

DEVELOPMENT OF BANANA FLOUR BASED  
BABY FOOD PRODUCTS

By

S.R.B.R.GOTHAMA CHARINI GANNORUWA

Thesis submitted to the University of Sri Jayewardenepura partial  
fulfillment requirement for the award of the Degree of  
Master of Science  
in Food Science and Technology

Faculty of Graduate Studies  
University of Sri Jayewardenepura

Sri Lanka

2008

## DECLARATION

The work described in this thesis was carried out by me under the supervision of Dr. K.K.D.S. Ranaweera, Head, Department of Food Science & Technology, University of Sri Jayewardenepura and a report on this has not been submitted in whole or in part to any University or any other institution for another Degree/ Diploma.




.....

S.R.B.R.G.C. Gannoruwa

## DECLARATION OF THE SUPERVISOR

I, Dr. K.K.D.S. Ranaweera certify that the above statement made by the candidate is true and that this thesis is suitable for submission to the University for the purpose of evaluation.



Dr. K.K.D.S. Ranaweera

Head, Department of Food Science & Technology

Co-ordinator / Food Science & Technology Programmes

University of Sri Jayewardenepura

Nugegoga, Sri Lanka

## Table of Contents

	<b>Page</b>
<b>Table of Contents</b>	<b>i</b>
<b>List of Tables</b>	<b>vii</b>
<b>List of Figures</b>	<b>viii</b>
<b>List of Plates</b>	<b>ix</b>
<b>List of Appendices</b>	<b>x</b>
<b>Acknowledgements</b>	<b>xi</b>
<b>Abstract</b>	<b>xii</b>
<b>Chapter 1- Introduction</b>	<b>1</b>
1.1 Importance and potential uses of Banana flour	2
1.2 Objectives of the Research Project	3
<b>Chapter 2- Literature Review</b>	
2.1 Important characteristics of banana	4
2.1.1 Scientific classification of Banana	4
2.1.2 Morphology	5
2.1.3 Ripening of bananas	6
2.1.4 Discoloration of banana	7
2.1.5 Inhibitors of browning	8
2.1.6 Ascorbic acid as an antioxidant/ browning inhibitor	10
2.2 Physical properties of Banana	11
2.3 Nutritional properties of Banana	12

2.3.1 Health & Nutrition	14
2.4 Banana Trade	17
2.5 Traditional uses of bananas	19
2.6 Banana and plantain processing technologies	21
2.6.1 Traditional processing	21
2.6.1.1 Products and uses	22
2.6.1.2 Preservation methods and processes	23
2.6.1.3 Potential for scaling up of traditional processes	
To industrial level	24
2.6.2 Industrial processing	25
2.6.2.1 Products and uses	25
2.6.2.2 Processing technology	25
2.6.2.3 Product stability and spoilage problems	29
2.6.2.4 Quality control Methods	30
2.7 Starch and starch properties	31
2.7.1 Sources for starch	31
2.7.2 Structural unit	31
2.7.3 Functional properties	31
2.7.4 Amylograph for starch	34
2.8 Food Extrusion	34
2.9 Manufacturing of Biscuits	36
2.10 Banana flour in Baby Cereals	39
2.10.1 Commercial cereals	39

2.10.2 Home made cereals	39
2.11 Processing of Banana Flour	40
2.12 Banana flour Recipes	41
2.13 Maturity	46
2.13.1 Types of Maturity	46
2.13.2 Methods available for determination of Maturity	47

### **Chapter 3- Methodology**

3.1 Determination of Maturity Index for Embul Kesel	48
3.1.1 Materials	48
3.1.2 Method	48
3.2 Preparation of Banana Flour	50
3.2.1 Materials	50
3.2.2 Method	50
3.2.3 Flow chart of making banana flour	51
3.3 Recovery percentage of banana flour	52
3.3.1 Method	52
3.4 Determination of the Keeping Quality of banana flour	53
3.4.1 Inhibition of browning	53
3.4.1.1 Method	53
3.4.2 Microbial Examination	53
3.4.2.1 Materials	54
3.4.2.2 Method	54

