2007). A unified model of sigmoid tumour growth based on cell proliferation and quiescence. *Cell Proliferation*, 40(6), 824-834.

Landete, J. M. (2013). Dietary intake of natural antioxidants: Vitamins and polyphenols. *Critical Reviews in Food Science and Nutrition*, 53(7), 706-721.

Lee, H., Kim, H., Cadwallader, K. R., Feng, H., & Martin, S. E. (2013). Sonication in combination with heat and low pressure as an alternative pasteurization treatment-Effect on *Escherichia coli* K12 inactivation and quality of apple cider. *Ultrasonics Sonochemistry*, 20(4), 1131-1138.

Lee, H., Zhou, B., Liang, W., Feng, H., & Martin, S. E. (2009). Inactivation of Escherichia coli cells with sonication, manosonication, thermosonication, and manothermosonication: Microbial responses and kinetics modeling. *Journal of Food Engineering*, 93(3), 354-364.

Lee, W. C., Yusof, S., Hamid, N. S. A., & Baharin, B. S. (2006). Optimizing conditions for hot water extraction of banana juice using response surface methodology (RSM). *Journal of Food Engineering*, 75(4), 473-479.

Lefebvre, F., Petit, J., Nassar, G., Debreyne, P., Delaplace, G., & Nongaillard, B. (2013). Inline high frequency ultrasonic particle sizer. *Review of Scientific Instruments*, 84(7).

Lenth, R. V. (2009). Response-surface methods in R, using RSM. *Journal of Statistical Software*, 32(7), 1-17.

Lieu, L. N., & Le, V. V. M. (2010). Application of ultrasound in grape mash treatment in juice processing. *Ultrasonics Sonochemistry*, 17(1), 273-279.

López-Malo, A., Palou, E., Jiménez-Fernández, M., Alzamora, S. M., & Guerrero, S. (2005). Multifactorial fungal inactivation combining thermosonication and antimicrobials. *Journal of Food Engineering*, 67(1-2), 87-93.

Luo, W., Wang, C., Hu, X., & Yang, T. (2012). Long-term creep assessment of viscoelastic polymer by time-temperature-stress superposition. *Acta Mechanica Solida Sinica*, 25(6), 571-578.

Magerramov, M. A., Abdulagatov, A. I., Azizov, N. D., & Abdulagatov, I. M. (2007). Effect of temperature, concentration, and pressure on the viscosity of pomegranate and pear juice concentrates. *Journal of Food Engineering*, 80(2), 476-489.

Manickavasagan, A., Al-Marhubi, I. M., & Dev, S. (2014). Rheological properties of rice-blackgram batter while replacing white rice with brown rice. *Food Science and Technology International*, 20(4), 299-307.

Manjuantha, S. S., Raju, P. S., & Bawa, A. S. (2012). Rheological behaviour of enzyme clarified Indian gooseberry juice. *International Agrophysics*, 26(2), 145-151.

Martín-Diana, A. B., Rico, D., Barat, J. M., & Barry-Ryan, C. (2009). Orange juices enriched with chitosan: Optimisation for extending the shelf-life. *Innovative Food Science and Emerging Technologies*, 10(4), 590-600.

Mason, T. J., Paniwnyk, L., & Lorimer, J. P. (1996). The uses of ultrasound in food technology. *Ultrasonics Sonochemistry*, 3(3), S253-S260.

Mena, P., Vegara, S., Martí, N., García-Viguera, C., Saura, D., & Valero, M. (2013). Changes on indigenous microbiota, colour, bioactive compounds and antioxidant activity of pasteurised pomegranate juice. *Food Chemistry*, 141(3), 2122-2129.

Mor-Mur, M., & Yuste, J. (2010). Emerging bacterial pathogens in meat and poultry: An overview. *Food and Bioprocess Technology*, 3(1), 24-35.

Nakada, M., Miyano, Y., Cai, H., & Kasamori, M. (2011). Prediction of long-term viscoelastic behavior of amorphous resin based on the time-temperature superposition principle. *Mechanics of Time-Dependent Materials*, 15(3), 309-316.

Nindo, C., Tang, J., Powers, J., & Singh, P. (2005). Viscosity of blueberry and raspberry juices for processing applications. *Journal of Food Engineering*, 69(3), 343-350.

