



UNIVERSITI PUTRA MALAYSIA

**EFFECTS OF INULIN AND OLIGOFRUCTOSE FORTIFICATION ON THE
PHYSICO-CHEMICAL, SENSORY AND FUNCTIONAL PROPERTIES OF
CLARIFIED BANANA JUICE**

MUHAMMAD SOHAIL YOUSAF

FSTM 2007 4

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**DOCTOR OF PHILOSOPHY
UNIVERSITY PUTRA MALAYSIA**

2007



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PHYSICO-CHEMICAL, SENSORY AND FUNCTIONAL PROPERTIES OF
CLARIFIED BANANA JUICE**

By

MUHAMMAD SOHAIL YOUSAF

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirements for the Degree of Doctor of Philosophy**

May 2007



DEDICATION

This Dissertation is dedicated to my late beloved mother

Safia Yousaf



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy.

EFFECTS OF INULIN AND OLIGOFRUCTOSE FORTIFICATION ON THE PHYSICO-CHEMICAL, SENSORY AND FUNCTIONAL PROPERTIES OF CLARIFIED BANANA JUICE

By

MUHAMMAD SOHAIL YOUSAF

May 2007

Chairman: Professor Salmah Yusof, PhD

Faculty: Food Science and Technology

A comparative study conducted between Berangan and Mas banana cultivars at the same maturity index 6 (fully yellow-good eating stage) revealed that Berangan was more suitable for value added processing because of its lower soluble protein concentration, peroxidases and polyphenoloxidase activity. The two enzymes are responsible for developing browning in fruit tissues and also ultimately in the juice. Berangan has better sensory attributes in terms of taste, colour and over-all acceptability. Inulin and oligofructose are non-digestible oligosaccharides found in banana at 0.3-0.7%, respectively. These are considered too low to have any significant prebiotic effect for host health. Therefore clarified banana juice was prepared and fortified with inulin and oligofructose in order to increase its nutritional and functional properties. The fortification levels of inulin and oligofructose optimized at 2% and 10%, respectively yield banana juice with acceptable sensory and physical characteristics without effecting the original taste and flavour of banana. Storage study was conducted for 8 weeks at 4 °C, 25 °C and 35 °C to determine the storage stability of clarified banana juice fortified



with inulin and oligofructose. The juice quality remained stable in terms of its physicochemical, microbiological and sensory characteristics for 8 weeks at different storage temperatures except for turbidity, whose continuous increase during storage in all the samples was found a critical quality problem especially for samples stored at 35 °C. However juice samples stored at 4 °C had less turbidity problem and were rated highest and most acceptable for different sensory parameters. The results of the *in vivo* study revealed that administration of fortified banana juice significantly increase the growth of health promoting bacteria i.e. *Bifidobacterium* and *Lactobacillus*, short chain fatty acids especially butyrate in the gut of the treated rats compared to rats fed distill water and with plain clarified banana juice. There was also an increase in mucosal thickness in cecum and proximal colon of rats fed with fortified juice, hence reduces the chances of many large bowel diseases. Rats of this same group also observed significant reduction in total cholesterol and LDL (Low density lipoprotein) concentration in the serum lipid thus contributing to hypocholesterolemic effect for patients with high serum cholesterol level.

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

KESAN PENAMBAHAN INULIN DAN OLIGOFRUCTOSA KETAS CIRI FISIKO-KIMIA, SENSORI DAN FUNGSIAN JUS JERNIH PISANG

Oleh

MUHAMMAD SOHAIL YOUSAF

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Satu kajian perbandingan yang telah dijalankan di antara kultivar pisang Berangan dan Mas pada indeks kematangan yang sama iaitu 6 (kuning sepenuhnya-peringkat yang sesuai untuk dimakan) menunjukkan bahawa pisang Berangan lebih sesuai bagi pemprosesan selanjutnya untuk menambahkan nilainya berikutan kerana tahap aktiviti peroksida dan polifenoloksidanya yang rendah. Kedua-dua enzim tersebut merupakan enzim utama di dalam pembentukan kesan pemerangan ke atas tisu buah dan juga di dalam jus. Kandungan protein terlarut berangan juga rendah dan mempunyai ciri-ciri penilaian deria yang lebih baik dari segi rasa/aroma yang tinggi, warna dan tahap penerimaan keseluruhan yang tinggi. Inulin dan oligofruktosa merupakan oligosakarida yang tidak boleh dihadam yang terdapat di dalam pisang pada kepekatan 0.3-0.7% masing-masing, di mana ia dianggap sebagai sangat rendah untuk memberikan kesan prebiotik yang nyata kepada kesihatan badan. Oleh itu jus jernih pisang disediakan dan diperkayakan dengan inulin dan oligofruktosa bagi meningkatkan tahap nutrisi dan ciri-ciri kefungsiannya. Kandungan inulin dan oligofruktosa telah dioptimakan pada 2% dan