3.5 Preparation of Starch	55
3.5.1 Materials	55
3.5.2 Method	55
3.5.3 Flow chart of preparation of Starch	56
3.5.4 Recovery percentage of Starch	57
3.5.5 Microscopic Examination of Starch	57
3.5.5.1 Material	57
3.5.5.2 Method	57
3.6 Gelatinization properties of banana flour	58
3.6.1 Materials	58
3.6.2 Method	58
3.7 Determination of Moisture	59
3.7.1 Materials	59
3.7.2 Method	59
3.8 Determination of Total Fat	60
3.8.1 Materials	60
3.8.2 Method	60
3.9 Determination of Crude Protein	61
3.9.1 Materials	61
3.9.2 Method	61
3.10 Determination of Fiber	62
3.10.1 Materials	62
3.10.2 Method	63

3.11 Determination of Total Ash	64
3.11.1 Materials	64
3.11.2 Method	64
3.12 Preparation of Banana Rice Baby Cereal	65
3.12.1 Home made Banana rice baby cereal	65
3.12.1.1 Materials	65
3.12.1.2 Method	65
3.12.2 Extrusion of Banana rice baby cereal	65
3.12.2.1 Materials	65
3.12.2.2 Method	66
3.12.3 Determination of Water Absorption Index for extrudates	66
3.12.3.1 Materials	66
3.12.3.2 Method	66
3.13 Preparation of baby Teething Biscuits/ Cookies	67
3.13.1 Banana Rice Cereal Cookies	67
3.13.1.1 Materials	67
3.13.1.2 Method	67
3.13.2 Eggless Banana Rice Cereal Cookies	68
3.13.2.1 Materials	68
3.13.2.2 Method	68
3.14 Sensory Evaluation	69
3.14.1 Format for Biscuit varieties	69
3.14.2 Format for Banana cookies	69



<b>Chapter 4- Results and Discussion</b>	
4.1 Determination of Maturity Index	70
4.2 Recovery percentage of banana flour	78
4.3 Keeping Quality	79
4.3.1 Inhibition of browning	79
4.3.2 Microbial examination	80
4.4 Preparation of Starch	82
4.4.1 Starch recovery percentage	82
4.4.2 Microscopic examination	84
4.4.3 Gelatinization properties (Amylograph)	85
4.5 Determination of Moisture content in Banana flour	88
4.6 Determination of Total Fat in Banana flour	91
4.7 Determination of Crude Protein in Banana flour	92
4.8 Determination of Fiber in Banana flour	93
4.9 Determination of Ash in Banana flour	94
4.10 Determination of Carbohydrates in Banana flour	95
4.11 Preparation of Banana rice baby cereal	96
4.12 Determination of Water Absorption Index for extrudates	98
4.13 Preparation of Banana rice cereal cookies	99
4.14 Results obtain on Sensory Evaluation	100
4.14.1 Sensory evaluation for 3 teething biscuit varieties	100
4.12.2 Sensory evaluation for Cookies	101
<b>Chapter 5- Conclusion</b>	<b>103</b>
<b>References</b>	<b>106</b>
<b>Appendices</b>	<b>110</b>

## **List of Tables**

	<b>Page</b>
Table 1- Nutritional Facts of Raw Banana	12
Table 2- Nutritional Facts of Banana Powder/ Flour	13
Table 3- Annual Banana production of the world	17
Table 4 Changes in Maturity Indices of Control	71
Table 5- Average parameters of the five banana samples and control	72
Table 6- Weight of banana samples	78
Table 7- Number of Microbial colonies appear in plates	80
Table 8- Recovery percentage of Starch samples	82
Table 9- Moisture content of banana flour samples	88
Table 10- Total Fat content of banana flour samples	91
Table 11- Crude Protein content of banana flour samples	92
Table 12- Total Fiber content of banana flour samples	93
Table 13- Ash content of banana flour samples	95
Table 14- Sensory evaluation data for 3 biscuit varieties	100
Table 15- Calculation based on rank sum test	100
Table 16- Sensory evaluation data for cookies	101
Table 17- Calculation based on rank sum test for cookies	101

## **List of Figures**

	<b>Page</b>
Figure 1- Reaction of Ascorbic acid with Quinone	10
Figure 2- Typical Twin-screw configuration showing feed mixing and conveying section	35
Figure 3- Changes of Maturity Indices before and after ripening of Embul banana	73
Figure 4- Variation in maturity indices of banana samples and control	74
Figure 5- Amylograph chart for banana flour	87

