

**Processing and Packaging of Selected Value Added  
Fruit products and their Promotion through  
Capacity Building Programme**

**By  
Thilagavathi. T**

**A thesis submitted to  
Avinashilingam Institute for Home Science and  
Higher Education for Women, University  
Coimbatore - 641 043.**

**In Partial Fulfillment of the requirements for the Degree of**

**Doctor of Philosophy  
In  
Food Service Management and Dietetics**

**February 2013**

## DECLARATION

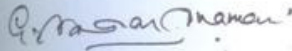
I declare that the thesis entitled "**Processing and Packaging of Selected Value Added Fruit Products and their Promotion through Capacity Building Programme**", submitted by me for the Degree of **Doctor of Philosophy** is the record of work carried out by me during the period from 2009 to 2013 under the guidance of **Dr.(Mrs.) V.Saradha Ramadas**, Professor, Department of Food Service Management and Dietetics, Avinashilingam Institute for Home Science and Higher Education For Women, Coimbatore-43 and has not formed the basis for the award of any Degree / Diploma / Associateship / Fellowship / Titles in this University or other similar institution of Higher Learning.



**Signature of the Candidate**

## CERTIFICATE

I certify that the thesis entitled "**Processing and Packaging of Selected Value Added Fruit Products and their Promotion through Capacity Building Programme**", submitted for the **Degree of Doctor of Philosophy** by **Ms. Thilagavathi, T.**, is a record of research work carried out by her during the period from 2009 to 2013 under my guidance and supervision and that this work has not formed the basis for the award of any Degree / Diploma / Associateship / Fellowship or other Titles in this University or any other University or institution of Higher Learning.



Signature of the H.O.D

Signature of the Supervisor  
with Designation

**Dr. V. SARADHA RAMADAS**  
M.Sc., M.Phil., Ph.D., M.Sc (HM), MBA (HR)  
Professor, Dept. of Food Service  
Management and Dietetics  
Avinashilingam Institute for Home Science  
and Higher Education for Women  
Coimbatore - 641043

## ACKNOWLEDGEMENT

At the outset, the investigator, most reverentially express her profound gratitude from the inner most recess of her heart to the **God Almighty**, who has given her wisdom, knowledge, strength and opportunity to do the thesis work effectively.

The investigator owes her respectful gratitude to **Thiru T.S. Avinashilingam**, Founder and First Chancellor of Avinashilingam Institute for Home Science and Higher Education for Women Coimbatore, for providing this temple of learning to do this research. The investigator records her reverential gratitude to **Late Hon. Colonel Dr.(Tmt.) Rajammal P. Devadas, M.A., M.Sc., PhD(Ohio State),Hon. D.Sc.(Madras, HonD.H.L.(OregonState),Hon.D.H.L.(OhioState),D.S.C.(Kanpur),Hon.D.Sc.(Northern Ireland)**, Former Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for being a perennial source of inspiration for conducting the study.

The investigator is grateful to Late **Thiru.T.K.S.Meenakshi Sundaram, M.A., M.Phil., Ph.D.** Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for providing an opportunity, infrastructure and all the amenities to conduct the study in the university.

She records her gratitude to **Hon. Col. Dr. (Tmt.) Saroja Prabhakaran, M.A., Dip. Ed.(Madras), Ph.D. (Mother Teresa)**, Former Vice Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for granting official permission to conduct the study. The investigator owes her special thanks to **Dr.(Tmt).Sheela Ramachandran, M.Sc, P.G.Dip.(Fd.Sc.&P), Ph.D.**, Vice chancellor, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for facilitating to complete the study.

The investigator expresses her thank s and gratitude to **Dr. (Tmt). Gowri Ramakrishnan, M.Sc.(Madras), M.Phil., Ph.D.** Registrar, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for extending all help for the smooth conduct of the study.

She expresses her heartfelt thanks to **Dr. (Tmt).K.Thangamani, M.Sc., Dip.Ed., M.Phil., Ph.D.**, Dean, Faculty of Home Science and Professor and Head of the Department of Home Science Extension Education, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for her help and constant support to carry out the research.

The investigator owes her heartfelt thanks to **Dr.(Tmt.) V. Anuradha, M.Sc., Dip.Ed., M.Phil.(Madras), PhD** Former Head, Department of Food Service Management and Dietetics, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for her blessing and moral support for the conduct of study.

