

**DEVELOPMENT OF SOURSOP**

**(*Annona muricata* L.) JAM**

**KANG CHAI WEN**

**DISSERTATION SUBMITTED IN PARTIAL  
FULFILLMENT OF THE REQUIREMENT FOR THE  
DEGREE OF BACHELOR OF FOOD SCIENCE WITH  
HONOURS (FOOD SCIENCE AND NUTRITION)**

**FACULTY OF FOOD SCIENCE AND NUTRITION**

**UNIVERSITI MALAYSIA SABAH**

**2015**



## UNIVERSITI MALAYSIA SABAH

## BORANG PENGESAHAN STATUS TESIS

JUDUL: DEVELOPMENT OF SOURSOP (ANNONA MURICATA L.) JAMIJAZAH: DEGREE OF BACHELOR OF FOOD SCIENCE WITH HONOURS  
(FOOD SCIENCE AND NUTRITION)SESI PENGAJIAN: 2011 / 2012Saya KANG CHAI HEN

(HURUF BESAR)

mengaku membenarkan tesis (LPS/ Sarjana/ Doktor Falsafah) ini di simpan di Perpustakaan Universiti Malaysia Sabah dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hakmilik Universiti Malaysia Sabah.
2. Perpustakaan Universiti Malaysia Sabah dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. \*\* Sila tandakan ( / )

☐

SULIT

(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

☐

TERHAD

(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

☐

TIDAK TERHAD



(TANDATANGAN PENULIS)

Disahkan oleh  
PERPUSTAKAAN  
UNIVERSITI MALAYSIA SABAH

NURULAIN BINTI ISMAIL  
LIBRARIAN

(TANDATANGAN PUSTAKAWAN)

alamat Tetap: 16, JALAN PUTRA PERMAI 84,

TAMAN EQUINE, 43300 SERI KEMBANGAN,

SELANGOR DARUL EHSAN.

DR. MUHAMMAD IQBAL HASHMI.

Nama Penyelia

Tarikh: 26/6/2015

Tarikh: \_\_\_\_\_

CATATAN: \* Potong yang tidak berkenaan.

\* Jika tesis ini SULIT atau TERHAD, sila lampiran surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT dan TERHAD.

\* Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah dan Sarjana secara penyelidikan disertasi bagi pengajian secara kerja kursus dan penyelidikan, atau Laporan Projek Sarjana Muda (LPSM).

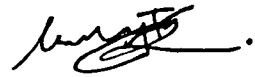


UMS  
UNIVERSITI MALAYSIA SABAH

## DECLARATION

I hereby declare that this dissertation is the work of my own independent study except for quotations, equations, summaries and references, which have been described and acknowledged.

05 MAY 2015



KANG CHAI WEN

BN 11110079

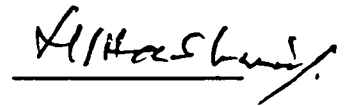
## CERTIFICATION

**NAME** : KANG CHAI WEN  
**MATRIC NO** : BN 11110079  
**TITLE** : DEVELOPMENT OF SOURSOP  
(*Annona muricata* L.) JAM  
**DEGREE** : BACHELOR OF FOOD SCIENCE WITH HONOURS  
(FOOD SCIENCE AND NUTRITION)  
**VIVA VOCE** : 21<sup>ST</sup> MAY 2015

### DECLARED BY

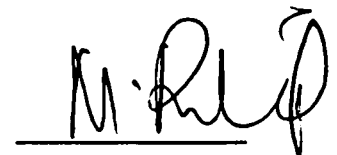
**1. SUPERVISOR**

(DR. MUHAMMAD IQBAL HASHMI)



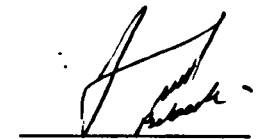
**2. EXAMINER 1**

(DR. MOHD. ROSNI SULAIMAN)



**3. EXAMINER 2**

(DR. BABAK RASTI)



**4. DEAN**

(PROF. MADYA DR. SHARIFUDIN MD SHAARANI)



## **ACKNOWLEDGEMENT**

First and foremost, I would like to express my deep and sincere gratitude to my supervisor, Dr. Muhammad Iqbal Hashmi for his continuous guidance and support throughout my research. I have never been able to finish my dissertation without the patience, motivation and immense knowledge given from him.

Another great appreciation is expressed to my examiners, Dr. Mohd. Rosni Sulaiman and Dr. Babak Rasti, for their helpful feedbacks and generous advices during my presentation. Following that, I would like to thanks all the lab assistants in Faculty of Food Science and Nutrition (FSMP), particularly Mr. Fritzgerald Andrew from Postharvest Technology Laboratory, Mr. Willie Yen from Food Analysis Laboratory and Mr. Duasin from Food Microbiology Laboratory, who have provided me assistance throughout my research study. Not forgetting all my panelists who have dedicated their time in sensory evaluation of this study as well.

Last but not least, special thanks to my beloved family and dearest friends, who always being there to support and cheer me up to strive into my goal whenever I faced difficulties. Their constant supports are indeed priceless to me.

Kang Chai Wen

May 2015

## ABSTRACT

### DEVELOPMENT OF SOURSOP (*Annona muricata* L.) JAM

This study was conducted to develop a new type of jam with soursop fruit which possesses a distinctive flavour. From a total of nine formulations being developed, F9 was chosen as the best formula through BIB ranking test and hedonic rating test. The sample F9 which consisted of 40% soursop puree and 55% sugar attained the highest mean rank for most of the sensory attributes being tested including flavour, texture, taste and overall acceptability. Proximate analysis showed that the soursop jam contained  $30.52 \pm 0.18\%$  moisture,  $0.37 \pm 0.07\%$  ash,  $0.47 \pm 0.09\%$  protein,  $0.02 \pm 0.00\%$  fat,  $0.66 \pm 0.03\%$  crude fiber and  $67.95 \pm 0.18\%$  carbohydrate with a total of  $273.87 \pm 1.08$  kcal energy in 100g of jam. In physicochemical composition, the total soluble solid, pH value and water activity of sample were  $69.0 \pm 0.00$  °Brix,  $3.10 \pm 0.01$  and  $0.823 \pm 0.01$ , respectively. A tendency for yellow colour was noticed by colour analysis with  $L^*$  value  $48.48 \pm 0.31$ ,  $a^*$  value  $0.08 \pm 0.02$  and  $b^*$  value  $9.42 \pm 0.24$ . Shelf life study of soursop jam was carried out for four weeks at ambient temperature of  $25 \pm 2^\circ\text{C}$ . From the results obtained, physicochemical analysis showed significant differences ( $p < 0.05$ ) for pH value, total soluble solid and colour attribute in the soursop jam developed while water activity did not differ significantly ( $p > 0.05$ ). Microbiological test showed that the colonies of bacteria, yeast and mould were still within the acceptable range of less than  $10^5$  CFU/g. Paired comparison test showed no significant differences ( $p > 0.05$ ) in colour, flavour, taste and overall acceptability while the texture attribute differed significantly ( $p < 0.05$ ) throughout the storage period. Consumer test showed that 85% of consumers are willing to purchase the developed product, 13% of them are still considering while 2% of them rejected it. In conclusion, the soursop jam developed presented a good acceptance and has a market potential.

