Date Quality Assessment in Postharvest Processing

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Date Production in Oman

- 8th largest date producer in the world
- 7 million trees
- 250 varieties
- 82% total fruit crops
- 49% total agricultural land
Production • 276,400 tones

Export • 10,000 tones

Stored • 60 -70%
Nutrition

Insect infestation

Stored Dates

Poor Quality

Proceed & Packaged

Low Export

End result

Causes

Stored Dates → Insect infestations → Lower Nutrition

Poor Quality → Proceed & Packaged → Low Export
Date Quality
Standard grading based on physical properties

- **Size**: 10 pt
- **Color**: 20 pt
- **Shape**: 40 pt
- **Defects**: 30 pt

CODEX and U.S Standards for Grades of Dates
<table>
<thead>
<tr>
<th>Date Quality (Defects)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Blemishes</strong></td>
</tr>
<tr>
<td><strong>Damaged</strong></td>
</tr>
<tr>
<td><strong>Unripe Dates</strong></td>
</tr>
<tr>
<td><strong>Un-pollinated Dates</strong></td>
</tr>
<tr>
<td><strong>Dirt</strong></td>
</tr>
<tr>
<td><strong>Insects and mites</strong></td>
</tr>
<tr>
<td><strong>Scouring</strong></td>
</tr>
<tr>
<td><strong>Mould</strong></td>
</tr>
<tr>
<td><strong>Decay</strong></td>
</tr>
</tbody>
</table>
Manual Inspection

- Laborious
- Inconstant
- Time consuming
- Costly
Date quality effects during harvesting and processing

Al Mabsili Date Stripping

Traditional – Manual Stripping

Mechanical Stripping
### Date damage – postharvest handling

- **Damage by bruises and scratches**

  - Traditional Bicycle Exercise Machine Electric Motor
  - Percentage of damaged date (%)
  - 0 (b) 3.0 (a) 2.0 (a) 4.7 (a)

- **Date without calyx**

  - Test type
  - Percentage of date without calyx (%)
  - Traditional Bicycle Exercise Machine Electric Motor
  - 3 (b) 17.7 (a) 19.3 (a) 13.3 (b)

- **Date thrown by the machine**

  - Percentage of date thrown by weight (%)
  - Bicycle Exercise Machine Electric Motor
  - 0.57 (a) 0.56 (a) 0.51 (a)

All comparisons show a significant difference (P< 0.05).
Imaging techniques to evaluate defects

- Detect surface cracks on dates and classify them (Color Imaging)
- Classify dates based on hardness (Monochrome Imaging)
- Detect internal infestations in dates by saw-toothed beetle (X-ray Imaging)
The NIR/RGB/Monochrome imaging systems

Algorithm using RGB color imaging technique to classify defects

Technique to detect surface cracks on dates and classify them depending on the amount of cracks
Surface Cracks

- Tiny breaks
- Transverse
- Longitudinal
- Irregular

differ in varieties
How do cracks occur?

1. Date Mite (Goubar Mite)
   - Before harvest
   - Make cuts and feed on the fruit
   - Covers the fruit with a web
How do cracks occur?

Wet weather

High relative humidity

High rainfall
Method using RGB Imaging technique

- “Khalas” variety
- 315 sample from 2 date factories
- Color Camera (RGB)
Method using RGB imaging technique

- Image processing in Matlab software:
  - Image Segmentation
Method using RGB imaging technique

Image processing in Matlab software:

- Image Segmentation
- Features Extraction
  - Gray Intensity
  - Red, Green and Blue Intensities
  - Hue, Saturation, Value Intensities
  - **Threshold Area**: The area extracted by Threshold
  - **Masks Area**: The area extracted by combining HSV masks
  - **Threshold %**: The percentage of the area extracted by Threshold over the total area of the object
  - **Masks %**: The percentage of the area extracted by combining HSV masks over the total area of the object
Method using RGB imaging technique

- Statistical Analysis in SPSS Software
- Two cases:
  - 3 classes (high crack, low crack, no crack)
  - 2 classes (with cracks, without cracks)
- Classification Model
  - Linear Discriminant Analysis (LDA)
  - Stepwise LDA
Results

Three classes model

Two classes model
Conclusions

– The developed algorithm was able to classify the cracked dates in 3 classes with accuracy of **67.3%**

– The developed algorithm was able to recognize the cracked dates from healthy dates with accuracy of **84.4%**
Using monochrome imaging technique to classify date

