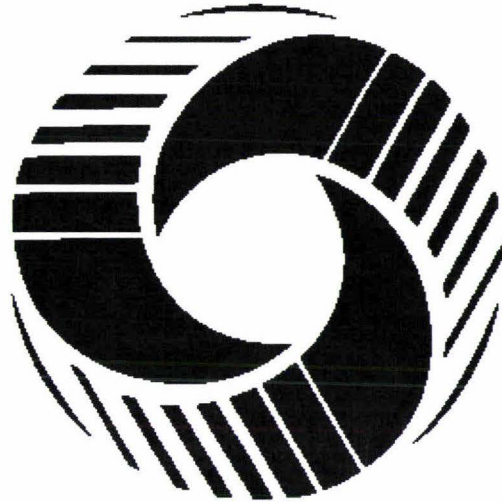


Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

**DEVELOPMENT OF A
NUTRACEUTICAL CONFECTIONERY FOR
CONSUMER MARKET USING
MANUKA HONEY AND PROPOLIS**



**MASSEY
UNIVERSITY**

A Thesis presented in partial fulfilment
of the requirements for the
Degree of Master of Technology in
Food Technology at
Massey University

DINESH SOFAT

2001

DEDICATION

**to my parents, Surendra and Ranjit Singh
my brothers and sisters Vipin, Goldie, Neelam, and Sweety
for their understanding and encouragement always.**

Everybody's a mad scientist, and life is their lab. We are all trying to experiment to find a way to live, to solve problems, to fend off madness and chaos.

David Cronenberg, Canadian film-maker

Abstract

As consumers have become proactive in health and medical issues, sales of healthy foods have recorded higher growth rate. Therefore, the concept of everyday foods containing ingredients with defined health benefits will significantly influence the types of new foods developed. New Zealanders are among the world's largest consumers of honey, propolis, and other bee products. Further, confirmation of antibacterial properties of a unique NZ honey, manuka honey, has increased its price manifolds.

A market research study indicated that potential exists for a familiar confectionery with nutraceutical properties. As a result, jellybeans with added functional properties were developed. Flavour, texture, antibacterial properties, and price were the important attributes to consumers. Lemon flavour was identified as the most acceptable flavour.

Jellybeans containing 'active' manuka honey, propolis, were developed using bench top facilities available at the Massey University. The antibacterial properties of manuka honey were found to be stable at 85⁰ C for an hour, and for propolis they were stable at 95⁰ C for 2 hours. In the literature, no procedure was found for testing the antibacterial properties of confectionery products. A 3-step method was developed for the removal of the interfering substances other than sugar, reduction of sugar, and final estimation of antibacterial properties. This gives extract, largely free of interfering substances and antibacterial components in a measurable quantity. The product and process were optimized by Response Surface Methodology (Echip). Using TAXT₂ for testing the texture, prototypes were screened down to suitable 8 formulations. Cost was then used as a screening factor to determine the prototypes for sensory testing.

Eight prototypes were evaluated with a trained panel as well as consumer panel. External (PREFMAP) and internal preference mapping (MDPREF) was used to interpret the data collected from these two panels. No consensus was reached for the most preferred product. Further, cluster analysis was performed on the results of MDPREF to understand

preferences of specific consumers. The study indicated that about half the consumer panel did not have marked differences in liking for the various jellybean prototypes. The product that was preferred by second largest cluster and at the same time well liked by the largest cluster was therefore selected for commercial trial. The product was low in hardness, chewiness, and denseness. The most preferred product was made from 9.2% starch, 5% gelatin, 10.2% honey, 1.8% propolis extract, 20% sugar, and 42% corn syrup. At deposition in the starch the product had 71-72% dissolved solids.

The optimized product formulation was scaled up at Cadbury's Confectionery Limited, Auckland. The jellybeans were processed in a Terbraak static cooker. The slurry was cooked to 135-140⁰ C and was then rapidly cooled under vacuum to 95⁰ C. Total solids of slurry were kept at 65-66% due to about 5% moisture evaporation in the plant to get final dissolved solids at 71-72% before deposition in starch. The antibacterial components and lemon flavour was added to the slurry before deposition. The slurry was taken out of the starch at 12-14% moisture and soft panned. The jellybeans were found to have antibacterial properties.