## ABSTRAK

### PEMBANGUNAN JEM DURIAN BELANDA (*Annona muricata* L.)

Kajian ini dijalankan untuk membangunkan jem dengan menggunakan buah durian belanda yang mempunyai aroma yang wangi. Daripada sembilan formulasi yang dibentuk, F9 telah dipilih sebagai formulasi yang terbaik melalui keputusan ujian pemeringkatan BIB dan ujian skala hedonik. Sampel F9 yang mengandungi 40% purul durian belanda dan 55% gula telah mendapat min tertinggi bagi kebanyakan atribut sensori termasuk aroma, tekstur, rasa dan penerimaan keseluruhan. Hasil analisis proksimat menunjukkan F9 mengandungi  $30.52 \pm 0.18\%$  kelembapan,  $0.37 \pm 0.07\%$  abu,  $0.47 \pm 0.09\%$  protein,  $0.02 \pm 0.00\%$  lemak,  $0.66 \pm 0.03\%$  serabut kasar and  $67.95 \pm 0.18\%$  karbohidrat dengan jumlah kandungan tenaga sebanyak  $273.87 \pm 1.08$  kkal dalam 100g jem. Dalam komposisi fizikokimia, kandungan pepejal larut, nilai pH serta aktiviti air dalam jem yang dihasilkan adalah  $69.0 \pm 0.00$  °Briks,  $3.10 \pm 0.01$  and  $0.823 \pm 0.01$  masing-masing. Kecenderungan kepada warna kuning telah didapati dalam ujian warna dengan nilai  $L^*$  sebanyak  $48.48 \pm 0.31$ , nilai  $a^*$  sebanyak  $0.08 \pm 0.02$  and nilai  $b^*$  sebanyak  $9.42 \pm 0.24$ . Ujian mutu simpanan jem durian belanda telah dijalankan selama empat minggu pada suhu bilik  $25 \pm 2^\circ\text{C}$ . Keputusan analisis fizikokimia telah menunjukkan bahawa perbezaan yang signifikan ( $p < 0.05$ ) terhadap nilai pH, kandungan pepejal larut, dan atribut warna antara sampel yang disimpan manakala aktiviti air tidak berbeza secara signifikan ( $p > 0.05$ ). Ujian mikrobiologi menunjukkan biliangan koloni bakteria, yis dan kulat masih berada dalam lingkungan selamat iaitu kurang daripada  $10^6$  CFU/g. Ujian perbandingan berganda menunjukkan tiada perbezaan signifikan ( $p > 0.05$ ) bagi atribut warna, aroma, rasa dan penerimaan keseluruhan tetapi perbezaan signifikan wujud dalam tekstur sepanjang tempoh penyimpanan selama empat minggu. Ujian pengguna menunjukkan sebanyak 85% pengguna akan membeli produk ini manakala 13% perlu berfikir lagi dan 2% tidak akan membelinya. Secara keseluruhan, jem durian belanda yang dihasilkan mendapat sambutan yang baik dan mempunyai potensi pasaran.

**TABLE OF CONTENTS**

|                                    | <b>Page</b> |
|------------------------------------|-------------|
| <b>TITLE</b>                       | <b>i</b>    |
| <b>DECLARATION</b>                 | <b>ii</b>   |
| <b>CERTIFICATION</b>               | <b>iii</b>  |
| <b>ACKNOWLEDGEMENT</b>             | <b>iv</b>   |
| <b>ABSTRACT</b>                    | <b>v</b>    |
| <b>ABSTRAK</b>                     | <b>vi</b>   |
| <b>TABLE OF CONTENTS</b>           | <b>vii</b>  |
| <b>LIST OF TABLES</b>              | <b>xi</b>   |
| <b>LIST OF FIGURES</b>             | <b>xii</b>  |
| <b>LIST OF ABBREVIATIONS</b>       | <b>xiii</b> |
| <b>LIST OF SYMBOLS</b>             | <b>xiv</b>  |
| <b>LIST OF FORMULAS</b>            | <b>xv</b>   |
| <b>CHAPTER 1 INTRODUCTION</b>      |             |
| 1.1    Background                  | 1           |
| 1.2    Rationale of Research       | 3           |
| 1.3    Objectives                  | 3           |
| <b>CHAPTER 2 LITERATURE REVIEW</b> |             |
| 2.1    Local Jam Industry          | 4           |
| 2.2    Local Fruit Industry        | 9           |
| 2.3    Soursop                     |             |
| 2.3.1    Origin and Distribution   | 11          |
| 2.3.2    Botany                    | 12          |



|       |                            |    |
|-------|----------------------------|----|
| 2.3.3 | Nutritional Value          | 12 |
| 2.3.4 | Medicinal Value            | 13 |
| 2.3.5 | Industrial Products        | 14 |
| 2.3.6 | Harvesting                 | 14 |
| 2.3.7 | Crop Protection            | 15 |
| 2.4   | Jam                        | 16 |
| 2.5   | Sweetening Agent           | 18 |
| 2.6   | Pectin                     | 19 |
| 2.7   | Citric Acid                | 20 |
| 2.8   | Failures in Jam Processing | 21 |
| 2.9   | Sensory Evaluation         | 24 |
| 2.9.1 | Importance                 | 24 |
| 2.9.2 | Panelist Selection         | 25 |
| 2.9.3 | Types                      | 25 |

### **CHAPTER 3 MATERIALS AND METHODS**

|       |                                       |    |
|-------|---------------------------------------|----|
| 3.1   | Raw Materials                         | 27 |
| 3.2   | Apparatus and Equipment               | 27 |
| 3.3   | Processing of Soursop Jam             | 29 |
| 3.4   | Formulation of Jam                    | 30 |
| 3.5   | Proximate Analysis                    | 32 |
| 3.5.1 | Determination of Moisture Content     | 32 |
| 3.5.2 | Determination of Ash Content          | 32 |
| 3.5.3 | Determination of Fat Content          | 33 |
| 3.5.4 | Determination of Protein Content      | 34 |
| 3.5.5 | Determination of Crude Fibre Content  | 34 |
| 3.5.6 | Determination of Carbohydrate Content | 35 |
| 3.6   | Storage Quality Test                  | 36 |
| 3.6.1 | Physicochemical Analysis              | 36 |
| a.    | pH value                              | 36 |
| b.    | Total Soluble Solids (TSS)            | 36 |
| c.    | Water Activity ( $a_w$ )              | 36 |
| d.    | Colour                                | 37 |
| 3.6.2 | Microbiological Analysis              | 37 |