Develop an algorithm using monochrome imaging technique to classify date based on hardness

(a) Soft Date  (b) Semi-hard Date  (c) Hard Date
Using monochrome imaging technique to classify date

- “Fardh” variety
- 1800 sample (60/class) from 3 date factories
- Hardness analysis using Texture Profile analysis (TPA)
- Moisture content in 105°C for 24 hours
- Monochrome Camera
Using monochrome imaging technique to classify date

- Image processing in Matlab software:
  - Image Segmentation
  - Features Extraction
    - **Histogram Features**: Mean gray value, Standard deviation, Variance, Smoothness, Eccentricity, Solidity and Extent
    - **Texture Features**: Contrast, Correlation, Energy, Homogeneity, Maximum, Probability, Entropy, Cluster Prominence, Cluster Shade and Dissimilarity
Using monochrome imaging technique to classify date

- Statistical Analysis in SPSS Software:
- Three cases
  - 3 classes (Soft, Semi Hard, Hard)
  - 2 classes (Soft, Hard)
- Classification Model
  - Linear Discriminant Analysis (LDA)
  - Stepwise LDA
Results

Three classes model

<table>
<thead>
<tr>
<th>Date class</th>
<th>LDA</th>
<th>SLDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft</td>
<td>69,5</td>
<td>58,3</td>
</tr>
<tr>
<td>semi-hard</td>
<td>69</td>
<td>69</td>
</tr>
<tr>
<td>Hard</td>
<td>68,7</td>
<td>69</td>
</tr>
<tr>
<td>Over all</td>
<td>65,6</td>
<td>65,8</td>
</tr>
</tbody>
</table>

Two classes model

<table>
<thead>
<tr>
<th>Date class</th>
<th>LDA</th>
<th>SLDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft</td>
<td>93,4</td>
<td>63,2</td>
</tr>
<tr>
<td>Hard</td>
<td>93,8</td>
<td>63</td>
</tr>
<tr>
<td>Over all</td>
<td>83,3</td>
<td>83,6</td>
</tr>
</tbody>
</table>
Conclusions

- The developed algorithm was able to classify the cracked dates in 3 classes with accuracy of 60 – 76 %

- The developed algorithm was able to recognize the hard dates from soft dates with accuracy of 83 – 86 %
X-ray imaging technique to detect internal infestations

Determine the potential of X-ray imaging technique to detect internal infestations by saw-toothed beetle *Oryzaephilus Surinamensis* in dates
X-ray imaging technique to detect internal infestations

- 40 date samples of “Fardh” variety
- *Oryzaephilus surinamensis* eggs
- Infested dates (30 ± 1°C, 70 ± 5 R.H & 0 LS)
- 1, 20, 25 and 27 days (egg, larvae, pupa and adult respectively)

Artificially infested dates under the microscope
X-ray imaging technique to detect internal infestations

- X-ray machine, SQUH
- Image resolution (512 x 512)
X-ray imaging technique to detect internal infestations

- Image processing in Matlab software:
  - Image Segmentation
X-ray imaging technique to detect internal infestations

– Feature Extraction
  ▪ **Histogram features**: Total gray value, Mean gray value, Standard deviation, Area of kernel, Minimum Intensity, H1-H23 & H8-H17 subdivided
  ▪ **Textural features**: Contrast (GLCM), Energy (GLCM), Mean (GLCM), Variance (GLCM), Maximum probability (GLCM), Entropy (GLCM)

– Statistical Analysis in SPSS Software:
  Classification Models
Results

Sample (1)

Sample (2)
Results
## Results

80.0% of original grouped cases were correctly classified

<table>
<thead>
<tr>
<th>Groups</th>
<th>Predicted Group Membership</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sound</td>
<td>Egg</td>
</tr>
<tr>
<td>Original</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sound</td>
<td>75.0</td>
<td>6.3</td>
</tr>
<tr>
<td>Egg</td>
<td>12.5</td>
<td>81.3</td>
</tr>
<tr>
<td>Larvae</td>
<td>18.8</td>
<td>.0</td>
</tr>
<tr>
<td>Pupae</td>
<td>.0</td>
<td>.0</td>
</tr>
<tr>
<td>Adult</td>
<td>.0</td>
<td>6.3</td>
</tr>
</tbody>
</table>

n = 16
Conclusions

- 16 \(\frac{1}{40}\) successfully reached the mature stage
- No noticeable visual appearance of the insect infestation in the X-ray image of infested dates.
- Misclassification of more than 10%
Thank You!