

VALUE ADDITION TO UNMARKETABLE RIPE & OVER RIPE BANANA : WASTE TO WEALTH



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Outline of presentation

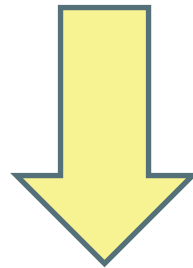
- Introduction
- Context
- Aim
- Activities
- Findings & Recommendations
- Technology Transfer
- Way Forward
- Acknowledgments

Ripe Banana Fruit

- Widely popular for its flavour and good nutritional value
- 4th most widely grown fruit in the world
- Most popular fruit in Mauritius (Backyard & Commercial; around 520 ha)
- Approx. 85 % local production consumed as fresh fruits, 5% (mature green) processed into crisps

Ripe & Over ripe fruits

- Highly perishable
- Ripe banana with skin blemishes or undersized: “labelled as unmarketable”
- Occasional glut (surplus & cheap)
- Rapid ripening of fruits during summer and limited time for distribution/sale



Wastage of 3-6% of production in Mauritius
Can be reduced or avoided through Rapid Processing
Techniques

Aim of the Study

- Develop a protocol for high quality banana puree production from unmarketable ripe/over ripe fruits with minimum inputs (low cost equipment) to
 - (i) reduce wastage
 - (ii) create new agribusiness opportunities to farmers/agro processors
 - (iii) provide banana puree as an ingredient for household and bakeries and as semi process raw material to the food industry through “ready to use banana puree”

Research Activities

- Protocol Development for puree production
- Varietal evaluation
- Determination of Blanching time/variety
- Pasteurisation i.e cooking of puree prior to packing & after packing of the puree v/s no pasteurisation evaluated
- Shelf life evaluation under 3 temperatures

PROTOCOL FOR PROCESSING OF BANANA INTO PUREE

Detach ripe/over ripe fruits (peel score 8) individually



↓
Wash fruits & Reduce microbial load

↓
Blanch fruits at 90°C

↓
Blanching time vary as per variety

↓
Cool fruits in water (ambient)

↓
Peel fruits **rapidly** to limit browning of pulp



↓
Add **citric acid (0.25% w/w)** and **ascorbic acid (0.025% w/w)** to prevent oxidative browning

↓
Homogenise or blend pulp **rapidly**

↓
(open pan cooking of pulp for storage at ambient & chill)






↓
Fill puree in PP, PET packs or in Metallised PET packs (**avoid/minimize formation of air pockets**) or PP containers

↓
Storage



Treatments

Variety	Treatment	Storage
Cavendish 	Open pan Cooking (Pasteurisation)	Ambient & Chill @ 4-6°C
Mamoul 		
Cavendish	Not pasteurised	@ -18°C
Mamoul		
Gingeli 		

Shelf life Assessment during storage

Parameters	Ambient (Pasteurization)	Chill (Pasteurization)	Frozen (Not Pasteurize)
Sensory Characteristics: 1. Colour 2. Flavour	<ul style="list-style-type: none"> • After processing 	<ul style="list-style-type: none"> • After processing 	<ul style="list-style-type: none"> • After processing & after 1 week
Physico-Chemical: 1. Brix 2. pH 3. Consistency	<ul style="list-style-type: none"> • At weekly intervals up to <u>6 weeks</u> • At 2 weeks intervals up to <u>2 months</u> • At monthly intervals up to <u>4 months</u> 	<ul style="list-style-type: none"> • At weekly intervals up to 6 weeks • At 2 weeks intervals up to <u>6 months</u> 	<ul style="list-style-type: none"> • At 2 weeks intervals up to <u>2 months</u> • At monthly intervals up to <u>13 months</u>
Microbiology 1. Visual evaluation (Bulging of packs) 2. Analysis for : TVC, Yeast, Mould			

Findings

Findings

- **Blanching Time**

Banana type	Blanching time (minutes)
Cavendish	8 - 10
Mamoul	10 - 15
Gingeli	5 - 7

- **Pasteurisation** (open pan cooking of puree before packing): colour changes from yellow/cream to cream or dark yellow & puree thickens (less than 0.6 Bostwick cm/30sec) & difficult to fill, moderate flavour
- **Non Pasteurised:** fresh puree maintained the natural yellow/cream colour & flavour of fresh ripe bananas

CHARACTERISTICS & YIELD OF BANANA PUREE

Banana Type	°Brix	pH	Vitamin C (Indicative ascorbic acid) mg/L	Consistency (Bostwick cm/30 sec)	Colour of puree	Flavour (banana flavour strength)	Yield (%)
Cavendish	16	4.3	50	0.5 - 1.5	Yellow	Strong	45 - 50
Gingeli	15	3.9	75	0.5 - 1.5	Cream	Good	55 - 60
Mamoul	18	3.7	75	0 - 0.5	Off –white	Moderate	55 - 65

