MODERATE VACUUM PACKAGING OF FRESH-CUT MANGOES
(Mangifera indica)

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BACKGROUND

Mango: has a high commercial value on the international market (Chien et al, 2007).

Trade of mango from Mauritius is limited due to: its highly perishable nature and susceptibility to fruit fly attack on the island.

As value addition to mango is being envisaged under local government policies.

The application of minimal processing to semi-ripe mangoes would be an interesting opportunity for the world market.
FRESH-CUT PRODUCE

- Fresh-cut produce: trimmed, peeled, cut into 100% usable product that pre-packaged to offer consumers high nutrition, convenience and flavour while still maintaining freshness (Gimenez et. al., 2003).

- Consumption of fresh-cut fruits and vegetables has increased considerably (Gil, Conesa and Artés, 2001).

- Main driving force: growing need for fresh, healthier, convenient, and additive-free prepared produce (Jaxsens et al., 2001).

FRESH-CUT PROCESSING ENSURES

- No fruit fly larvae inside the mango ➢ Hence no SPS barrier to export!

Also,
- High-value product
- Convenience
- Reduced air-freight cost

- In fact, value-earned in foreign currency per unit cost incurred for air-freighting would be OPTIMISED
Many techniques have been studied to extend the shelf life of fresh-cut produce: controlled and modified atmospheres, low temperature storage and use of preservatives among others.

Another alternative would be the use of edible coatings, in particular those of natural origin.

Edible coatings have the potential to improve the quality and to extend the shelf-life of fresh-cut produce.

NatureSeal™, is one such edible coating, which has shown to extend the shelf-life of fresh-cut carrots and apples.

Martin-Belloso and Soliva Fortuny (2006) proposed the use of edible coating as a complement to MAP systems & as a good alternative for improving the microbial stability and quality of fresh-cut fruits.

Scientific literature on the combination of MAP system and an edible coating to extend the shelf life of fresh-cut produce is scanty.
1. Characterisation of the Dauphine and Early Gold variety

4. Determining the microbiological quality of the fresh-cut slices upon storage

2. Determining suitability of variety for processing

3. Assessing the effectiveness of a combination of moderate vacuum packaging & an edible coating in maintaining the quality of fresh-cut mango slices

OBJECTIVES

MATERIALS AND SAMPLING METHODS

- Varieties used: Early Gold and Dauphine
- Fruits selected: uniform maturity and size, free from bruises and physical damage
- Precautions were taken to transport mangoes from grower’s premises to the Food Processing Unit (AREU).
PHYSICAL PARAMETERS
- Fruit weight
- Length and width
- Pulp to peel ratio
- Pulp to seed ratio
- Texture
- Colour

CHEMICAL PARAMETERS
- Total soluble solids
- Titratable acidity
- pH
- % moisture content
- Ascorbic acid content

PHYSICO-CHEMICAL CHARACTERISATION

EXPERIMENTAL DESIGN
- Randomised block design (RBD) using a 3x2 factorial arrangement.
- Blocked by days (0, 2, 4, 7, and 8).

Table 1.0 Different treatments used on mango slices

<table>
<thead>
<tr>
<th>Concentration of NatureSeal™</th>
<th>% Vacuum</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>0%</td>
<td>T1(Control)</td>
</tr>
<tr>
<td>1.5%</td>
<td>T2</td>
</tr>
<tr>
<td>3.0%</td>
<td>T3</td>
</tr>
</tbody>
</table>
QUALITY ASSESSMENT

3 packages were randomly selected for physico-chemical analyses on day 0, 2, 4, 7, 8

- Physical analysis (colour & texture determination)
- Chemical analysis (TSS determination, titratable acidity and pH measurement)
- Microbiological analysis (Total viable count, Yeast and Mould count)

STATISTICAL ANALYSIS

MANGO VARIETY CHARACTERISATION
- Means were computed together with their standard errors of means.
- t-test analysis: to determine any significant difference between the physico-chemical parameters for Early Gold and Dauphiné varieties.