|   |                                    |    |
|---|------------------------------------|----|
| a.  | Preparing Medium and Peptone Water | 37 |
| b.  | Preparing Sample                   | 38 |
| c.  | Slanting                           | 38 |
| d.  | Colony Count                       | 38 |
| 3.6.3                                       | Sensory Evaluation                 | 39 |
| 3.7   | Statistical Analysis               | 39 |
| <br><b>CHAPTER 4 RESULTS AND DISCUSSION</b> |                                    |    |
| 4.1   | Sensory Evaluation                 | 40 |
| 4.1.1                                       | BIB Ranking Test                   | 40 |
| 4.1.2                                       | Hedonic Rating Test                | 43 |
| 4.2   | Proximate Analysis                 | 47 |
| 4.2.1                                       | Moisture Content                   | 48 |
| 4.2.2                                       | Ash Content                        | 48 |
| 4.2.3                                       | Protein Content                    | 49 |
| 4.2.4                                       | Fat Content                        | 49 |
| 4.2.5                                       | Crude Fiber Content                | 50 |
| 4.2.6                                       | Carbohydrate Content               | 50 |
| 4.2.7                                       | Energy Value                       | 51 |
| 4.3   | Physicochemical Analysis           | 52 |
| 4.3.1                                       | pH Value                           | 52 |
| 4.3.2                                       | Total Soluble Solids (°Brix)       | 53 |
| 4.3.3                                       | Water Activity ( $a_w$ )           | 53 |
| 4.3.4                                       | Colour                             | 54 |
| 4.4   | Storage Quality Test               | 54 |
| 4.4.1                                       | Physicochemical Analysis           | 54 |
| 4.4.2                                       | Microbiological Test               | 58 |
| 4.4.3                                       | Paired Comparison Test             | 60 |
| 4.5   | Consumer Test                      | 62 |
| 4.5.1                                       | Colour                             | 63 |
| 4.5.2                                       | Flavour                            | 64 |
| 4.5.3                                       | Taste                              | 65 |
| 4.5.4                                       | Texture                            | 66 |
| 4.5.5                                       | Overall Acceptability              | 67 |

|   |    |
|---|----|
| 4.5.6 Purchase Intention                                    | 68 |
| <b>CHAPTER 5 CONCLUSION AND SUGGESTION</b>                  |    |
| 5.1 Conclusion  | 70 |
| 5.2 Suggestion  | 71 |
| 5.3 Limitation  | 72 |
| <b>REFERENCES</b>   | 73 |
| <b>APPENDIX</b>   |    |
| APPENDIX A Photos of Soursop Fruit, Flesh, Jam              | 79 |
| APPENDIX B Method of Jam Processing                         | 80 |
| APPENDIX C Sensory Evaluation Form (Rank Preference Test)   | 81 |
| APPENDIX D Sensory Evaluation Form (Hedonic Rating Test)    | 82 |
| APPENDIX E Sensory Evaluation Form (Paired Comparison Test) | 83 |
| APPENDIX F Sensory Evaluation Form (Consumer Test)          | 84 |
| APPENDIX G Calculation for BIB Ranking Test                 | 85 |
| APPENDIX H Friedman Analysis for Hedonic Rating Test        | 86 |
| APPENDIX I ANOVA Analysis for Physicochemical Test          | 88 |
| APPENDIX J ANOVA Analysis for Paired Comparison Test        | 92 |

## LIST OF TABLES

|  | <b>Page</b> |
|--|-------------|
| Table 2.1: List of Exporters for the Jams, Fruit Jellies and Marmalades Products, 2009-2013                                    | 4           |
| Table 2.2: Consumer Price Index for Food and Non-Alcoholic Beverages Group, Malaysia   | 5           |
| Table 2.3: Contribution to the Changes in the Overall Consumer Price Index by Food and Non-Alcoholic Beverages Group, Malaysia | 6           |
| Table 2.4: Consumer Price Index for Subgroup of Food and Non-Alcoholic Beverages, Malaysia                                     | 6           |
| Table 2.5: Production and Sales in Malaysia  | 8           |
| Table 2.6: Planted Area and Production of Fruits in Malaysia, 2000-2012  | 9           |
| Tables 2.7: Common Names of Soursop  | 11          |
| Table 2.8: Nutritional Composition of 100 g Edible Pulp of Soursop Fruit   | 12          |
| Table 2.9: Maturity Index of Soursop   | 14          |
| Table 2.10: Skin Colour Index of Soursop   | 15          |
| Table 2.11: Nutritional Information for a Typical Jam and Jellies  | 16          |
| Table 2.12: Basic Formulation for Jam Production   | 17          |
| Table 2.13: Method of Overcoming Jam Product Problems  | 21          |
| Table 3.1: Raw Materials and the Sources   | 27          |
| Table 3.2: Apparatus and Equipment Used  | 28          |
| Table 3.3: Chemical Substances Used  | 28          |
| Table 3.4: Formulation of Soursop Jam  | 30          |
| Table 3.5: Method of Sample Arrangement for BIB  | 31          |
| Table 4.1: Summary of the Results for BIB Design   | 42          |
| Table 4.2: Result of Hedonic Rating Test   | 44          |
| Table 4.3: Proximate Composition of Soursop Jam (%)  | 48          |
| Table 4.4: Calculation of Energy Value for 100g of Soursop Jam   | 51          |
| Table 4.5: Physicochemical Composition of Soursop Jam  | 52          |
| Table 4.6: Physicochemical Analysis of Soursop Jam (pH, ° Brix, a <sub>w</sub> )   | 55          |
| Table 4.7: Physicochemical Analysis of Soursop Jam (Colour)  | 55          |
| Table 4.8: Colony Count for Bacteria   | 58          |
| Table 4.9: Colony Count for Yeast and Mould  | 58          |
| Table 4.10: Result of Paired Comparison Test   | 60          |
| Table 4.11: Result of Consumer Test  | 63          |

## LIST OF FIGURES

|  | <b>Page</b> |
|--|-------------|
| Figure 4.1: Consumers' Acceptance towards Colour of Soursop Jam                | 64          |
| Figure 4.2: Consumers' Acceptance towards Flavour of Soursop Jam               | 65          |
| Figure 4.3: Consumers' Acceptance towards Taste of Soursop Jam                 | 66          |
| Figure 4.4: Consumers' Acceptance towards Texture of Soursop Jam               | 67          |
| Figure 4.5: Consumers' Acceptance towards Overall Acceptability of Soursop Jam | 68          |
| Figure 4.6: Consumers' Purchase Intention for Soursop Jam                      | 69          |

## LIST OF ABBREVIATION

|       |  |
|-------|--|
| ANOVA | Analysis of Variance   |
| AOAC  | The Association of Official Analytical Chemist                                 |
| BIB   | Balanced Incomplete Block  |
| CPI   | Consumer Price Index   |
| FSMP  | Fakulti Sains Makanan dan Pemakanan<br>(Faculty of Food Science and Nutrition) |
| HSD   | Honest Significant Difference  |
| LSD   | Least Significant Difference   |
| MARDI | Malaysia Agriculture Research and Development                                  |
| PCA   | Plate Count Agar   |
| PDA   | Potato Dextrose Agar   |
| SPSS  | Statistic Package for Social Science   |
| TSS   | Total Soluble Solids   |
| UMS   | Universiti Malaysia Sabah  |

## LIST OF SYMBOL

|        |                |
|--------|----------------|
| %      | Per Cent       |
| ° Brix | Degree Brix    |
| °C     | Degree Celcius |
| $a_w$  | Water Activity |
| cm     | Centimeter     |
| g      | Gram           |
| kcal   | kilocalories   |
| kg     | Kilogram       |
| L      | Litre          |
| mg     | Milligram      |
| mL     | Millilitre     |
| mm     | Millimeter     |
| s      | Second         |

# LIST OF FORMULA

|                                       | Page |
|---------------------------------------|------|
| 3.1: Moisture Content                 | 32   |
| 3.2: Ash Content                      | 33   |
| 3.3 Fat Content                       | 33   |
| 3.4: Crude Fibre Content              | 35   |
| 3.5: Carbohydrate Content             | 35   |
| 3.6: Colony Count for Bacteria        | 39   |
| 3.7: Colony Count for Yeast and Mould | 39   |

Handwritten signature or stamp, possibly reading "UNIVERSITI MALAYSIA SABAH".