The commercially produced developed product was tested with 51 consumers using a Central Location Test (CLT). The developed product had an overall liking comparable to the commercially available jellybeans. About 69% of the panelists showed their willingness to buy this product. The Home Use Test (HUT) held over 8 weeks verified the results of CLT. In HUT 66% of the consumers liked this unique idea and showed preference over the currently available product. About 65% showed willingness to replace the current product. HUT provided validity of the results from CLT and liking of the product did not drop over time ($p>0.05$) and to the repeated exposure. The results also indicated that immediate use response (Week-0, CLT) for the consumer acceptance could be used as a valid predictor of the extended use responses (Week -8, HUT).

As the product's overall liking score is very high (7.5), it is ready for a launch. However, minor changes in the attributes may be considered after market trial. The developed product has antibacterial properties, which were tested by a method developed during the study. As the product offers lot of potential, a food company has shown interest to market this product.

Acknowledgements

Carol Pound for supervising the project and providing the whole-hearted support. Her continuous encouragement and guidance during the study is deeply acknowledged.

Lisa Duizer for co-supervising the project and providing her timely and valuable advise.

Several staff members of Institute of Food Nutrition and Human Health for their understanding and cooperation. In particular, Professor Ray Winger for sanctioning the funds for the project. Steve Glasgow, Gary Radford, John Palmer, John Dawber, and Wibha Desai for their technical assistance during the experimental work.

Associate Professor D.R.K Harding for allowing me to work in the chemistry laboratory.

Duncan Hedderley, Research Officer for providing help in analysing the data of internal and external preference mapping.

Cadbury's Confectionery Limited, Auckland for the commercial product trials. My special thanks to David Bayliss, Manager at Cadbury's for his cooperation during the production run.

Kenneth R. Markham, Industrial Research Ltd. for his guidance on propolis during the initial stages.

To all members of the trained, and consumer panels for the product evaluation and feedback.

Comvita, Bush Boake, National Starch, and Bee and Herbal for providing the ingredients.

Fellow graduates, researchers and all others for their friendship and help.

Last but not the least, Indu, my wife for her support and understanding throughout my studies. Special thanks to my sons Nippun and Vibhas for letting me work on their computer.

TABLE OF CONTENTS

ABSTRACT	iii
ACKNOWLEDGEMENTS	vi
TABLE OF CONTENTS	vii
LIST OF FIGURES	xv
LIST OF TABLES.....	xvii
LIST OF APPENDICES	xx
PUBLICATIONS	xxii
1 INTRODUCTION.....	1
1.1 Product Development Process	1
1.2 Consumer Involvement in the Product Development Process	3
1.3 Prototype Development and Optimization	4
1.4 Selection of Jellybeans as the Prototype Product	5
1.5 Significance of Honey and Propolis to the Project	6
1.6 Aim, Objectives and Constraints	8
1.6.1 Aim.....	8
1.6.2 Objectives.....	8
1.6.3 Project Constraints	9
1.6.3.1 Product Constraints	9
1.6.3.2 Processing Constraints	9
1.6.3.3 Marketing Constraints.....	9
1.6.3.4 Financial Constraints.....	9
1.7 Project Strategy.....	9
2 LITERATURE REVIEW	12
2.1 Functional Properties of Ingredients	12
2.1.1 Sucrose, Corn Syrup and Maltodextrin	12
2.1.2 Honey and Propolis	14