Noordin, M. Y., Venkatesh, V. C., Sharif, S., Elting, S., & Abdullah, A. (2004). Application of response surface methodology in describing the performance of coated carbide tools when turning AISI 1045 steel. *Journal of Materials Processing Technology*, 145(1), 46-58.

Nwokocha, L. M., & Williams, P. A. (2009). New starches: Physicochemical properties of sweetsop (Annona squamosa) and soursop (Anonna muricata) starches. *Carbohydrate Polymers*, 78(3), 462-468.

Oroian, M., Amariei, S., Escriche, I., & Gutt, G. (2013). A Viscoelastic Model for Honeys Using the Time-Temperature Superposition Principle (TTSP). *Food and Bioprocess Technology*, 6(9), 2251-2260.

Ozer, E. A., Ibanoğlu, S., Ainsworth, P., & Yağmur, C. (2004). Expansion characteristics of a nutritious extruded snack food using response surface methodology. *European Food Research and Technology*, 218(5), 474-479.

Panikov, N. S. (2013). Kinetics of Microbial Growth, in Upstream Industrial Biotechnology: Expression Systems and Process Development. In: Flickinger, M. C. John Wiley & Sons, Inc., Hoboken, New Jersey, pp.346.

Passos, C. J., Mergler, D., Gaspar, E., Morais, S., Lucotte, M., Larribe, F., Davidson, R., & De Grosbois, S. (2003). Eating tropical fruit reduces mercury exposure from fish consumption in the Brazilian Amazon. *Environmental Research*, 93(2), 123-130.

Patist, A., & Bates, D. (2008). Ultrasonic innovations in the food industry: From the laboratory to commercial production. *Innovative Food Science and Emerging Technologies*, 9(2), 147-154.

Pearl, R., & Reed, L. J. (1920). On the rate of growth of the population of the United States since 1790 and its mathematical representation. *Proceedings of the National Academy of Sciences of the United States of America*, 6(6), 275.

Pereira, F. M. V., Carvalho, A. D. S., Cabeça, L. F., & Colnago, L. A. (2013). Classification of intact fresh plums according to sweetness using time-domain nuclear magnetic resonance and chemometrics. *Microchemical Journal*, (108), 14-17.

Piasek, A., Kusznierewicz, B., Grzybowska, I., Malinowska-Pańczyk, E., Piekarska, A., Azqueta, A., Collins, A. R., Namieśnik, J., & Bartoszek, A. (2011). The influence of sterilization with EnbioJet® Microwave Flow Pasteurizer on composition and bioactivity of aronia and blue-berried honeysuckle juices. *Journal of Food Composition and Analysis*, 24(6), 880-888.

Quek, M. C., Chin, N. L., & Yusof, Y. A. (2012). Optimisation and comparative study on extraction methods of soursop juice. *Journal of Food, Agriculture and Environment*, 10(3&4), 245-251.

Quek, M. C., Chin, N. L., & Yusof, Y. A. (2013). Modelling of rheological behaviour of soursop juice concentrates using shear rate-temperature-concentration superposition. *Journal of Food Engineering*, 118(4), 380-386.

Quek, S. Y., Chok, N. K., & Swedlund, P. (2007). The physicochemical properties of spray-dried watermelon powders. *Chemical Engineering and Processing: Process Intensification*, 46(5), 386-392.

Ranganna, S. (1986). Handbook of Analysis and Quality Control for Fruit and Vegetable Products. Second edition, Tata McGraw-Hill, New Delhi.

Rawson, A., Tiwari, B. K., Patras, A., Brunton, N., Brennan, C., Cullen, P. J., & O'donnell, C. (2011). Effect of thermosonication on bioactive compounds in watermelon juice. *Food Research International*, 44(5), 1168-1173.

Rodriguez-Caturla, M. Y., Valero Díaz, A., Vallejo, J. L. R., García-Gimeno, R. M., & Cosano, G. Z. (2012). Effect of pre-incubation conditions on growth and survival of *Staphylococcus aureus* in sliced cooked chicken breast. *Meat Science*, 92(4), 409-416.

Sagu, S. T., Nso, E. J., Karmakar, S., & De, S. (2014). Optimisation of low temperature extraction of banana juice using commercial pectinase. *Food Chemistry*, 151), 182-190.