The investigator acknowledges the support given by **Dr. G. Vasanthamani**, Professor and Head In-charge, Department of Food Service Management and Dietetics, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore.

The investigator records her deep sense of gratitude and whole hearted thanks to her supervisor **Dr. (Mrs.) Saradha Ramadas, M.Sc., M.Ed., M.Phil., Ph.D.**, Professor, Department of Food Service Management and Dietetics, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, whose ability to probe beneath the text was a true gift, and her insights have strengthened this study significantly. Her meticulous guidance, deep concern, constructive suggestions, continued motivation, enduring support and gentle caring rendered throughout the study enabled the investigator to complete the research successfully.

The investigator acknowledges with gratitude the good wishes and encouragement of all the **Staff members** of Department of Food Service Management and Dietetics, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore for their constructive suggestions.

She expresses her heartfelt thanks to her **Husband** and **Children** for their constant motivation and moral support rendered and to all those who supported her in any respect during the course completion of the study.

## CONTENTS

CHAPTER NO.	TITLE	PAGE NO.
	<b>LIST OF TABLES</b>	
	<b>LIST OF FIGURES</b>	
	<b>LIST OF PLATES</b>	
	<b>LIST OF APPENDICES</b>	
<b>I</b>	<b>INTRODUCTION</b>	1
<b>II</b>	<b>REVIEW OF LITERATURE</b>	10
	A. Need for value added fruit products	10
	B. Processing techniques to extend the shelf life of fruits	18 21
	C. Quality assessment - Organoleptic and nutritional quality	28
	D. Suitability of packing material and shelf life of processed value added products and	36
<b>III</b>	E. Capacity building programme for entrepreneurship development of women and farmer.	39
	<b>METHODOLOGY</b>	
	<b>PHASE I</b>	39
	A. Production scenario of banana, guava and papaya	41
	B. Market survey on the availability of processed fruit products	41
	C. Study on consumer preference	42
	<b>PHASE II</b>	
	Processing of banana, guava and papaya by dehydration, pulping and pickling techniques	59
	<b>PHASE III</b>	
	Quality analysis and shelf life study of dehydrated fruits and formulated products and	64

	<b>PHASE IV</b>	
	Capacity building programme on fruit processing to Self Help Group women and Farmers.	68
<b>IV</b>	<b>RESULTS AND DISCUSSION</b>	
	<b>PHASE I</b>	
	A. Production scenario of banana, guava and papaya	68
	B. Market survey on the availability of processed fruit products	75
	C. Study on consumer preference	78
	<b>PHASE II</b>	
	Processing of banana, guava and papaya by dehydration, pulping and pickling techniques	80
	<b>PHASE III</b>	
	Quality analysis and shelf life study of dehydrated fruits and formulated products and	86
	<b>PHASE IV</b>	
	Capacity building programme on fruit processing to Self Help Group women and Farmers.	142
<b>V</b>	<b>SUMMARY AND CONCLUSION</b>	146
	<b>BIBLIOGRAPHY</b>	155
	<b>APPENDICES</b>	161

## LIST OF TABLES

<b>TABLE NO.</b>	<b>TITLE</b>	<b>PAGE NO.</b>
1	Global Production of Banana	69
2	Global Production of Guava	70
3	Global Production of Papaya	70
4	National Production of Banana	72
5	National Production of Guava	73
6	Indian Production of Papaya	74
7	Availability of Fruit Products in the Market	75
8	Preferences of Consumers for the Fruit Products	76
9	Major Market Outlets of Fruit Products	76
10	Satisfactory levels of consumer on the quality and price of Fruit Products	77
11	Consumer Expectations on Fruit Products	78
12	Reasons for the Preference of Fruit Product	79
13	Edible Portion of Banana, Guava and Papaya	81
14	Colour and Texture of Dehydrated Banana, Guava and Papaya	82
15	Time and Temperature for Dehydration of Banana, Guava and Papaya	84
16	Yield of Banana, Guava and Papaya Fruit Pulp	85
17	Yield of Mixed Fruit Pickle	86
18	Mean Scores of Banana, Guava and Papaya by Sun Drying	87
19	Mean Scores of Banana, Guava and Papaya by	89