2.1.3	Hydrocolloids	14
2.1.4	Gelatin	15
2.1.5	Starch.....	17
	2.1.5.1 <i>Selection of Starch</i>	17
2.1.6	Colouring Agents	18
2.1.7	Flavouring Agents	19
2.2	Jellybeans Manufacturing Process	20
	2.2.1 Cooking Method.....	21
	2.2.2 Panning Process.....	22
2.3	Changes in Raw Materials Properties during the Cooking Process	23
	2.3.1 Starch Degradation	23
2.4	Measurement of Jellybean Centers and Finished Product	25
	2.4.1 Texture Measurement.....	25
	2.4.2 Colour Measurement	26
2.5	Antibacterial Activity of Propolis and Honey	27
	2.5.1 Sources of Propolis.....	27
	2.5.2 Processing of Propolis	28
	2.5.3 Antibacterial Properties of Propolis	29
	2.5.4 Toxicity of Propolis.....	30
	2.5.5 Variation in the Activity of Propolis	30
	2.5.6 Source of Antibacterial Activity in Honey	31
	2.5.7 Sensitivity of Antibacterial Activity to Heat	32
	2.5.8 Effect of Light	33
2.6	Market Research	34
	2.6.1 Market Research Plan.....	34
	2.6.1.1 <i>Defining the Research Objective</i>	34
	2.6.1.2 <i>Formulating the Research Plan</i>	35
	2.6.1.3 <i>Executing the Research Plan</i>	35
	2.6.1.4 <i>Data Interpretation</i>	36
	2.6.2 Product Attributes and Characteristics	36
2.7	Product Optimization	37

2.7.1	Response Surface Methodology	38
2.7.2	Echip Experimental Design.....	39
2.8	Consumer Input in the Product Development Process	40
2.9	Sensory Evaluation	41
2.9.1	Measurement of Sensory Response.....	42
2.9.2	Importance of Sensory Evaluation	42
2.9.3	Scaling Methods in Product Testing	43
2.9.4	Techniques for Measuring Sensory Response.....	44
2.9.4.1	<i>Affective Testing</i>	45
2.9.4.2	<i>Discrimination Testing</i>	46
2.9.4.3	<i>Descriptive Analysis</i>	46
2.9.4.4	<i>Texture Profile Analysis</i>	47
2.9.5	Environment	47
2.9.6	Consumer Panel.....	48
2.9.7	Correlation between Sensory Evaluation with Objective Measurements	49
2.9.8	Trained Panel.....	50
2.10	Discussion	51
2.11	Conclusion	52
3	PRELIMINARY STUDY OF CONFECTIONERY PRODUCTS	53
3.1	Confectionery Market	53
3.1.1	Trend of Confectionery Market in the World.....	53
3.1.2	Development of Nutraceutical Market in the Market.....	56
3.1.3	Consumer Attitude towards Nutraceutical Products	57
3.1.4	Success Factors of Nutraceutical Products.....	58
3.1.5	Important Issues of Nutraceutical Products.....	59
3.2	Confectionery Market in New Zealand	60
3.3	Important Product Attributes	62
3.4	Product Concept Development	64
3.5	Conclusion	65

4	PROTOTYPE DEVELOPMENT AND TESTING	66
4.1	Jellybean Ingredients	66
	4.1.1 Raw Materials.....	66
4.2	Jellybean Manufacturing	66
	4.2.1 Ingredients Mixture Preparation.....	66
	4.2.2 Process of Jellybeans Manufacture	67
	4.2.3 Storage of Jellybean Centres	71
4.3	Jellybean Testing Methods	71
	4.3.1 Raw Materials.....	71
	4.3.1.1 <i>Moisture Content</i>	71
	4.3.1.2 <i>Antibacterial Activity of Honey and Propolis</i>	71
	4.3.1.3 <i>Extraction of Antibacterial Components from Propolis</i>	72
	4.3.1.4 <i>Antibacterial Activity of Propolis Extract</i>	73
	4.3.1.5 <i>Turbidity Test</i>	73
	4.3.2 Premix and Slurry.....	74
	4.3.2.1 <i>Degree of Cook</i>	74
	4.3.2.2 <i>Total Dissolved Solids</i>	75
	4.3.3 Jellybean Centres and Finished Products	75
	4.3.3.1 <i>Texture Profile Analysis</i>	75
	4.3.3.2 <i>Colour Measurement</i>	78
	4.3.3.3 <i>Sugar Content</i>	78
	4.3.3.4 <i>Moisture Content</i>	80
	4.3.3.5 <i>Extraction of Antibacterial Component from Jellybeans</i>	80
4.4	Sensory Evaluation	82
	4.4.1 Flavour and Taste Testing	82
	4.4.2 Trained Panel Testing.....	83
	4.4.2.1 <i>Assessment of Texture</i>	83
	4.4.3 Final Consumer Testing	84
	4.4.3.1 <i>Hedonic Liking Test</i>	84
4.5	Data Processing Method	85