Sarvamangala, D., Kondala, K., Murthy, U., Rao, B. N., Sharma, G., & Satyanarayana, R. (2013). Biogenic Synthesis of AGNP's Using Pomelo Fruit–Characterization and Antimicrobial Activity against Gram+ Ve and Gram–Ve Bacteria. *International Journal of Pharmaceutical Sciences Review & Research*, 19(2.

Shah, N. S., & Nath, N. (2007). Optimization of an enzyme assisted process for juice extraction and clarification from litchis (Litchi chinensis Sonn.). *International Journal of Food Engine*.

Sharma, M., & Beuchat, L. R. (2004). Sensitivity of *Escherichia coli* O157:H7 to commercially available alkaline cleaners and subsequent resistance to heat and sanitizers. *Applied and Environmental Microbiology*, 70(3), 1795-1803.

Sharma, R., Manikantan, M. R., Ranote, P. S., & Singh, T. (2014). Rheological behavior of litchi juice concentrates during storage. *International Food Research Journal*, 21(3), 1169-1176.

Sharoba, A. M., & Ramadan, M. F. (2011). Rheological behavior and physicochemical characteristics of goldenberry (physalis peruviana) juice as affected by enzymatic treatment. *Journal of Food Processing and Preservation*, 35(2), 201-219.

Šimunek, M., Jambrak, A. R., Dobrović, S., Herceg, Z., & Vukušić, T. (2013). Rheological properties of ultrasound treated apple, cranberry and blueberry juice and nectar. *Journal of Food Science and Technology*), 1-17.

Sin, H. N., Yusof, S., Abdul Hamid, N. S., & Abd. Rahman, R. (2006). Optimization of hot water extraction for sapodilla juice using response surface methodology. *Journal of Food Engineering*, 74(3), 352-358.

Singh, J., Sharma, H. K., Premi, M., & Kumari, K. (2014). Effect of storage conditions of egg on rheological properties of liquid whole egg. *Journal of Food Science and Technology*, 51(3), 543-550.

Singh, N. I., & Eipeson, W. E. (2000). Rheological behaviour of clarified mango juice concentrates. *Journal of Texture Studies*, 31(3), 287-295.

Steffe, J. F. (1996). Rheological Methods in Food Processing Engineering. Second Edition, Freeman Press, USA.

Swami Hulle, N. R., Patruni, K., & Rao, P. S. (2014). Rheological properties of aloe vera (aloe barbadensis miller) juice concentrates. *Journal of Food Process Engineering*, 37(4), 375-386.

Tajvidi, M., Falk, R. H., & Hermanson, J. C. (2005). Time–temperature superposition principle applied to a kenaf-fiber/high-density polyethylene composite. *Journal of Applied Polymer Science*, 97(5), 1995-2004.

Ten Brinke, A. J. W., Bailey, L., Lekkerkerker, H. N. W., & Maitland, G. C. (2007). Rheology modification in mixed shape colloidal dispersions. Part I: Pure components. *Soft Matter*, 3(9), 1145-1162.

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.

Tiwari, B. K., Muthukumarappan, K., O'donnell, C. P., & Cullen, P. J. (2008). Colour degradation and quality parameters of sonicated orange juice using response surface methodology. *LWT - Food Science and Technology*, 41(10), 1876-1883.

Tiwari, B. K., Muthukumarappan, K., O'donnell, C. P., & Cullen, P. J. (2009a). Inactivation kinetics of pectin methylesterase and cloud retention in sonicated orange juice. *Innovative Food Science and Emerging Technologies*, 10(2), 166-171.

Tiwari, B. K., O'donnell, C. P., & Cullen, P. J. (2009b). Effect of sonication on retention of anthocyanins in blackberry juice. *Journal of Food Engineering*, 93(2), 166-171.

Tiwari, B. K., O'donnell, C. P., Muthukumarappan, K., & Cullen, P. J. (2009c). Effect of sonication on orange juice quality parameters during storage. *International Journal of Food Science and Technology*, 44(3), 586-595.

Torres, E. F., Bayarri, S., Sampedro, F., Martínez, A., & Carbonell, J. V. (2008). Improvement of the fresh taste intensity of processed clementine juice by separate pasteurization of its serum and pulp. *Food Science and Technology International*, 14(6), 525-529.