# CHAPTER 1

## INTRODUCTION

### 1.1 Background

Fruits are very important in human daily diets due to their high nutritional values. However, they are seasonal and highly perishable because of juicy content and thus need to be processed into more stable forms like jam, juices, jellies, ice creams, yogurt and fruit bars.

The most common reason for quality deterioration of food product is the result of microbial activity and this usually leads to food moulding, fermenting and change in acidity (Umme *et al.*, 1999). Therefore, several types of processing techniques have been introduced in order to minimize the undesirable changes in products while maintaining the inherent quality of fruits.

In this study, a new type of fruit jam will be developed. It is one of the fruit preservation methods which can conserve and utilize the fruits during the off-season. A fruit jam is prepared by boiling the fruit pulp with sweetening agents to a suitable gelled consistency (CODEX, 2008). Pectin, acidulant and other ingredients such as preservatives, colouring and flavouring are also added to enhance the quality of fruit jam produced. Thus, the characteristics and quality of jam produced highly depend on the type of fruits, proportions of the ingredients and cooking methods.

As sugar is main ingredient in jam processing, it is able to inhibit the growth of food-spoilage microorganisms such as bacteria, yeasts and moulds by withdrawing water out of fruits and forming chemical bonds between the water molecules and sugar molecules. The bound water is held tightly that is no longer available to support the microbial growth. Hence, it can prolong the shelf-life of jam and provide a nutritive product to consumers throughout the years.



Fruits processing industry in Malaysia has a tremendous potential to be developed for import substitution and export opportunities. Jam processing is one of the methods used to preserve fruits in order to minimize the wastage and indirectly help to increase the growers' economic condition. In 1990, RM 830,000 worth of jam and jelly and RM 1,858,700 jam and jelly were exported and imported by Malaysia respectively (Abdullah & Tan, 2001). Most of the jam processed in Malaysia utilizes the imported fruits such as strawberry, blackcurrant, gooseberry and grapes (Abdullah & Tan, 2001). Meanwhile, pineapple is the most widely tropical fruit used by local processors compared to the other local tropical fruits like papaya, mango, banana, Roselle and carambola guava.

Malaysia Agriculture Research and Development Institute (MARDI) has also successfully carried out processing of some fruits products such as durian powder, frozen durian, durian pudding, durian paste, *cempedak* sauce, *cempedak* jam, *cempedak* cordial, *cempedak* juice drink, fruit salsa (pineapple, musklime, mango and soursop) and fruit dessert sauce which use banana, mango, durian, pineapple, strawberry, carambola and papaya (Omar, 2010). Thus, fruits are widely used to be further processed into products such as juices, jams, jellies and nectars so that consumers can diversify the consumption of fruit based products in their daily diets.

In addition, fruit jam gives variety in ways of enjoying the foods. It is not only used as bread or cracker spread solely, but also can be used as fillings in bakery products like cookies, pies, pastries and cakes. Thus, this can lead to an increase in consumers' choices of fruits products.

In this study, soursop is utilized to make the fruit jam. It is one of the exotic fruits valued for its pleasant, aromatic, sub-acid and juicy flesh which consists of edible white pulp and a core of indigestible black seeds. Its white cottony pulp is very juicy, varying flavour from acid to sweet and highly regarded due to its distinctive aroma and flavour (Buesco, 1980). As soursop has unique taste, it has higher potential to be processed into juices, jam, jelly and ice-cream to attract consumers. In addition to the pleasing taste of soursop, it also possesses substantial nutritive values. For example, the juice is diuretic while other fruit parts have antibacterial, anti-cancerous, astringent, sedative and other therapeutic properties (Asprey and Thornton, 1995).

## **1.2 Rationale of Research**

The rationale to carry out this research is to develop a new flavour of fruit jam. Soursop fruits are highly susceptible to spoilage, soften very rapidly during ripening and become mushy easily and thus difficult to consume. Hence, further processing is required to enhance their freshness and nutritive values. There are various types of fruit jams available in the market including strawberry jam, blueberry jam, raspberry jam, grape jam, red plum jam, apricot jam, pineapple jam and mango jam. Therefore, soursop jam would be a new choice for the consumers.

Soursop is one of the exotic fruits that have greater potential to be commercialized and able to compete in the international markets. As soursop is a seasonal fruit which is rarely found, the food industry is constantly looking for opportunities to make it available for consumers throughout the years. Hence, this study is undertaken to obtain the best formulation of soursop jam that has higher values in market.

## **1.3 Objective**

This research is carried out to achieve the following objectives:

1. To develop soursop jam using the fresh fruit pulps with different formulations.
2. To determine the proximate composition of soursop jam.
3. To examine the storage stability of soursop jam at ambient temperature.
4. To analyze the physicochemical properties, microbial content and sensory characteristics of soursop jam throughout the storage period.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Local Jam Industry

Based on the trade statistics for international business development (2014), the exported value of jams, fruit jellies and marmalades products increased gradually from 2009 to 2013. The table below shows the major exporters around the world.

**Table 2.1: List of Exporters for the Jams, Fruit Jellies and Marmalades Products, 2009-2013**

| Exporters   | Exported value in 2009 | Exported value in 2010 | Exported value in 2011 | Exported value in 2012 | Exported value in 2013 |
|-------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| World       | 2,110,296              | 2,384,324              | 2,705,834              | 2,825,322              | 3,132,172              |
| France      | 302,630                | 317,816                | 341,348                | 325,330                | 373,286                |
| Germany     | 179,024                | 177,499                | 209,364                | 235,967                | 248,871                |
| Turkey      | 134,848                | 182,143                | 217,911                | 236,698                | 246,607                |
| Belgium     | 174,762                | 166,277                | 188,288                | 189,605                | 234,630                |
| Italy       | 118,943                | 136,679                | 162,513                | 183,183                | 231,057                |
| Chile       | 95,179                 | 104,949                | 159,776                | 181,499                | 175,670                |
| Spain       | 64,355                 | 74,175                 | 81,203                 | 91,203                 | 143,813                |
| India       | 57,351                 | 64,800                 | 76,099                 | 82,109                 | 113,632                |
| Netherlands | 63,128                 | 58,199                 | 76,932                 | 82,817                 | 111,009                |
| China       | 68,277                 | 78,759                 | 93,142                 | 98,381                 | 97,333                 |
| USA         | 47,017                 | 50,930                 | 67,055                 | 79,768                 | 81,538                 |
| Malaysia    | 7,208                  | 8,226                  | 8,769                  | 11,669                 | 13,142                 |

Unit: US Dollar Thousand

Source: ITC (2014)



In Malaysia, the exported value of jams, fruit jellies and marmalades products increased from USD 7,208 thousand in year 2009 to USD 13,142 thousand in year 2013. Hence, the local jam industry has a great potential to be developed.