Cavendish best flavour & attractive colour


Physico-Chemical Parameters for Cavendish Puree during storage at Ambient

Parameters	Period									
	0 week (wk)	1 wk	2 wks	3 wks	4 wks	5 wks	6 wks	8 wks	12 wks	16 wks
Visual Contamination (Bulging packs / Spores)	X	X	X	5% of packs	5% of packs	10% of packs	10% of packs	15% of packs	15% of packs	20% of packs
Colour	Cream	Cream	Cream	Light brown	Light brown	Brown	Brown	Brown	Dark Brown	Dark brown
Smell	Good	Good	Good	Good	Good to Slightly fermented	Good to Slightly fermented	Good to Fermented	Fermented	Fermented	Fermented
Taste (flavour)	Moderate	Moderate	Moderate	Moderate	Slightly fermented	Slightly fermented	Fermented	Fermented	Fermented	Fermented
Brix	16-19	16 – 18	15-18	15-18	15-18	15–18	15-18	15 - 18	15-18	15-18
pH	4.3	4.20-4.25	4.20 – 4.29	4.30-4.35	4.30-4.35	4.35 – 4.37	4.36-4.38	4.30-5-4.40	4.20-4.40	4.0-4.40
Consistency (Bostwick cm / 30 sec)	0.5	0.5	0.55	0.55	0.6	0.65	0.70	0.75	1.5	3.0 (Visible disintegration noted)

Physico-Chemical Parameters for Cavendish Puree during storage under Chill conditions

Parameters	Period										
	0 week (wk)	1 wk	2 wks	3 wks	4 wks	5 wks	6 wks	8 wks	12 wks	16 wks	24 wks
Visual Contamination (Bulging packs / Spores)	X	X	X	X	X	X	X	X	5% of packs	10% packs swollen	15% of packs
Colour	Yellow	Yellow	Yellow	Yellow	Cream	Cream	Cream	Cream	Slightly Brown	Slightly Brown	Dark Brown
Smell	Good	Good	Good	Good	Good	Good	Good	Good	Good + slightly fermented	Slightly fermented	Fermented
Taste (flavour)	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate + slightly fermented	Slightly fermented	Fermented
Brix	18-22	18-22	18-22	18-22	16-21	16-21	15-18	15-18	18-20	15-16	15
pH	4.3	4.25-4.30	4.25-4.30	4.25-4.30	4.30-4.35	4.30-4.35	4.35-4.37	4.35-4.40	4.35-4.40	4.20-4.39	4.10-4.40
Consistency (Bostwick cm / 30 sec)	0.5	0.5	0.5	0.55	0.55	0.6	0.65	0.7	0.8	1.5	3.5

Physico-Chemical Parameters for Cavendish Puree @ -18°C

Parameters	Period							
	0 week (WK)	1 wk	1 month	2 mnths	3 mnths	6 mnths	9 months	10-13 months
Visual Contamination (Swelling packs / Spores)	X	X	X	X	X	X	X	X
Colour	Yellow Cream							Slight darkening of pulp (dark cream) – Localised browning visible only around air pockets (formed during filling)
Smell	Good	Good						
Taste	Good	Good						
Brix	15 – 18	15 – 18						
pH	4.3	4.25– 4.40						
Consistency (Bostwick cm / 30 sec)	1.0	1.0	1.2	1.2	1.2	1.2	1.3	1.3

Note: Under freezing conditions, the natural flavor, colour and characteristics are stable. Similar trend noted for other varieties
Gingeli & Mamoul natural colour is maintained during storage at freezing

Total viable counts (cfu/g) for Cavendish Banana Puree stored at Ambient, 4-6°C & -18°C for samples which do not show any visual sign of contamination

Storage Period	Ambient (Pre cooked puree)	Chill (Pre cooked puree)	Frozen (no pre heat treatment)	Remarks
< 1 week	Present but Less than 4 at dilution 10 ¹		3.9 x10 ²	<p>The TVC load varied over time but is within the maximum prescribed limit of 10⁷ as prescribed in Mauritian Food Regulations 1999</p> <p>Puree at ambient has a higher load over time.</p> <p>TVC presence could be due to localized air pockets formed during filling & sealing.</p>
2 weeks	1.5 x 10 ²	1.2 x 10 ²	Present but less than 4 at dilution 10 ² to 3.5 x 10 ²	
3 weeks	1.6 x 10 ²	5.5 x 10 ¹ to less than 1 at dilution 10 ¹	Present but less than 4 at dilution 10 ¹	
4 weeks	1.9 x 10 ³	1.6 x 10 ³ to present but less than 4 at dilution 10 ²	Present but less than 4 at dilution 10 ¹ to 4.5 x 10 ¹	
6 weeks	2.3 x 10 ² to 4.5 x 10 ³	Less than 1 at dilution 10 ²	2.5 x 10 ²	
8 weeks (2 months)	5.5 x10 ³	Less than 1 at dilution 10 ²	Present but less than 4 at dilution 10 ² to 3.5 x 10 ²	
12 weeks (3 months)	9.6 x 10 ³	3.8 x 10 ²	2.5 x 10 ²	
16 weeks (4 months)	3.0 x 10 ⁴	1.7 x 10 ⁴	2.7 x 10 ²	
24 weeks (6 months)		2.0 x 10 ⁴	Less than 1 at 10 ¹	
32 weeks (9 months)			Less than 1 at 10 ¹ to 3.5 x 10 ²	
48 weeks (12 months)			Less than 1 at to 10 ¹ to 2.8 x 10 ²	
52 weeks (13 months)			Less than 1 at 10 ¹ to 2.9 x 10 ²	