5	STUDY OF THE PROPERTIES OF JELLYBEANS CENTRES	87
5.1	Introduction	87
5.2	Experimental Plan	88
5.3	Experimental Design for the Jellybeans Base Formulation	88
5.4	Analysis of Raw Material, Pre-Mix and Jellybean Centres	91
5.4.1	Raw Materials.....	91
5.4.1.1	<i>Propolis and Honey</i>	91
5.4.1.2	<i>Moulding Starch</i>	92
5.4.2	Pre-Mix and Slurry.....	92
5.4.2.1	<i>Formulation Accuracy</i>	92
5.4.2.2	<i>Solids Contents</i>	92
5.4.2.3	<i>Degree of Cook</i>	92
5.4.3	Jellybean Centres.....	93
5.4.3.1	<i>Texture Profile Analysis</i>	93
5.4.3.2	<i>Zones of Inhibition</i>	94
5.4.3.3	<i>Sugar Content</i>	94
5.5	Results: Effect of Ingredients and Process Conditions on the Jellybean Characteristics	94
5.5.1	Textural Properties	95
5.5.1.1	<i>Gumminess</i>	95
5.5.1.2	<i>Chewiness</i>	98
5.5.1.3	<i>Hardness</i>	99
5.5.1.4	<i>Zones of Inhibition</i>	102
5.5.1.5	<i>Colour Measurement</i>	105
5.6	Conclusions	105
6	PREFERENCE MAPPING.....	107
6.1	Introduction	107
6.2	Experimental	108
6.2.1	Selection of Samples for Trained and Consumer Panel	108
6.2.2	Consumer Testing.....	109

6.2.2.1	<i>Consumer Selection</i>	109
6.2.2.2	<i>Testing of Consumer Preference</i>	110
6.2.2.3	<i>Questionnaire for Consumer Testing</i>	110
6.2.3	Trained Panel.....	111
6.2.3.1	<i>Panel Selection and Training</i>	111
6.2.3.2	<i>Panel Testing of Jellybean Attributes</i>	111
6.2.4	Statistical Analysis	112
6.3	Results	113
6.3.1	Sensory Profiling.....	113
6.3.1.1	<i>Performance and Agreement among Panelists</i>	113
6.3.2	External Preference Mapping.....	114
6.3.2.1	<i>Sensory Profile Data</i>	114
6.3.3	Summary Statistics of Consumer Data.....	117
6.3.4	Internal Preference Mapping - MDPREF.....	121
6.3.5	Cluster Analysis	122
6.3.5.1	<i>Segmentation by Similarity of Preference</i>	122
6.4	Conclusion	124
6.4.1	Trained Panel.....	124
6.4.2	Preference Mapping.....	124
6.4.3	Consumer Preference-Cluster Analysis.....	126
7	PROCESS SCALE UP.....	127
7.1	Introduction	127
7.2	Commercial Production	128
7.3	Experimental Conditions	131
7.3.1	Cooking Method.....	131
7.3.2	Jelly Forming Method	133
7.3.3	Moulding Starch and Starch Conditions	133
7.3.4	Product Finishing	134
7.3.5	Soft Panning of Centres.....	134
7.3.6	Panning Process.....	134

