DEVELOPMENT A CINNAMON BARK PEELING EQUIPMENT

Kalum Sanjeewa Ranaweera

128410N

Degree of Master of Engineering

Department of Mechanical Engineering

University of Moratuwa

Sri Lanka

November 2016
DEVELOPMENT A CINNAMON BARK PEELING EQUIPMENT

Kalum Sanjeewa Ranaweera

128410N

Thesis submitted in partial fulfillment of the requirements for the degree Master of Engineering in Manufacturing Systems Engineering

Department of Mechanical Engineering

University of Moratuwa

Sri Lanka

November 2016
Abstract

The Cinnamon Industry has been in Sri Lanka for hundreds of years and the product is commonly known as Ceylon Cinnamon. Sri Lanka is the dominant supplier in the world cinnamon market from the past due to its special taste and quality. Therefore, this has been a solid export earner over the years for Sri Lanka. At present it accounts for 80% of the global cinnamon market and brings in an annual income of LKR 3,000 million.

Although the cinnamon industry is bringing in foreign exchange to the country, development activities in the cinnamon industry have been rare compared to the other industries. There is potential to develop the industry in various facets. The cinnamon peeling is one such process that needs development in this industry. It is a time consuming process. This is also a labour intensive process, and requires highly skilled labour to perform the task. Therefore, the new generation is reluctant to work in this sector. This has badly affected the entire cinnamon industry. In addition, only primitive tools are being used in the cinnamon peeling process. Thus, mechanization of process is one of the options available to overcome the existing issues in the industry.

In the current study, a new cinnamon peeling equipment was developed by introducing a new peeling technology. Existing cinnamon peeling method and other peeling technologies have been scrutinised to propose an appropriate peeling method. Cinnamon peelers’ (n = 12) and exporters (n = 2) feedback was gathered to improve the design. It was identified that the introduced equipment in general can be used with minimal training and knowledge. The study also showed that the safety and efficiency of the cinnamon peeling process is increased significantly when the equipment was used. Apart from that, there is a possibility to automate the process and it is suggested as future work.

Key Words

Cinnamon Peeling
Cinnamon Production
Cinnamon Bark
Cinnamon Quills
Peeling Equipment
Acknowledgement

My heartiest gratitude is granted to Dr. Himan Punchihewa who was the Supervisor of the research, for his guidance and support as well as for providing necessary information regarding the research & also for his dedication for the students’ researches of the course.

I specially acknowledge Dr. Ruwan Gopura who was the Coordinator of the M. Eng. Course, for his coordination and guidance to direct us to accomplish final target. And I acknowledge the all lecture staff of the University of Moratuwa Mechanical Department, and the way in which lectures were conducted, are absolutely admirable. I believe that University of Moratuwa is one of my destinations where my entire life has been uplifted and is one of the greatest universities of the world.

I would like to express my special gratitude and thanks to Cinnamon industry persons especially Palmgarden Factory Manager of Balangoda Plantation, Plantation Superintendent and Cinnamon Peelers for giving me such attention and time to success the experimental works related to the research.

Finally, I gratefully thank my parents who wish my success all the time and my wife who have shared ups and downs in my life.
Declaration

I declare that this is my own work and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis/dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature:  
Date:

The above candidate has carried out research for the Masters/MPhil/PhD thesis/Dissertation under my supervision.

Name of the supervisor:

Signature of the supervisor:  
Date:
TABLE OF CONTENT

Abstract ........................................................................................................................................... i
Acknowledgement.......................................................................................................................... ii
Declaration.......................................................................................................................................... iii
TABLE OF CONTENT ......................................................................................................................... iv
CHAPTER 1 INTRODUCTION ............................................................................................................ 1
  1.1 Background .................................................................................................................................. 1
  1.2 Ceylon Cinnamon ...................................................................................................................... 2
  1.3 Cinnamon Production ................................................................................................................ 3
    1.3.1 Harvesting ............................................................................................................................ 4
    1.3.2 Removing Knots .................................................................................................................. 6
    1.3.3 Scraping ............................................................................................................................... 6
    1.3.4 Rubbing ............................................................................................................................... 7
    1.3.5 Peeling .................................................................................................................................. 8
    1.3.6 Drying .................................................................................................................................. 8
    1.3.7 Quills Making ...................................................................................................................... 9
  1.4 Products of Cinnamon Quills .................................................................................................... 10
    1.4.1 Packaging ............................................................................................................................ 13
    1.4.2 Storage .................................................................................................................................. 13
    1.4.3 Cinnamon Quillings (broken tubes) .................................................................................... 13
    1.4.4 Ground Cinnamon ............................................................................................................... 14
  1.5 Quality Requirements .............................................................................................................. 14
CHAPTER 2 IMPROVEMENTS IN CINNAMON INDUSTRY .............................................................. 16
  2.1 Machines Introduced In Cinnamon Processing ........................................................................ 17
  2.2. Scraper ...................................................................................................................................... 19
  2.3. Cinnamon Bark Scraping Machine ......................................................................................... 19
  2.4. Cinnamon Rubbing Machine .................................................................................................. 20
  2.5. Cinnamon Processing Bench .................................................................................................. 21
CHAPTER 3 SELECTING A MECHANISM ..................................................................................... 23
  3.1. Study the Cinnamon Peeling Method ...................................................................................... 23
  3.2. Study the Existing Methods for Bark Peeling ................................................................. 24
    3.2.1. Remove the Bark Scraping ............................................................................................... 24
3.2.2. Cut & Remove the Bark Using Sharp Knife