10% masing-masing, bagi menghasilkan jus jernih pisang yang boleh diterima dari segi penilaian deria dan ciri-ciri fizikalnya tanpa merencatkan rasa dan aroma pisang yang asli. Kajian penyimpanan selama 8 minggu pada 4°C, 25° dan 35°C telah dijalankan bagi menentukan tahap kestabilan jus jernih pisang yang telah diperkayakan dengan inulin dan oligofruktosa. Kualiti jus kekal stabil dari segi fizikokimia, mikrobiologi dan ciri-ciri penilaian deria selama 8 minggu pada suhu penyimpanan yang berbeza kecuali kekeruhan, di mana ia terus meningkat sepanjang penyimpanan di dalam kesemua sampel, menunjukkan bahawa ia merupakan masalah kualiti yang kritikal terutamanya sampel yang disimpan pada suhu 35°C. Bagaimanapun, sampel jus yang disimpan pada suhu 4°C menunjukkan kurang bermasalah dan daripada penilaian deria, ia dipilih sebagai yang paling tinggi dan paling diterima dari segi kepelbagaian ciri penilaian deria. Keputusan dari kajian *in vivo* menunjukkan bahawa penggunaan jus jernih pisang yang telah diperkayakan ini terbukti secara nyata dapat meningkatkan pertumbuhan bakteria yang baik bagi kesihatan, contohnya *Bifidobacterium* dan *Lactobacillus*, asid-asid lemak berantai pendek terutamanya butirrat di dalam usus tikus jika dibandingkan dengan tikus-tikus yang diberikan dengan air suling dan jus jernih pisang biasa. Terdapat juga peningkatan ketebalan mukuosa di dalam sekum dan kolon proksimal bagi tikus-tikus yang diberikan dengan jus jernih pisang yang diperkayakan, dan ini akan membantu dalam pengurangan risiko penyakit-penyakit berkaitan usus besar. Tikus-tikus ini juga mengalami pengurangan yang nyata dalam kandungan kolesterol keseluruhan dan LDL (lipoprotein berketumpatan rendah) di dalam serum lemak, dengan itu ia menyumbangkan kesan hipokolesterolemik bagi pesakit hiperkolesterolemia.

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I certify that an examination committee met on 29 May 2007 to conduct the final examination of Muhammad Sohail Yousaf on his Doctor of Philosophy thesis entitled “Utilization of inulin and oligofructose in clarified banana juice and its *in vivo* studies.” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommended that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

MUHAMMAD SOHAIL YOUSAF

Date: 15 JUNE 2007



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LIST OF ABBREVIATIONS

%	Percentage
/	per
μ	micro
μg	microgram
μL	microliter
°C	degree Celsius
ANOVA	analysis of variance
ca.	approximately
CFU	colony forming units
CH ₄	methane
CO ₂	carbon dioxide
d	day
DMRT	Duncan's multiple range test
DNA	deoxy ribose nucleic acid
DP	degree of polymerization
E.coli	<i>Eschericia coli</i>
e.g	<i>example gratia</i> (for example)
<i>et al</i>	et cetera (and company)
FAMA	Food and Agriculture Marketing Authority
FAO	Food and Agriculture Organization
FOS	fructooligosaccharides



g	gram
GC	gas chromatography
GI-tract	gastrointestinal tract
GOS	galactooligosaccharides
h	hour
H ⁺	hydrogen ion
H ₂	hydrogen
HClO ₄	per chloride
HCO ⁺³	bicarbonate ion
HDL	high density lipoprotein
HMF	hexamethylfurfural
HPLC	high performance liquid chromatography
i.e.	<i>id est</i> (that is)
K	potassium
Kcal	Kilocalories
Kg	kilogram
KJ	kilo joule
LDL	low density lipoprotein
log	logarithm
M	molar
mg	milligram
min	minute
ml	milliliter



mM	millimolar
mRNA	messenger ribose nucleic acid
MWCO	molecular weight cut off
n	number
Na ⁺	sodium ion
NaOH	sodium hydroxide
NSP	non starch polysaccharides
PVPP	polyvinylpolypyrrolidone
QDA	quantitative descriptive analysis
R ²	regression coefficient
RSM	response surface methodology
SAS	statistical analysis system
SCFA	short chain fatty acids
TC	total cholesterol
TG	triglyceride
TPY	Trypticase-Phytone-Yeast Extract
TSS	total soluble solids
w/v	weight by volume
WHO	World Health Organization
α	alpha
β	beta