FRESH-CUT MANGO EXPERIMENT
- Analysis of variance - to determine the differences among the treatments.
- Significance of difference was determined at the 5% level.
### RESULTS: CHARACTERISATION

#### Physical characteristics

<table>
<thead>
<tr>
<th></th>
<th>Dauphiné</th>
<th>Early Gold</th>
<th>Significance at 5% level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (g)</td>
<td>321 ± 8.45*</td>
<td>425 ± 12.53*</td>
<td>S</td>
</tr>
<tr>
<td>Length (cm)</td>
<td>8.28 ± 0.21</td>
<td>12.55 ± 0.13</td>
<td>S</td>
</tr>
<tr>
<td>Width (cm)</td>
<td>8.28 ± 0.21</td>
<td>8.55 ± 0.13</td>
<td>S</td>
</tr>
<tr>
<td>Pulp to peel ratio (w/w basis)</td>
<td>4.35 ±0.08</td>
<td>10.43 ± 1.05</td>
<td>S</td>
</tr>
<tr>
<td>Pulp to seed ratio (w/w basis)</td>
<td>4.68 ±0.29</td>
<td>8.47 ± 0.41</td>
<td>S</td>
</tr>
<tr>
<td>Firmness</td>
<td>3.34 ± 0.02</td>
<td>3.35 ± 0.04</td>
<td>NS</td>
</tr>
</tbody>
</table>

* Mean ± Standard error of mean (SE)  
# S: Significant  
NS: Not significant

#### Chemical characteristics

<table>
<thead>
<tr>
<th></th>
<th>Dauphiné</th>
<th>Early Gold</th>
<th>Significance at 5% level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total soluble solids (%)</td>
<td>3.66 ± 0.08*</td>
<td>13.77 ± 0.15*</td>
<td>S</td>
</tr>
<tr>
<td>Titratable acidity (g of citric acid/100g pulp)</td>
<td>1.08 ± 0.02</td>
<td>0.91 ± 0.02</td>
<td>S</td>
</tr>
<tr>
<td>pH</td>
<td>3.66 ± 0.08</td>
<td>3.73 ± 0.06</td>
<td>NS</td>
</tr>
<tr>
<td>Ascorbic acid content (mg/ 100g fruit)</td>
<td>33.51 ± 1.08</td>
<td>84.81 ± 1.01</td>
<td>S</td>
</tr>
<tr>
<td>Moisture Content (%)</td>
<td>80.29 ±0.85</td>
<td>79.22 ± 0.82</td>
<td>NS</td>
</tr>
</tbody>
</table>

* Mean ± Standard error of mean (SE)  
# S: Significant  
NS: Not significant
DISCUSSION: CHARACTERISATION

Mango for processing should have: high yield recovery, high sugar content, bright colour, good flavour and aroma after ripening, low acidity, no fibre and low tannin content (Maneepun and Yunchalad, 2004).

- Early Gold had significantly higher TSS, ascorbic acid content and lower titratable acidity value compared to Dauphine variety.
- Early Gold variety: more suitable for processing into fresh-cut produce
- More cost effective to process Early Gold variety higher yield of final product.

QUALITY ATTRIBUTE: MEAN FIRMNESS

Figure 1.0 Changes in mean firmness of fresh-cut mangoes over storage days

No significant difference among the different treatments was noted
No evidence of any interaction effect between vacuum & edible coating.
An increase in colour score noted over time.
No significant difference over storage days (p>0.05).

Vacuum & NatureSeal™ independently or in combination (p<0.01) delayed browning in the mango slices.
ANOVA: No evidence of interaction effect between % vacuum and NatureSeal™.

Changes in TSS: correlated with starch hydrolysis and conversion of starch to sugar during the ripening process in mango and further hydrolysis decreased the TSS during storage (Rathore et al, 2007, Martinez-Ferrer et al., 2002).