According to Department of Statistics Malaysia (2014), the consumer price index (CPI) for food and non-alcoholic beverages increased from 2013 to 2014 by 3.5% as shown in the following table.

**Table 2.2: Consumer Price Index for Food and Non-Alcoholic Beverages Group, Malaysia**

| Group                                    | Wt.   | Index       |             |             |                     |                     | % Change                    |                             |                              |
|--|-------|-------------|-------------|-------------|---------------------|---------------------|-----------------------------|-----------------------------|------------------------------|
|  |       | Oct<br>2013 | Sep<br>2014 | Oct<br>2014 | Jan-<br>Oct<br>2013 | Jan-<br>Oct<br>2014 | Oct<br>2014/<br>Sep<br>2014 | Oct<br>2014/<br>Oct<br>2013 | Jan-<br>Oct<br>2014/<br>2013 |
| Total                                    | 100.0 | 108.3       | 110.7       | 111.3       | 106.8               | 110.2               | 0.5                         | 2.8                         | 3.2                          |
| Food &<br>Non-<br>Alcoholic<br>Beverages | 30.3  | 112.4       | 115.8       | 115.6       | 111.1               | 115.0               | -0.2                        | 2.8                         | 3.5                          |
| Non-Food                                 | 69.7  | 106.5       | 108.5       | 109.4       | 104.9               | 108.1               | 0.9                         | 2.7                         | 3.0                          |

Source: Department of Statistics Malaysia (2014)

Based on the above changes, the relative contribution to the increase of 3.5% in the CPI can be identified as shown in Table 2.3 while the CPI for subgroup of food and non-alcoholic beverages is shown in Table 2.4.

**Table 2.3: Contribution to the Changes in the Overall Consumer Price Index by Food and Non-Alcoholic Beverages Group, Malaysia**

| Group                          | Wt.  | 2013/2012 |                | October 2014/2013 |                | January - October 2014/2013 |                |
|--------------------------------|------|-----------|----------------|-------------------|----------------|-----------------------------|----------------|
|                                |      | % Change  | % Contribution | % Change          | % Contribution | % Change                    | % Contribution |
| Food & Non-Alcoholic Beverages | 30.3 | 3.6       | 50.2           | 2.8               | 32.2           | 3.5                         | 34.7           |

Source: Department of Statistics Malaysia (2014)

**Table 2.4: Consumer Price Index for Subgroup of Food and Non-Alcoholic Beverages, Malaysia**

| Subgroup                    | Wt.  | Index    |          |          |              |              | % Change           |                    |                        |
|-----------------------------|------|----------|----------|----------|--------------|--------------|--------------------|--------------------|------------------------|
|                             |      | Oct 2013 | Sep 2014 | Oct 2014 | Jan-Oct 2013 | Jan-Oct 2014 | Oct 2014/ Sep 2014 | Oct 2014/ Oct 2013 | Jan-Oct 2014/ Oct 2013 |
| Food                        | 28.9 | 112.6    | 116.2    | 116.0    | 111.3        | 115.3        | -0.2               | 3.0                | 3.6                    |
| Food At Home                | 18.9 | 112.5    | 115.7    | 115.2    | 111.2        | 115.0        | -0.4               | 2.4                | 3.4                    |
| Rice, Bread & Other Cereals | 4.4  | 104.7    | 105.7    | 105.6    | 104.3        | 105.4        | -0.1               | 0.9                | 1.1                    |
| Meat                        | 2.9  | 114.2    | 119.3    | 115.6    | 112.1        | 116.4        | -3.1               | 1.2                | 3.8                    |
| Fish & Seafood              | 4.5  | 121.0    | 124.8    | 124.9    | 118.2        | 124.3        | 0.1                | 3.2                | 5.2                    |
| Milk & Eggs                 | 1.8  | 114.9    | 118.6    | 119.3    | 112.8        | 116.9        | 0.6                | 3.8                | 3.6                    |
| Oils & Fats                 | 0.6  | 100.8    | 101.0    | 101.1    | 101.0        | 101.1        | 0.1                | 0.3                | 0.1                    |
| Fruits                      | 1.2  | 113.4    | 116.1    | 115.9    | 112.0        | 115.9        | -0.2               | 2.2                | 3.5                    |

Source: Department of Statistics Malaysia (2014)

**Table 2.4: Consumer Price Index for Subgroup of Food and Non-Alcoholic Beverages, Malaysia (continued)**

| Subgroup  | Wt.  | Index       |             |             |                     |                     | % Change                    |                             |                              |
|---|------|-------------|-------------|-------------|---------------------|---------------------|-----------------------------|-----------------------------|------------------------------|
|   |      | Oct<br>2013 | Sep<br>2014 | Oct<br>2014 | Jan-<br>Oct<br>2013 | Jan-<br>Oct<br>2014 | Oct<br>2014/<br>Sep<br>2014 | Oct<br>2014/<br>Oct<br>2013 | Jan-<br>Oct<br>2014/<br>2013 |
| Vegetables  | 2.1  | 107.0       | 110.5       | 110.6       | 108.4               | 110.0               | 0.1                         | 3.4                         | 2.4                          |
| Sugar, Jam,<br>Honey, Choc.<br>&<br>Confectionery     | 0.6  | 121.6       | 129.4       | 129.4       | 119.6               | 129.1               | 0.0                         | 6.4                         | 7.9                          |
| Food<br>Products<br>n.e.c                             | 0.8  | 111.8       | 114.3       | 114.6       | 111.0               | 113.8               | 0.3                         | 2.5                         | 2.5                          |
| Food Away<br>From Home                                | 10.0 | 112.9       | 117.1       | 117.4       | 111.5               | 116.1               | 0.3                         | 4.0                         | 4.1                          |
| Coffee, Tea,<br>Cocoa &<br>Non-Alcoholic<br>Beverages | 1.4  | 107.1       | 108.1       | 108.1       | 106.7               | 107.8               | 0.0                         | 0.9                         | 1.0                          |

Source: Department of Statistics Malaysia (2014)

Among the subgroups of food, the consumer price index of sugar, jam, honey, chocolate and confectionery contributed to the highest increase during the period which was 7.9%. This indicates the changes in purchasing pattern of population and costs of items.

The following table shows the production and sales of packaged food in Malaysia in year 2009 and 2010.