7.3.7	Testing of Jellybeans	136
7.4	Comparison of Jellybeans Characteristics Produced with Commercial Plant and Bench Top	136
7.5	Conclusion	140
8	CENTRAL LOCATION TEST OF COMMERCIALY PRODUCED JELLYBEANS.....	142
8.1	Aim of Central Location Test	142
8.2	Materials and Methods	142
8.2.1	Selection of Consumers.....	142
8.2.2	Products.....	143
8.2.3	Consumer Testing.....	143
8.2.4	Questionnaire Design	145
8.2.5	Data Processing and Analysis of Results	145
8.3	Evaluation of Jellybeans by Consumers	146
8.4	Comparison with Lemon Flavoured Jellybeans (Competitors Product)	148
8.5	Effect of Product Information on the Acceptability of the Nutraceutical Product	151
8.6	Comparison of Informed and Uninformed Score of New Product With Commercial Product	153
8.7	Perception of the Product	155
8.8	Usage of Throat Products	156
8.9	Usage of Health Products	157
8.10	Buying Intention of New Products	157
8.11	Believability of Claims	158
8.12	Conclusions	160

9	HOME USE TEST	162
9.1	Aim of Home Use Test	162
9.2	Materials and Methods	162
9.2.1	Selection of Consumers.....	162
9.2.2	Products.....	163
9.2.3	Consumer Testing.....	163
9.2.4	Questionnaire Design	165
9.2.5	Data Processing and Analysis of Results	167
9.3	Consumer Acceptability of the Jellybeans	167
9.4	Comparison of Product Acceptability of Central Location Test with Home Use Test	169
9.5	Perception of the Product	171
9.6	Buying Intention of the New Product	172
9.7	Frequency of Buying	174
9.8	Preference of the Product over Jellybeans Available in the Market	174
9.9	Replacement of the Current Jellybeans with the New Product	175
9.10	Price of the New Product	177
9.11	Believability of Claims	178
9.11.1	Anecdotal Evidence.....	179
9.12	Eating Frequency of New Product	179
9.13	Conclusions	181
10	OVERALL DISCUSSION AND RECOMMENDATIONS	184
10.1	Introduction	184
10.2	Successful Development of Nutraceutical Jellybeans	184
10.2.1	Successful Development of Testing procedure for Antibacterial	185
10.3	Suitability of Various Techniques for product Development Process	185
10.3.1	Preference Mapping and Clustering by Preferences	185
10.3.1.1	<i>Trained Panel</i>	186
10.3.2	Feasibility of Central Location.....	187
10.3.3	Home Use Test.....	188

10.3.3	Home Use Test	188
10.4	Recommendations for Further Study	189
10.5	Conclusions	191

LIST OF FIGURES

1.1	Product Development Process.....	2
1.2	Project Strategy for Nutraceutical Jellybeans.....	11
2.1	Amino Acids Composition of Gelatin.....	15
3.1	Per Capita Consumption of Confectionery 1991.....	53
3.2	Stages of Maturity for Confectionery Products in Important World Markets.....	54
3.3	Proportion of Market by Type of Sugar Confectionery (AC Nielsen)	60
3.4	Sugar Confectionery Growth Rates (Thousands Dollars)	61
3.5	A Sample of Confectionery Products Available in the Palmerston North	62
3.6	Important Attributes of Manuka Honey Jellybeans.....	63
4.1	Variable Speed Engrossing Pan.....	68
4.2	Process Flow Chart for Jellybean Centers.....	69
4.3	Soft Panning of Jellybeans Centers	70
4.4	Force Time Curve for Measurement of Texture of the Product	76
5.1	Contour Plot for Gumminess showing Interaction between Starch and Cooling Temperature	97
5.2	Effect of Starch and Gelatine on the Chewiness	99
5.3	Contour Plot for Hardness	101
5.4	Contour Plot for Zones of Inhibition	104
6.1	Plot Obtained for 8 Jellybean Types (A-H) Relative to the First Two Components	114
6.2	Plot of Replicates of Products (A-H) for Three Sessions.....	115
6.3	Plot of Product and Correlation of Six Sensory Attributes to the First Two Components	117
6.4	Means of Ratings Scored by Consumers for Sweetness, Overall Flavour, Texture and Overall Liking	118
6.5	External Preference Mapping of Jellybeans	119
6.6	External Preference Mapping of Jellybeans Samples, Described by a Linear Model in the First Two Components ($p < 0.05$)	120
6.7	MDPREF of Jellybean Data Derived from Consumer Vector	121