NatureSeal™ treatment had a significant effect on the TSS values (p<0.05)
**QUALITY ATTRIBUTE: TITRATABLE ACIDITY**

![Graph showing changes in mean titratable acidity of fresh-cut mangoes over storage days.](image)

*Figure 1.5 Changes in mean titratable acidity of fresh-cut mangoes over storage days*

- ANOVA revealed significant difference in storage days (p<0.01)
- No evidence of any interaction effect between vacuum and NatureSeal™ levels

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**QUALITY ATTRIBUTE: pH**

![Graph showing changes in mean pH of fresh-cut mangoes over storage days.](image)

*Figure 1.6 Changes in mean pH of fresh-cut mangoes over storage days*

- A gradual increase in pH
- Increase was more prominent in the control and for MVP treatment
- Storage time had a highly significant difference on pH (p<0.01).
Figure 1.7 Changes in mean TVC and Y&M counts in fresh-cut mangoes

- Counts increased significantly with storage time (p<0.01)
- ANOVA showed no significant interaction effect (p>0.05)
- Greater counts were noted in the control and in treatment 3 (0% vacuum and 3.0% NatureSeal™).

Figure 1.8 Main effect plot for mean TVC and Y&M counts

- Lower counts were obtained when vacuum was used (p<0.05).
- Main effect due to vacuum packaging was also significant (p<0.05).
**QUALITY ATTRIBUTE: MICROBIOLOGICAL COUNTS**

![Bar Chart showing Log CFU/g for different treatments](chart.png)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1: Control</td>
<td>Control</td>
</tr>
<tr>
<td>T2: 0% Vacuum &amp; 1.5% NatureSeal™</td>
<td></td>
</tr>
<tr>
<td>T3: 0% Vacuum &amp; 3.0% NatureSeal™</td>
<td></td>
</tr>
<tr>
<td>T4: 55% Vacuum &amp; 0% NatureSeal™</td>
<td></td>
</tr>
<tr>
<td>T5: 55% Vacuum &amp; 1.5% NatureSeal™</td>
<td></td>
</tr>
<tr>
<td>T6: 55% Vacuum &amp; 3.0% NatureSeal™</td>
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</tr>
</tbody>
</table>

**Fig 1.9: Effect of treatments on TVC and Y&M counts**

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**RESULTS AND DISCUSSION**

Mean counts increased significantly with storage time: transfer of skin microflora to fruit flesh where microorganisms can grow rapidly upon exposure to nutrient laden juices.

Microbiological values obtained were all below $10^7$ cfu/g and were in accordance with the Mauritian Food Regulations (1999).

The lower pH of the fruit: major factor that influences the composition of their microflora. Mango slices had: pH<4.6 on day 8 and this has restricted the microbial growth.
RESULTS AND DISCUSSION

NatureSeal™ did not help in controlling the proliferation of microorganisms (p>0.05) since it does not contain any antimicrobial agent.

Both TVC and YM count, significant difference was obtained when vacuum packaging was used (p<0.05).

The lower O₂ availability in moderate packaging slows the growth of aerobic microorganisms and stabilizes the produce.

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RESULTS AND DISCUSSION

- Martin-Belloso and Soliva-Fortuny (2006) : low oxygen atmospheres effectively reduce the proliferation of aerobic bacteria while high carbon dioxide atmospheres inhibit most aerobic microorganisms especially gram-negative bacteria and moulds.
- Loss of firmness was the main limiting factor for all the treatments.
- Rivera-Lopez et al. (2005) reported that variety plays an important role in shelf-life of fresh-cut mangoes.
- Some varieties slight storage life extension achieved other varieties extend storage life up to one month (Trinidad et al., 1997).
CONCLUSIONS

- Early Gold: more suitable for processing than the Dauphiné because of higher yield recovery, low fibre content, higher TSS, high pH, lower TA and higher ascorbic acid content.

- Loss of firmness was found to limit the shelf-life of fresh-cut Dauphiné mango slices.

- 2 days shelf-life was obtained for the control. MVP alone did not extend the shelf-life significantly.

- NatureSeal™ edible coating: combined with MVP extended the shelf-life of the product up to 4 days at 5 °C.

CONCLUSIONS

- No major difference in overall quality was observed among the two levels of NatureSeal™ used. However, 1.5 % NatureSeal™ gave slightly lower pH, lower TSS and higher TA.

- MVP lowered the microbial load and reduced browning of fresh-cut mangoes.
RECOMMENDATIONS

- Validate the findings of this study, using other mango varieties with export potential
- Use of 1-methylcyclopropene (1-MCP) treatment and/or calcium chloride to maintain firmness
- Use of other edible coating with antimicrobial properties can also be evaluated.

Thank You!