**Table 2.5: Production and Sales in Malaysia**

| Production Volume (in 1000 tons) |       |       |        | Sales Volume in min RM |         |        |
|----------------------------------|-------|-------|--------|------------------------|---------|--------|
| Type                             | 2009  | 2010  | Growth | 2009                   | 2010    | Growth |
| Baby Food                        | -     | -     | n.a    | 1218.3                 | 1316    | 8.02%  |
| Bakery                           | 259.8 | 263.4 | 1.39%  | 2406.5                 | 2463.3  | 2.36%  |
| Canned/Preserved Food            | 86.6  | 88.7  | 2.42%  | 902.5                  | 931.2   | 3.18%  |
| Chilled Processed Food           | 5.3   | 5.4   | 1.89%  | 250.3                  | 259.1   | 3.52%  |
| Confectionery                    | 29.3  | 29.8  | 1.71%  | 894.3                  | 917.5   | 2.59%  |
| Dairy                            | -     | -     | n.a    | 2891.4                 | 3006.2  | 3.97%  |
| Dried Processed Food             | 818.9 | 848.8 | 3.65%  | 2794.1                 | 2991.7  | 7.07%  |
| Frozen Processed Food            | 37.6  | 38.7  | 2.93%  | 474.1                  | 491.5   | 3.67%  |
| Ice-cream                        | 44.1  | 45.2  | 2.49%  | 534.8                  | 548.6   | 2.58%  |
| Meal Replacement                 | 0.8   | 0.8   | 0.00%  | 130.9                  | 142     | 8.48%  |
| Noodles                          | 104.7 | 109.3 | 4.39%  | 939.9                  | 1044    | 11.08% |
| Oils and Fats                    | 699.8 | 713.8 | 2.00%  | 2223.5                 | 2281.6  | 2.61%  |
| Pasta                            | 1.5   | 1.6   | 6.67%  | 11.2                   | 12.6    | 12.50% |
| Ready Meals                      | 6.4   | 6.6   | 3.12%  | 101                    | 105     | 3.96%  |
| Sauces, Dressings and Condiments | 77.5  | 79.7  | 2.84%  | 1158.4                 | 1192.9  | 2.98%  |
| Snack Bars                       | 0.2   | 0.2   | 0.00%  | 7.2                    | 7.7     | 6.94%  |
| Soup                             | 2.6   | 2.7   | 3.85%  | 49.2                   | 51.8    | 5.28%  |
| Spreads                          | 10.3  | 10.6  | 2.91%  | 129.7                  | 134.7   | 3.86%  |
| Sweet and Savory Snacks          | 31.1  | 31.9  | 2.57%  | 603.7                  | 623.2   | 3.23%  |
| Impuls and Indulgence Products   | -     | -     | n.a    | 3592.3                 | 3688.6  | 2.68%  |
| Nutrition/Staples                | -     | -     | n.a    | 10256                  | 10759.3 | 4.91%  |
| Meal Solutions                   | 209.6 | 215.3 | 2.72%  | 2836.5                 | 2928.6  | 3.25%  |
| Packaged Food                    | -     | -     | n.a    | 16666.3                | 17357.2 | 4.15%  |

Source: Euromonitor International (2012)



## REFERENCES

- Abdullah, A. and Tan, C.C. 2001. Optimization of Reduced Calorie Tropical Mixed Fruits Jam. *Food Quality and Preference*. **12**: 63-68.
- Afoakwa, E., Nartey, E., Ashong, J. and Annor, G. 2006. Effect of sugar, pectin and acid balance on the quality characteristics of pineapple (*Ananas comosus*) jam. *Proceeding of the 13<sup>th</sup> World Food Congress, Nantes, France*. pp. 1405-1406.
- Ahmed, T., Burhanuddin, M., Haque, M.A. and Hossain, M.A. 2011. Preparation of Jam from Sapota (*Achras zapota*). *Scientific Journal of Krishi Foundation*. **9**(1-2): 1-7.
- Ali Muhammad, Durrani, Y., Zeb, A., Ayub, M., and Ullah, J. 2008. Development of diet jam from apple grown in swat (NWFP). *Sarhad Journal of Agriculture*. **24**(3): 461-467.
- Aminah, A. 2000. *Prinsip Penilaian Sensori*. Bangi: UKM.
- Amusa, N.A., Ashaye, O.A., Oladapo, M.O. and Kafaru, O.O. 2003. Preharvest deteriorations of soursop (*Annona muricata*) at Ibadan South Western Nigeria and its effect on nutrient composition. *African Journal of Biotechnology*. **2**: 23-25.
- Ashaye, O.A. and Adeleke, T.O. 2009. Quality attributes of stored Roselle jam. *International Food Research Journal*. **16**: 363-371.
- Asprey, G.F and Thornton, P. 1995. Medicinal plants of Jamaica. *Journal of West Indian Medicinal Plants*. **4**: 69-92.
- Association of Official Analytical Chemists (AOAC). 2006. *The Official Methods of Analysis of AOAC International*. 18<sup>th</sup> Ed. USA: The Association Official Analysis Chemistry Arlington.
- Bajwa, E.E., Parwaz, N.Z., Javed, A. and Ahmad, N. 2003. Development, standardization and storage studies on grape fruit apple marmalade. *Pakistan Journal of Food Science*. **13**(3-4): 11-15.
- Barrett, D.M., Somogyi, L. and Ramaswamy, H.S. 2004. *Processing Fruits: Science and Technology*. 2<sup>nd</sup> Ed. USA: CRC Press.
- Basu, S. and Shivhare, U.S. 2010. Rheological, textural, micro-structural and sensory properties of mango jam. *Journal of Food Engineering*. **100**: 357-365.
- Berolzheimer, R., Bentley, M. and Flora, R. 1959. *The American Woman's Cook Book*. UK: Cornell University Press. pp. 10-22.
- Besbes, S., Drira, L., Blecker, C., Deroanne, C. and Attia, H. 2009. Adding value to hard date (*Phoenix dactylifera* L.): Compositional, functional and sensory characteristics of date jam. *Food Chemistry*. **112**: 406-411.