6.8	Consumer Preference Vectors for each of the Subgroup Labeled with Different Symbols	123
7.1	Jellybean Process Schematic Diagram	129-30
7.2	Terbraak Static Cooker used in the Manufacturing of Jellybeans.....	132
7.3	Antibacterial Properties of Finished Product at Different Concentration of Extract in the Testing Medium by MIC.....	138
7.4	The Antibacterial Properties of the Finished Product by Agar Diffusion Method	140
8.1	Samples of Jellybeans Used in the Study	143
8.2	Relationship between Change in Attribute Liking and Corresponding Change in Overall Liking of Jellybeans	147
8.3	Comparison of Uninformed score (developed product) with Informed Score (developed product).....	155
9.1	Samples Delivered to Panelists	164
9.2	Flow Diagram Showing the Experimental Process	166
9.3	Comparison of Product Characteristics between Two Methods	170
9.4	Eating Frequency of New Product during the Study Period.....	180

LIST OF TABLES

2.1	Behaviour of Type A and Type B Gelatin.....	16
2.2	Comparison between Degree of Gelatinization-of Various Systems	24
2.3	Effect of Heat on Peroxide and Non-Peroxide Activity of Honey	32
2.4	Effect of Light on Peroxide Activity of Honey	33
2.5	Advantages and Disadvantages of Central Location and Home Placement Tests.....	48
3.1	Concept of Antibacterial Confectionery Product	64
4.1	The Equations Used for Calculation of Colour and Difference in Colour	78
4.2	Nine Point Hedonic Scale.....	85
5.1	Variables Used in the Experimental Design.....	90
5.2	Antibacterial Activity of Honey and Propolis	91
5.3	Equation Coefficients and Variables that Significantly Affected the Gumminess of Jellybean Centres	96
5.4	Equation Coefficients and Variables that Significantly Affected the Chewiness of Jellybean Centres	98
5.5	Equation Coefficients and Variables that Significantly Affected the Hardness of Jellybean Centres.....	100
5.6	Equation Coefficients and Variables that Significantly Affected the Zones of Inhibition of Jellybeans Centres	103
6.1	The Formulation of the Prototypes Tested in Consumer and Trained Panel.....	109
6.2	Fixed Choice Profile Developed for Use on Jellybeans with their Definition....	111
6.3	Coefficients of Each Attribute for the First Three Components	116
6.4	Mean Scores of the Jellybeans by Cluster of Consumers.....	123
7.1	Ingredients for Formulation.....	131
7.2	Terbraak Process Control Sheet of the Trial	133
7.3	Ingredients Used in the Soft Panning Process.....	135

7.4	The Jellybeans Characteristics Produced on Bench-Top and Commercial Run	137
7.5	Antibacterial Properties of the Developed Product Compared to Market Sample (Without Antibacterial Ingredients).....	139
8.1	Age and Gender Characteristics of the Panelists.....	144
8.2	The Consumer Acceptability of Nutraceutical Jellybeans (Uninformed Scores)	146
8.3	The Mean Acceptability of Jellybeans and Degree of Association of Attributes with Overall Liking	147
8.4	The Consumer Acceptability of the Commercial Jellybean.....	148
8.5	The Mean Acceptability of Commercial Jellybeans and Degree of Association of Attributes with Overall Liking	149
8.6	Comparison of Overall Liking of Nutraceutical and Lemon Flavoured Jellybeans	150
8.7	The Comparison of Different Product Attributes.....	150
8.8	The Consumer Acceptability of Jellybeans (Informed Scores).....	152
8.9	The Mean Acceptability of Nutraceutical Jellybeans (Informed Score) and Degree of Association of Attributes with Overall Liking.....	153
8.10	Comparison of Attributes Score of Informed and Uninformed New Product with Commercial Product	154
8.11	Perceived Effectiveness of Jellybeans.....	156
8.12	The Usage of Throat Products by the Panelists	156
8.13	Usage of Health Products	157
8.14	Buying Intention of the Nutraceutical Product.....	158
8.15	Believability of Claims	159
9.1	The Panel Demographics.....	163
9.2	Change of Liking Ratings for the Attributes over the Period.....	168
9.3	Change in Liking During the Home Use Study at Week-0	169
9.4	Perception of Concept and of Product at Week-0	171
9.5	Change in Buying Intention of the Consumer with Time	172
9.6	Frequency of Buying Pattern of New Product.....	174
9.7	Change in Preference over Existing Jellybeans with Time	175
9.8	Replacement of the Current Jellybeans with New Product	176