Yeast & Mold counts for Cavendish puree for samples which do not show sign of contamination

Treatment	Period		
	Period	Number of microorganisms / g	
		Yeast	Mould
Ambient	0 week	Less than 10 @ dilution 10 ¹	Less than 10 @ dilution 10 ¹
	0 -2 month	Less than 10 @ dilution 10 ¹	Less than 10 @ dilution 10 ¹ to less than 40 @ dilution 10 ¹
	2 – 4 months	Present but less than 40 @ 10 ¹ to 6.4 x 10 ²	Less than 10 @ dilution 10 ¹ to less than 40 @ dilution 10 ¹
Chilled	0 week	Less than 10 @ dilution 10 ¹	Less than 10 @ dilution 10 ¹
	0 – 1 month	Less than 10 @ dilution 10 ¹	Less than 10 @ dilution 10 ¹
	1 – 2 months	Present but less than 40 @ 10 ¹ dilution	Present but less than 40 @ 10 ¹ dilution to 4.5 x 10 ²
	2 – 6 months	More than 150 at dilution 10¹ to 4.0 x 10²	Less than 10 @ dilution 10¹
Frozen	0-1 month	Less than 10 @ 10 ¹ to Present but less than 40 @ 10 ¹	Less than 10 @ 10 ¹ to less than 40 at dilution 10 ¹
	1 – 2 months	Less than 10 at dilution 10 ¹ to 3.6 x 10 ²	Less than 10 @ 10 ¹ to less than 40 at dilution 10 ¹
	2 – 13 months	Less than 10 at dilution 10 ¹	Less than 1 @ dilution 10 ¹ to less than 10 at @ dilution 10 ¹

Microbial load in contaminated packs stored at Ambient & Chill

- Visually detected “bulging packs”: contaminated packs due to anaerobic fermentation; fermentative smell & taste detected.
- Contaminated packs:
- **TVC load** varied from **$2.8 - 3.0 \times 10^7$** which is above prescribed limit of **10^7 cfu/g**
Yeast : 5.2×10^5 (very high)
Mould: less than 40 @ dilution 10^1

Recommendations based on shelf life studies

Storage	Shelf life studies findings	Recommended storage
Ambient	<p>Colour: change as from 3 weeks visible</p> <p>Flavour: mild banana flavour</p> <p>Texture: puree turns watery as from 4 months</p> <p>Microbiology: By 3 weeks, 5% packs contaminated and by 2 months, cumulative of 45% packs contaminated (source: air pockets in the packs)</p>	2 weeks (type of packaging)
Chill: 4-6°C	<p>Colour: change as from 4 weeks visible</p> <p>Flavour: mild banana flavour</p> <p>Texture: puree turns watery as from 20-24 weeks</p> <p>Microbiology: By 12 weeks (3 months) , 5% packs contaminated and by 24 weeks (6 months) months, cumulative of 25% packs contaminated</p>	2 months (type of packaging)
Frozen : -18°C	<p>Colour: stable, yellow cream</p> <p>Flavour: stable</p> <p>Texture: consistency maintained</p> <p>Microbiology: stable</p>	<p>9 months (Cavendish)</p> <p>12 months (Gingeli & Mamoul type)</p>

Recommendation

Optimum treatment & storage:

Freezing of puree immediately after blending for a high quality puree using low cost equipment (use of domestic or small scale equipment)

USES OF BANANA PUREE

- As filling for pastries (pie and Danish Pastry)
- As an ingredient (up to 40% of puree) in the preparation of cakes and muffins , eggless cakes
- For jam & fruit paste/bar production
- In the preparation of smoothies (mixed with fruits like mango & papaya)
- In pancake mix
- As fruit ingredient to yoghurt
- In Beverage preparation
- As a fruit puree (pure or mixed with other fruits): a ready to eat healthy snack “



Other Varieties suitable for puree

- Novaria (Cavendish Type)
- FHIA varieties: 01 (Goldfinger), 017, “France”, “Ollier”

Capacity Building -Training

- Training of banana growers (11%) , agro processors (32%), homemakers (21%), bakers (14%), shop owners (7%)
- 70% were women participants
- Hands on practice on puree making from Cavendish & Gingeli
- Preparation of Banana Pie
- 3 participants adopted the technology



Publication



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Way forward

- Dissemination of technology to countries forming part of the Australian African Awards through the Booklet
- Training of banana planters & Agro Processors/Bakers
- Promote Production of banana puree at household level to reduce wastage
- Evaluation of other banana varieties for puree production

Acknowledgements

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Thank you for your attention