- Buesco, C.E. 1980. *Soursop, Tamarind and Chironja*. In Nagy, S. and Shaw, P.E. (Eds.). *Tropical and Subtropical Fruits*. pp.375-406. Westport, CT: AVI Publishing.
- Coakes, S.J. and Ong, C. 2011. *SPSS: Analysis Without Anguish: Version 18 for Windows*. Australia: John Wiley & Sons Australia Ltd.
- Cochran, W.G. and Cox, G.M. 1957. *Experimental Designs*. New York: John Wiley and Sons. pp. 469.
- Codex Alimentarius Commission. 2008. *Report of the 24<sup>th</sup> Session of the Codex Committee on Processed Fruits and Vegetables*. Rome: Joint FAO/WHO Food Standards Programme.
- CP Kelco. 2008. *GENU<sup>®</sup> Pectin Book*. USA: CP Kelco.
- Damiani, C., Asquieri, E.R., Lage, M.E., Oliveira, R.A., Silva, F.A., Pereira, D.E.P. and Vilas Boas, V.B. 2012. Study of the shelf-life of a mixed araçá (*Psidium guineensis* Sw.) and marolo (*Annona crassiflora* Mart.) jam. *Journal of Food Technology*. **32**(2): 334-343.
- Department of Agriculture Malaysia. 2013. *Selected Agricultural Indicators*. Malaysia: Department of Agriculture Malaysia.
- Department of Statistics Malaysia. 2014. *Consumer Price Index - October 2014*. Malaysia: Department of Statistics Malaysia.
- Dervisi, P., Lamb, J. and Zabetakis, I. 2001. High pressure processing in jam manufacture: effects on textural and colour properties. *Food Chemistry*. **73**: 85-91.
- Eke-Ejiofor, J. and Owuno, F. 2013. The physico-chemical and sensory properties of jackfruit (*Artocarpus heterophilus*) jam. *International Journal of Nutrition and Food Science*. **2**: 149-152.
- Euromonitor International. 2012. "Market Watch 2012", *The Malaysian Food Industry*. Retrieved on November 20, 2014 from <http://www.euromonitor.com/packaged-food-in-malaysia/report>
- Fellows, P.J. 2000. *Food Processing Technology, Principles and Practice*. 2<sup>nd</sup> Ed. Cambridge: Wood Head Publishing.
- Ferreira, I.M.P.L.V.O., Pestana, N., Alves, M.R., Mota, F.J.M., Reu, C., Cunha, S. and Oliveira, M.B.P.P. 2004. Quince jam quality: microbiological, physicochemical and sensory evaluation. *Food Control*. **15**: 291-295.
- Food Act 1983 and Food Regulations 1985. (Amendments up to August 2014). Malaysia: International Law Book Services.
- Food and Agricultural Organization (FAO). 2003. *Food energy – Methods of Analysis and Conversion Factors*. Rome: FAO.
- Food and Drug Association (FDA). 2001. *Bacteriological Analytical Manual: Chapter 3 Aerobic Plate Count*. US: FDA.

- Food and Drug Association (FDA). 2001. *Bacteriological Analytical Manual: Chapter 18 Yeast, Moulds and Mycotoxins*. US: FDA.
- Garcia-Martinez, E., Ruiz-Diaz, G., Martinez-Monzo, J., Camacho, M.M., Martinez-Navarrete, N. and Chiralt, A. 2002. Jam manufacture with osmodehydrated fruit. *Food Research International*. **35**: 301-306.
- Habiba, R.A. and Mehaia, M.A. 2008. Improving Carrot Jam Characteristics and Its Nutritional Value by Using Date Paste Instead of Sugar. *Journal of Agricultural and Veterinary Sciences*. **1**(1): 13-18.
- Harrison, J.A. and Andress, E.L. 2013. *Preserving Food: Jams and Jellies*. US: University of Georgia Cooperative Extension.
- Herbstreith and Fox. 2012. *Jams, Jellies and Marmalades*. Germany: Herbstreith and Fox.
- Hussain, I. and Shakir, I. 2010. Chemical and organoleptic characteristics of jam prepared from indigenous varieties of apricot and apple. *World Journal of Dairy & Food Sciences*. **5**(1): 73-78.
- Ingham, B.H. 2008. *Making Jam, Jellies and Fruit Preserves*. Madison: University of Wisconsin-Extension Cooperative Extension.
- International Jelly & Preserve Association. 2010. *Jellies and Jams 101*. Retrieved on November 20, 2014 from <http://jelly.org/bodyjamsjellies.html>.
- International Pectin Producers Association (IPPA). 2001. *Facts about pectin*. Retrieved on 23 November, 2014 from [http://www.ippa.info/what\\_is\\_pectin.htm](http://www.ippa.info/what_is_pectin.htm)
- International Trade Centre (ITC). 2014. *Trade Map: Trade Statistics for International Business Development*. Retrieved on November 7, 2014 from [http://www.trademap.org/tradestat/Country\\_SelProduct\\_TS.aspx](http://www.trademap.org/tradestat/Country_SelProduct_TS.aspx)
- Javanmard, M. and Endan, J. 2010. A Survey on Rheological Properties of Fruit Jams. *International Journal of Chemical Engineering and Applications*. **1**(1): 31-37.
- Kemp, S.E., Hollowood, T. and Hort, J. 2009. *Sensory Evaluation: A Practical Handbook*. UK: Wiley-Blackwell.
- Kerdsup, P. and Naknean, P. 2013. Effect of sorbitol substitution on physical, chemical and sensory properties of low-sugar mango jam. *Proceeding - Science and Engineering*. **4**: 12-18.
- Kopjar, M., Pilizota, V., Tiban, N.N., Subaric, D., Babic, J., Ackar, D. and Sajdl, M. 2009. Strawberry Jams: Influence of Different Pectins on Colour and Textural Properties. *Czech Journal of Food Science*. **27**: 20-28.
- Lawless, H.T. and Heymann, H. 1999. *Sensory Evaluation of Food: Principles and Practices*. New York: Chapman & Hall.

- Manisha, G., Soumya, C. and Indrani, D. 2012. Studies on interaction between stevioside, liquid sorbitol, hydrocolloids and emulsifiers for replacement of sugar in cakes. *Food Hydrocolloids*. **29**: 363-73.
- Meilgaard, M.C., Civille, G.V. and Carr, B.T. 2007. *Sensory Evaluation Techniques*. 4<sup>th</sup> Ed. USA: CRC Press.
- Morton, J.F. 1987. *Fruits of Warm Climates*. USA: Creative Resources Systems.
- Murano, P.S. 2003. *Understanding Food Science and Technology*. USA: Cengage Learning.
- Mohd Naeem, M.N., Mohd Fairulnizal, M.N., Norhayati, M.K., Zaiton, A., Norliza, A.H., Wan Syuriahti, W.Z., Azerulazree, J.Mohd., Aswir, A.R. and Rusidah, S.
- Nakasone, H.Y. and Paull, R.E. 1998. *Tropical Fruits*. Crop Production Science in Horticulture. CABI Publishing.
- Ndabikunze, B.K., Masambu, B.N., Tilsekwa, B.P.M. and Issa-Zacharia, A. 2011. The production of jam from indigenous fruits using baobab (*Adansonia digitata* L.) powder as a substitute for commercial pectin. *African Journal of Food Science*. **5**(3): 168-175.
- Nwachukwu, E. and Ezeigbo, C.G. 2013. Changes in the microbial population of pasteurized soursop juice treated with benzoate and lime during storage. *African Journal of Microbiology Research*. **7**(31): 3992-3995.
- Oliveira Mamede, M.E., Carvalho, L.D., Souza Viana, E., Oliveira, L.A., Santos Soares Filho, W. and Ritzinger, R. 2013. *Food and Nutrition Science*. **4**: 461-468.
- Omar, N. 2010. *Enhancing Food Processing through Technological Innovations*. MARDI FAMA Walk-In Seminar.
- Onyechi, Uchenna, A., Ibeanu, Nkiruka, V., Eme, Eze, P., Kelechi, Madubike. 2012. Nutrient, Phytochemical Composition and Sensory Evaluation Of Soursop (*Annona muricata*) Pulp and Drink in South Eastern Nigeria. *International Journal of Basic and Applied Sciences*. **12**(6): 53-57.
- Orsi, D.C., Carvalho, V.S., Nishi, A.C.F., Damiani, C., Asquiere, E.R. 2012. Use of sugar apple, atemoya and soursop for technological development of jams – chemical and sensorial composition. *Journal of Agricultural Technology*. **36**(5): 560-566.
- Paladi, D. and Tatarov, P. 2008. Physical-chemical characteristics of the taste of jam type products. *Food Technology*. **31**: 66-70.
- Pavlova, V., Karakashova, L., Stamatovska, V., Delchev, N., Necinova, L., Nakov, G., Menkinoska, M. and Blazevska, T. 2013. Storage impact on the quality of raspberry and peach jams. *Journal of Hygienic Engineering and Design*. **5**: 25-28.