Trappey, A. F., Johnson, C. E., & Wilson, P. W. (2008). Characterization of juice extraction methods utilizing fresh mayhaw (Crataegus opaca Hook.) fruit. *International Journal of Fruit Science*, 8(4), 318-331.

Tribess, T. B., & Tadini, C. C. (2006). Inactivation kinetics of pectin methylesterase in orange juice as a function of pH and temperature/time process conditions. *Journal of the Science of Food and Agriculture*, 86(9), 1328-1335.

Tu, T., Meng, K., Bai, Y., Shi, P., Luo, H., Wang, Y., Yang, P., Zhang, Y., Zhang, W., & Yao, B. (2013). High-yield production of a low-temperature-active polygalacturonase for papaya juice clarification. *Food Chemistry*, 141(3), 2974-2981.

Udyarajan, C. T., Horne, D. S., & Lucey, J. A. (2007). Use of time–temperature superposition to study the rheological properties of cheese during heating and cooling. *International Journal of Food Science & Technology*, 42(6), 686-698.

Ugarte-Romero, E., Feng, H., & Martin, S. E. (2007). Inactivation of Shigella boydii 18 IDPH and Listeria monocytogenes Scott A with power ultrasound at different acoustic energy densities and temperatures. *Journal of Food Science*, 72(4), M103-M107.

Usfda, 2001. Hazard Analysis and Critical Control Point (HACCP) Procedures for the Safe and Sanitary Processing and Importing of Juices: Final Rule. Federal Register, 66, 6138-6202.

Valdramidis, V. P., Cullen, P. J., Tiwari, B. K., & O'donnell, C. P. (2010). Quantitative modelling approaches for ascorbic acid degradation and non-enzymatic browning of orange juice during ultrasound processing. *Journal of Food Engineering*, 96(3), 449-454.

Valero, M., Recrosio, N., Saura, D., Muñoz, N., Martí, N., & Lizama, V. (2007). Effects of ultrasonic treatments in orange juice processing. *Journal of Food Engineering*, 80(2), 509-516.

Van Breemen, R. B., & Pajkovic, N. (2008). Multitargeted therapy of cancer by lycopene. *Cancer Letters*, 269(2), 339-351.

Van Loey, A., Verachtert, B., & Hendrickx, M. (2001). Effects of high electric field pulses on enzymes. *Trends in Food Science and Technology*, 12(3-4), 94-102.

Vandresen, S., Quadri, M. G. N., Souza, J. a. R. D., & Hotza, D. (2009). Temperature effect on the rheological behavior of carrot juices. *Journal of Food Engineering*, 92(3), 269-274.

Verlent, I., Van Loey, A., Smout, C., Duvetter, T., & Hendrickx, M. E. (2004). Purified tomato polygalacturonase activity during thermal and high-pressure treatment. *Biotechnology and Bioengineering*, 86(1), 63-71.

Waliszewski, K. N., Aparicio, M. A., Bello, L. A., & Monroy, J. A. (2003). Changes of banana starch by chemical and physical modification. *Carbohydrate Polymers*, 52(3), 237-242.

Walkling-Ribeiro, M., Noci, F., Riener, J., Cronin, D. A., Lyng, J. G., & Morgan, D. J. (2009). The impact of thermosonication and pulsed electric fields on *Staphylococcus aureus* inactivation and selected quality parameters in orange juice. *Food and Bioprocess Technology*, 2(4), 422-430.

Wang, J., Sun, B., Cao, Y., Tian, Y., & Li, X. (2008). Optimisation of ultrasound-assisted extraction of phenolic compounds from wheat bran. *Food Chemistry*, 106(2), 804-810.

Worrell, D. B., Carrington, C. M. S., & Huber, D. J. (1994). Growth, maturation and ripening of soursop (Annona muricata L.) fruit. *Scientia Horticulturae*, 57(1-2), 7-15.

Wu, J., Gamage, T. V., Vilkhu, K. S., Simons, L. K., & Mawson, R. (2008). Effect of thermosonication on quality improvement of tomato juice. *Innovative Food Science and Emerging Technologies*, 9(2), 186-195.

Yilmaz, M. T., Sert, D., & Demir, M. K. (2010). Rheological properties of tarhana soup enriched with whey concentrate as a function of concentration and temperature. *Journal of Texture Studies*, 41(6), 863-879.