	<b>Microwave Drying</b>	
<b>20</b>	<b>Mean Scores of Banana, Guava and Papaya by Cabinet Drying</b>	<b>91</b>
<b>21</b>	<b>Mean Scores of Banana, Guava and Papaya by Osmotic Dehydration Method</b>	<b>93</b>
<b>22</b>	<b>Nutrient Content of Fresh and Dried Banana</b>	<b>95</b>
<b>23</b>	<b>Nutrient Content of Fresh and Dried Guava</b>	<b>97</b>
<b>24</b>	<b>Nutrient Content of Fresh and Dried Papaya</b>	<b>97</b>
<b>25</b>	<b>Total Plate Count of Dehydrated Fruits by Sun Drying and Packed in Various Packing Materials</b>	<b>98</b>
<b>26</b>	<b>Total Plate Count of Dehydrated Fruits by Microwave Drying and Packed in Various Packing Materials</b>	<b>99</b>
<b>27</b>	<b>Total Plate Count of Dehydrated Fruits by Cabinet Drying and Packed in Various Packing Materials</b>	<b>100</b>
<b>28</b>	<b>Total Plate Count of Dehydrated Fruits by Osmotic Drying and Packed in Various Packing Materials</b>	<b>101</b>
<b>29</b>	<b>Mean Score of Banana Candy using Score Card</b>	<b>102</b>
<b>30</b>	<b>Mean Hedonic Rating Scale for Banana Candy</b>	<b>103</b>
<b>31</b>	<b>Nutrient Content of Banana and Banana Candy</b>	<b>104</b>
<b>32</b>	<b>Mean Score of Banana Candy during Shelf Life Study</b>	<b>105</b>
<b>33</b>	<b>Mean Hedonic Rating Scale for Banana Candy during Shelf Life Study</b>	<b>106</b>
<b>34</b>	<b>Nutrient Content of Banana Candy during Shelf Life Study</b>	<b>107</b>
<b>35</b>	<b>Mean Score of Guava Candy using Score Card</b>	<b>108</b>
<b>36</b>	<b>Mean Hedonic Rating Scale for Guava Candy</b>	<b>109</b>
<b>37</b>	<b>Nutrient Content of Guava and Guava Candy</b>	<b>110</b>
<b>38</b>	<b>Mean Score of Guava Candy during Shelf Life Study</b>	<b>111</b>

39	Mean Hedonic Rating Scale for Guava Candy during Shelf Life Study	112
40	Nutrient Content of Guava Candy during Shelf Life Study	113
41	Main Score of Papaya Candy Using Score Card	114
42	Mean Hedonic Rating Scale for Papaya Candy	115
43	Rank Correlation on Hedonic Rating Scale of Candies	116
44	Nutrient Content of Papaya and Papaya Candy	117
45	Mean Score of Papaya Candy during Shelf Life Study	118
46	Mean Hedonic Rating Scale for Papaya Candy during Shelf Life Study	119
47	Nutrient Content of Papaya Candy during Shelf Life Study	120
48	Moisture Content of Candies	120
49	Total Plate Count at 37 <sup>0</sup> C of Candies	121
50	Variation of Fruit Candies	121
51	Yield and Cost of Fruit Candies	122
52	Mean Score of Banana Sauce using Score Card	123
53	Mean Hedonic Rating Scale for Banana Sauce	124
54	Nutrient Content of Banana and Banana Sauce	125
55	Mean Score for Banana Sauce during Shelf Life Study	126
56	Mean Hedonic Rating Scale for Banana Sauce during Shelf Life study	127
57	Nutrient Content of Banana Sauce during Shelf Life Study	128
58	Mean Score of Guava Sauce using Score Card	129