- Poiana, M.A., Moigradean, D., Dogaru, D., Mateescu, C., Raba, D. and Gergen, I. 2011. Processing and storage impact on the antioxidant properties and color quality of some low sugar fruit jams. *Romanian Biotechnological Letters*. **16**(5): 6504-6512.
- Polshettiwar, S.A., Ganjiwale, R.O., Yeole, P.G., Zamwar, S.P. and Wani, M.S. 2008. Studies on pesticide residue, heavy metal content and microbial count of some popular brands of chywanprash samples. *The Bioscan*. **3**(1): 75-78.
- Ramkhelawan, E. 2008. *Production Guide for Sapodilla, Soursop and Sugar Apple*. Trinidad: IICA.
- Rolle, R. 2008. *Good Practice for Assuring the Post-Harvest Quality of Exotic Tree Fruit Crops Produced in Jamaica*. Rome: FAO.
- Safdar, M.N., Mumtaz, A., Hameed, T., Siddiqui, N., Khalil, S. and Amjad, M. 2012. Storage Studies of Jam Prepared from Different Mango Varieties. *Pakistan Journal of Nutrition*. **11**(7): 555-561.
- Scibisz, I. and Mitek, M. 2009. Effect of processing and storage conditions on phenolic compounds and antioxidant capacity of highbush blueberry jams. *Polish Journal of Food and Nutritional Science*. **59**(1): 45-52.
- Second Sabah Agriculture Policy (SAP2). 1999. *Second Sabah Agriculture Policy 1999-2010*. Sabah: Ministry of Agriculture Development and Food Industry.
- Selvamuthukumaran, M. and Khanum, F. 2014. Processing seabuckthorn fruit for antioxidant rich jam development and shelf stability assessment. *Indian Journal of Traditional Knowledge*. **13**(2): 335-346.
- Shahnawaz, M., Sheikh, S.A. and Nizamani, S.M. 2009. Determination of Nutritive Values of Jamun Fruit (*Eugenia jambolana*) Products. *Pakistan Journal of Nutrition*. **8**(8): 1275-1280.
- Shakir, I., Durrani, Y., Hussainm, I., Qazi, I.M. and Zeb, A. 2007. Physicochemical Analysis of Apple and Pear Mixed Fruit Jam Prepared from Varieties Grown in Azad Jammu and Kashmir. *International Journal of Food Safety*. **9**: 22-24.
- Sharma, D.S. 2014. Quality evaluation and storage stability of jamun-mango blended jam. *International Quarterly Journal of Life Sciences*. **9**(3): 953-957.
- Slavin, J. L. 2005. Dietary fibre and body weight. *Nutrition*. **21**: 411-418.
- Sood, S. 2015. Studies on the Assessment of Storage Stability of Jamun Jam. *International Journal of Innovative Research and Development*. **4**(3): 239-243.
- Southampton Centre for Underutilized Crops (SCUC). 2006. *Annona: Annona cherimola, A. muricata, A. reticulata, A. senegalensis and A. squamosa, Field Manual for Extension Workers and Farmers*. UK: University of Southampton.
- Stone, H. and Sidel, J.L. 2004. *Sensory Evaluation Practices*. 3<sup>rd</sup> Ed (Food science and Technology. International Series). USA: Elsevier Academic Press.

- Sundar Raj, A.A., Rubila, S., Jayabalan, R. and Ranganathan, T.V. 2012. A Review on Pectin: Chemistry due to General Properties of Pectin and its Pharmaceutical Uses. *Scientific Reports*. **1**(550): 1-4.
- Tanwar, B., Andallu, B. and Chandel, S. 2014. Influence of Processing on Physicochemical and Nutritional Composition of *Psidium Guajava* L. (Guava) Products. *International Journal of Agriculture and Food Science Technology*. **5**(2): 47-54.
- Touati, N., Tarazona-Dí'az, M.P., Aguayo, E., Louaileche, H., 2014. Effect of storage time and temperature on the physicochemical and sensory characteristics of commercial apricot jam. *Food Chemistry*. **145**: 23-27.
- Thuy, N.M., Binh, L.N., Thach, N.A., Tri, N.M., Hurong, H.T., Curong, N.P., Dinh, D.C. and Tuyen, N.T.M. 2014. Effect of processing conditions and gelling agents on the physico-chemical and sensory characteristics of jackfruit jam adding to yogurt. *Journal of Science and Development*. **12**(1): 78-88.
- Umme, A., Salmah, Y., Jamilah, B. and Asbi, B.A. 1999. Microbial and Enzymatic Changes in Natural Soursop Puree during Storage. *Food Chemistry*. **65**: 315-322.
- United States Department of Agriculture (USDA). 2011. *USDA Nutrient Database for Standard Reference*. Retrieved on April 16, 2015 from <http://www.ars.usda.gov/ba/bhnrc/ndl>.
- United States Department of Agriculture (USDA). 2014. *What's in the Foods you eat Search Tool, 2011-2012 ARS*. Food and Nutrient Database for Dietary Studies (FNDDS). Retrieved on November 20, 2014 from <http://ars.usda.gov/Services/docs.htm?docid=17032>.
- Vidhya, R. and Narain, A. 2011. Formulation and evaluation of preserved products utilizing under exploited fruit, wood apple (*Limonia acidissima*). *American-Eurasian Journal of Agricultural & Environmental Science*. **10**(1): 112-118.
- Wicklund, T., Rosenfeld, H. J., Martinsen, B. K., Sundfor, M. W., Lea, P. and Bruun, T., 2005. Antioxidant capacity and colour of strawberry jam as influenced by cultivar and storage conditions. *Food Science and Technology*. **38**: 387-391
- Worch, T., Dooley, L., Meullenet, J-F. and Punter, P.H. 2010. Comparison of PLS dummy variables and Fishbone method to determine optimal product characteristics from ideal profiles. *Food Quality and Preference*. **21**: 1077-1087.
- Zainun, C.A. 1992. Jam Processing Technology. *Teknologi Makanan*. MARDI **11**: 85-88.