9.9	Recommended Price of the New Product Compared with the Current Product Available in the Market	177
9.10	Believability of Claims.....	178
A4.1	Comparison of Antibacterial Properties of Honey at Different Temperatures....	227
A4.2	Comparison of Antibacterial Properties of Propolis at Different.....	227
A4.3	Preliminary Trials	230
A4.4	Analysis of Jellybean Centers Produced During the Preliminary Trials	232
A4.5	Formulation Soft Panning Syrup A.....	234
A4.6	Final Formulation Used in the Soft Panning Process.....	235

LIST OF APPENDICES

1.1	Gantt Chart of Jellybean Project.....	211
3.1	Sugar Confectionery and Nutraceutical Products Available in Palmerston North.....	212
4.1	Preliminary Production Trials	217
5.1	Experimental Conditions for the 31 Trials (Response Surface Methodology) ...	223
5.2	Texture Profile Analysis of Jellybeans.....	225
5.3	Analysis of Raw Materials	227
5.4	The Physical Attributes of the Prototypes	228
5.5	Coefficients of Estimated Quadratic Models for the Parameters of Zones of Inhibition, Gumminess, Hardness and Chewiness	230
5.6	Variables Affecting the Product Attributes	231
5.7	Cost of Jellybeans Centres for Each Formulation Based on Major Ingredients..	233
6.1	Cluster Analysis of Different Product Formulations.....	235
6.2	Questionnaire for the Consumer panel.....	237
6.3	Questionnaire Used for Training the Panelists.....	245
6.4	Overall Liking of the Nutraceutical Jellybeans Centres.....	255
6.5	PRINQUAL MTV Iteration History.....	257
6.6	Scree Plot of Eigenvalues.....	258
6.7	Analysis of Variance and Tukey's Honestly Significant Comparison Test for Overall Liking.....	259
6.8	Analysis of variance and the non-parametric rank interaction test.....	260
7.1	Costing of Developed Jellybean.....	264
7.2	Soft Panning Preparations for Jellybean Centers	265
7.3	C.O.A of manuka honey.....	266
8.1	Information Sheet provided to the Panelists.....	267
8.2	The Consent Form Filled by the Prospective Panelists	269
8.3	Questionnaire for the Central Location Test	270
8.4	Summary of Results for the Central Location Test	279
8.5	Analysis of Variance and Tukey's Honestly Significant Comparison Test	

	For Each Product Attribute.....	285
9.1	Information Sheet provided to the Consumer Panelists	290
9.2	Consent Form Filled by Prospective Consumer Panelists.....	292
9.3	Forwarding Letter Sent to Consumer Panelists-.....	293
9.4	Questionnaires Used in Home Use Test.....	294
9.5	Summary of Results for the Home Use Test-Week-0	315
9.6	Analysis of Variance and Tukey's Honestly Significant Different Test For Each Product Attribute	330

PUBLICATION

Sofat, D., Pound, C.J. and Duizer L.M. (1999) Change in consumer response to written and physical product concepts. Annual New Zealand Engineering and Technology Postgraduate Conference 5 184-89.