## **List of Plates**

	<b>Page</b>
Plate 1- Maturity stages of Embul banana fruit	75
Plate 2- Ripening Chart of banana fruit	75
Plate 3- Flour samples made by using three inhibitors and dis. Water	80
Plate 4- Isolated Starch	83
Plate 5,6- Starch granules in fresh raw banana	84
Plate 7- Starch granules isolated from raw banana	84
Plate 8- Home made Banana rice baby cereal	96
Plate 9- Baby cereal made by extrusion with 20% banana flour	96
Plate 10- Baby cereal made by extrusion with 20% banana flour	97
Plate 11- Banana rice cereal cookies	99
Plate 12- Eggless banana rice cereal cookies	99

## List of Appendices

	<b>Page</b>
Appendix 1- Maturity Indices of sample 1	110
Appendix 2- Maturity Indices of sample 2	111
Appendix 3- Maturity Indices of sample 3	112
Appendix 4- Maturity Indices of sample 4	113
Appendix 5- Maturity Indices of sample 5	114

## **ACKNOWLEDGEMENT**

First of all I would like to express my heartfelt gratitude to my project supervisor, Dr. K.K.D.S. Ranaweera for his valuable advises and guidance throughout the study.

I also wish to thank to Mrs. P.R.D. Perera , Mr. W.M.S.K. Weerasinghe and Mr. D.P. Rupasinghe for helping me to carryout the experiments at the Food Science and technology laboratory of the University of Sri Jayewardenepura.

I offer my sincere thanks to Dr. Nazeera Salim, Head of the Dept. of Botany, University of Sri Jayewardenepura for helping me to carryout experiments at the Botany laboratory.

Special word of thanks must go to Dr. A.M. Mubarak, Director, Industrial Technology Institute and Mrs. Damitha Rajapaksha for their kind assistance to carryout experiments at ITI Cereal laboratory.

Finally I would like to offer my thanks to my husband and my family members for encourage me to complete this project.

# **DEVELOPMENT OF BANANA FLOUR BASED**

## **BABY FOOD PRODUCTS**

**BY: S.R.B.R.G.C. GANNORUWA**

### **ABSTRACT**

Banana, *Musa* species is one of the major fruit cultivated in Sri Lanka. Embul kesel is the most common and is cheaper banana variety in the local market. Bananas are subjected to post harvest losses during their reach to market place. In the present study, an attempt was made to determine the maturity index to banana ( Embul variety), determine the banana flour properties and preparation of banana flour based baby food products.

The pH value, Total Soluble Solid and Penetration are suitable maturity indices for banana. Weight, Length and Diameter vary from plant to plant. Full three-quarter stage is the correct maturity stage for harvesting before onset of ripening.

Oven dried banana gave fine flour with little banana flavour. Recovery percentage of banana flour is 18.06% from the fresh banana or 27.69% from the pulp weight. Banana flour can be stored in polythene pouches for 10 months without changing the quality. Quality of the banana flour was assessed by several methods. Inhibitors such as Sodium Metabisulphite (SMS), Citric acid and Ascorbic acid were used to prevent the browning reactions during processing of flour. SMS is the most suitable inhibitor than others. Microbial examination was done to determine colony forming units in banana flour and

cookies as well. Number of colony forming units (cfu) in banana flour is about  $17 \times 10^4$  and cfu in cookies is about  $9 \times 10^2$ .

Starch was isolated from raw banana and examined under the microscope. Starch granules are elongated angular shape (carrot root shape) and white in colour. Starch recovery percentage of Embul banana is 1.88% from wet basis or 6.78% from dry basis. Gelatinization properties of banana flour also examined. Gelatinization temperature is 78-90 °C and gave a sharp high peak. Viscosity of banana flour is 1470 Brabender units. Flour was gelatinized well and gave thick paste.

Proximate analysis carried out to determine the chemical (nutritional) composition of banana flour; moisture  $4.8 \pm 0.04$  %, fat  $1.015 \pm 0.04$  %, protein  $1.542 \pm 0.06$  %, fiber  $6.1 \pm 0.03$  %, Ash  $2.16 \pm 0.08$  %. Banana flour has high fiber and ash content and low fat and protein content. Carbohydrate content was determined by calculation is 84.38%.

Banana flour used for prepares two types of baby cereals and two types of cookies. Twenty five to twenty percent (25-20 %) banana flour was added to prepare banana rice baby cereal. Home made baby cereal and extruded baby cereal were made according to the modified recipes. Sensory evaluation was carried out with 25 untrained panelists to select the best combination of banana flour for cookies showed that the cookies with fifteen percent (15%) Banana flour was satisfactory for prepare banana rice cereal cookies (Teething biscuit).