3.2.3. Remove the Bark by Hammering

3.2.4. Remove the Bark by Grinding

3.2.5. Remove the Bark Using Vacuum

3.2.6. Remove the Bark Using Chemicals

3.2.7. Remove the Bark Using Torsion

3.3. Discussion of Methods

3.4. Design Tree to Selecting Appropriate Mechanisms

3.5. Design Constrain

CHAPTER 4 PROPOSED DESIGN

4.1. Design Concept

4.1.1. Design Dimensions

4.2. Material Selection

4.2.1. Calculate Maximum Cutting Force

4.2.2. Find Suitable Fork Angles of the Equipment

4.2.3. Forks Adjusting Mechanism

4.2.4. Cutting Cable Assembly

4.2.5. Analysis Force Distribution on Cutting Cable

4.2.6. Selecting Optimum Blades Angle

4.3. Special Features of the Improved Design

4.4. Design Calculations

4.4.1. Calculate Stresses on Handle

4.4.2. Stress Calculation for the Connecting Bar of the Handle

4.4.3. Stress Calculation for a Fork

4.5. Detailed Design

4.6. Stress Analyses

4.7. Cost Analyses

4.7.1. Manufacturing Steps

4.7.2. Labor Cost Calculation

4.7.3. Machine Cost Calculation

4.7.4. Material Cost Calculation

CHAPTER 5 DESIGN EVALUATION

5.1. Evaluate Efficiency of the New Design
LIST OF FIGURE

FIGURE 1.1: CINNAMON PRODUCTION FLOW CHART .................................................. 4
FIGURE 1.2: CINNAMON HARVESTING ................................................................. 5
FIGURE 1.3: REMOVING KNOTS ............................................................................ 6
FIGURE 1.4: TRADITIONAL KOKATTA ................................................................. 6
FIGURE 1.5: SAWTHTUWA .................................................................................. 7
FIGURE 1.6: BRASS ROD FOR RUBBING .............................................................. 7
FIGURE 1.7: CINNAMON PEELING ...................................................................... 8
FIGURE 1.8: QUILLS DRYING ON ROPE RACK .................................................... 9
FIGURE 1.9: QUILLS MAKING ............................................................................ 10
FIGURE 1.10: QUILLS 5MAXICAN ...................................................................... 11
FIGURE 1.11: QUILLS 5CONTINENTAL ............................................................. 11
FIGURE 12: QUILLS ALBA ................................................................................... 12
FIGURE 1.13: CINNAMON FEATHERINGS ......................................................... 13
FIGURE 2.1: CINNAMON SCRAPING DEVICE .................................................... 19
FIGURE 2.2: CINNAMON SCRAPING MACHINE ................................................ 19
FIGURE 2.3: CINNAMON RUBBING DEVICE – RUWEEKA_CG............................ 20
FIGURE 2.4: CINNAMON RUBBING DEVICE – RUWEEKA-PG........................... 21
FIGURE 2.5: CINNAMON PROCESSING BENCH .................................................. 21
FIGURE 3.1: DESIGN TREE – DESIGN CINNAMON BARK PEELING EQUIPMENT .... 30
FIGURE 4.1: PROTOTYPE CINNAMON PEELING EQUIPMENT ............................... 34
FIGURE 4.2: CUTTING LOAD MEASURING ......................................................... 35
FIGURE 4.3: FORK ANGLE OF THE PEELING DEVICE .......................................... 37
FIGURE 4.4: FORKS ADJUSTING MECHANISM .................................................. 39
FIGURE 4.5: FORCES ON CUTTING CABLE ......................................................... 40
FIGURE 4.6: FORCE DISTRIBUTION ALONG CUTTING CABLE ......................... 41
FIGURE 4.7: BLADE ANGLE OF THE PEELING EQUIPMENT ................................. 43
FIGURE 4.8: FORCES ON THE HANDLE ............................................................. 45
FIGURE 4.9: FORCES ON THE FORKS .................................................................48
FIGURE 4.10: FORCE ON THE BLADE OF THE FORK ........................................50
FIGURE 4.11: FINAL DESIGN OF CINNAMON PEELING EQUIPMENT ....................53
FIGURE 4.12: STRESS ANALYZE OF BARK PEELING EQUIPMENT ..........................54
FIGURE 4.13: DEFORMATIONS OF PEELING EQUIPMENT ....................................54
FIGURE 5.1: CINNAMON PEELING BY INTRODUCED PEELING EQUIPMENT ..........60
LIST OF TABLE

TABLE 1.1: CINNAMON PRODUCTS GRADING.................................................................11
TABLE 1.3: COMMERCIAL SPECIFICATIONS OF CINNAMON ..................................15
TABLE 1.4: DEFECT ACTION LEVEL – USFDA FROM CINNAMON ..............................15
TABLE 2.1: EFFICIENCY OF RUBBING WITH RUWEEKA MACHINE .........................20
TABLE 3.1: BARK PEELING TECHNIQUE EVALUATION .............................................28
TABLE 4.1: MAXIMUM CUTTING LOAD ON THE PEELING DEVICE ..........................35
TABLE 4.2: SAFETY FACTOR FOR MECHANICAL DESIGN .......................................36
TABLE 4.3: CINNAMON PEELERS FEEDBACK FOR VARIOUS FORK ANGLES ..........37
TABLE 4.4: FORCE DISTRIBUTION OF CUTTING CABLE ........................................40
TABLE 4.5: MAXIMUM CINNAMON BARK WIDTH FOR VARIOUS STICK DIAMETER ....41
TABLE 4.6: CINNAMON BARK WIDTH FOR PRODUCT GRADING ..............................42
TABLE 4.7: MACHINE COST FOR PEELING EQUIPMENT ........................................57
TABLE 4.8: MATERIAL COST FOR PEELING EQUIPMENT .........................................57
TABLE 5.1: COMPARE EFFICIENCY OF DESIGNED PEELING EQUIPMENT ...............59
## LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>USFDA</td>
<td>United States Food and Drug Administration</td>
</tr>
<tr>
<td>MPM</td>
<td>Mycroanalytical Procedures Manual</td>
</tr>
<tr>
<td>AOAC</td>
<td>Association of Official Analytical Chemists.</td>
</tr>
<tr>
<td>HACCP</td>
<td>Hazard Analysis and Critical Control Point</td>
</tr>
<tr>
<td>ITI</td>
<td>Industrial Testing Institute</td>
</tr>
<tr>
<td>DEA</td>
<td>Department of Export Agriculture</td>
</tr>
<tr>
<td>SFD</td>
<td>Shear Force Diagram</td>
</tr>
<tr>
<td>BMD</td>
<td>Bending Moment Diagram</td>
</tr>
<tr>
<td>S/S</td>
<td>Stainless Steel</td>
</tr>
</tbody>
</table>