<b>59</b>	<b>Mean Hedonic Rating Scale for Guava Sauce</b>	<b>130</b>
<b>60</b>	<b>Nutrient Content of Guava and Guava Sauce</b>	<b>131</b>
<b>61</b>	<b>Mean Score of Guava Sauce during Shelf Life Study</b>	<b>132</b>
<b>62</b>	<b>Mean Hedonic Rating Scale for Guava Sauce during Shelf Life Study</b>	<b>133</b>
<b>63</b>	<b>Nutrients Content of Guava Sauce during Shelf Life Study</b>	<b>134</b>
<b>64</b>	<b>Mean Score of Papaya Sauce using Score Card</b>	<b>135</b>
<b>65</b>	<b>Mean Hedonic Rating Scale for Papaya Sauce</b>	<b>136</b>
<b>66</b>	<b>Rank correlation of hedonic rating scale of sauces</b>	<b>136</b>
<b>67</b>	<b>Nutrient Content of Papaya and Papaya Sauce</b>	<b>137</b>
<b>68</b>	<b>Mean Score of Papaya Sauce during Shelf Life Study</b>	<b>138</b>
<b>69</b>	<b>Mean Hedonic Rating Scale for Papaya Sauce during Shelf Life Study</b>	<b>139</b>
<b>70</b>	<b>Nutrients Content of Papaya Sauce during Shelf Life Study</b>	<b>140</b>
<b>71</b>	<b>Moisture Content of Sauces</b>	<b>141</b>
<b>72</b>	<b>Total Plate Count at 37<sup>0</sup>c of Sauces</b>	<b>141</b>
<b>73</b>	<b>Impact of Capacity Building Programme on the Knowledge of Self Help Group Women and Farmers</b>	<b>142</b>

## LIST OF FIGURES

<b>FIGURE NO.</b>	<b>TITLE</b>	<b>PAGE NO.</b>
1	Major Banana, Guava and Papaya Producing States in India	40
2	Model Diagram of Cluster Sampling	42
3	Mass Transfer in Osmotic Dehydration	51
4	Global Production of Banana	69
5	Global Production of Guava	70
6	Global Production of Papaya	71
7	National Production of Banana	72
8	National Production of Guava	73
9	Indian Production of Papaya	74
10	Nutrient Content of Banana and Banana Candy	104
11	Nutrient Content of Guava and Guava Candy	110
12	Nutrient Content of Papaya and Papaya Candy	115
13	Nutrient Content of Banana and Banana Sauce	125
14	Nutrient Content of Guava and Guava Sauce	131
15	Nutrient Content of Papaya and Papaya Sauce	137

## LIST OF PLATES

<b>PLATE NO.</b>	<b>TITLE</b>	<b>PAGE NO.</b>
<b>1</b>	<b>Variety of Fruits</b>	<b>46</b>
<b>2</b>	<b>Ripening Stages of Banana, Guava and Papaya</b>	<b>47</b>
<b>3</b>	<b>Variations Of Fruit Sauces</b>	<b>58</b>
<b>4</b>	<b>Sensory Evaluation by Panel Members</b>	<b>60</b>
<b>5</b>	<b>Types of Packing Material</b>	<b>62</b>
<b>6</b>	<b>Stacking of Banana for Processing by the Women Entrepreneur</b>	<b>65a</b>
<b>7</b>	<b>Processing of Banana by Women Entrepreneur</b>	<b>65b</b>

## LIST OF ANNEXURES

<b>ANNEXURE NO.</b>	<b>TITLE</b>	<b>PAGE NO.</b>
1	Market Survey Questionnaire	161
2	Questionnaire to Elicit the Information Regarding Preference of Target Consumers on Fruit Products	163
3	Recipe for Mixed Fruit Pickle	164
4	Score Card	165
5	Hedonic Rating Scale	170
6	Estimation of Energy (Analytical Chemistry by Dr.Pearson)	170
7	Estimation of Protein by Micro-Kjeldahl Method	171
8	Estimation of fat by volumetric method	172
9	Determination of Total Carbohydrate by Anthrone Method	172
10	Estimation of Total Ash	173
11	Determination of Ash Insoluble in dil Hcl	174
12	Determination of Total Dietary Fibre	174
13	Estimation of Moisture by Gravimetric Method	177
14	Determination of Vitamin A by	177

	<b>spectrophotometric Method</b>	
<b>15</b>	<b>Determination of Vitamin C (Ascorbic Acid)</b>	<b>179</b>
<b>16</b>	<b>Determination of Sodium</b>	<b>180</b>
<b>17</b>	<b>Determination of Potassium</b>	<b>181</b>
<b>18</b>	<b>Determination of the Aerobic Colony Count in Foods by HPB Method</b>	<b>182</b>
<b>19</b>	<b>Determination of Total Anti Oxidant Activity by ORAC Assay</b>	<b>185</b>