AN IMPROVEMENT OF BANANA AND YAM CUTTING MACHINE FOR VILLAGE INDUSTRY APPLICATION

Ronny Friday

Bachelor of Engineering with Honours
(Mechanical and Manufacturing Engineering)
2008
This final year projects report, which entitled “An Improvement of Banana and Yam Cutting Machine for Village Industry Application” was prepared by Ronny Friday (10903) as a partial fulfillment for the Degree of Bachelor of Mechanical and Manufacturing Engineering is hereby read and approved by:

DR. MOHAMMAD OMAR BIN ABDULLAH
(Supervisor)
AN IMPROVEMENT OF BANANA AND YAM CUTTING MACHINE FOR VILLAGE INDUSTRY APPLICATION

RONNY FRIDAY

A dissertation submitted to
Faculty of Engineering, University Malaysia Sarawak
in partial fulfillment of the requirement for the
Degree of Bachelor of Engineering
With Honours (Mechanical and Manufacturing Engineering)
2008
Dedicate to my loving Parents; Mr. Friday & Mdm. Mina, Eva Empira, brother and sisters, and all my friends who has supported and encouraged me through good time and hard time

Thank you for your support and encouragement
ACKNOWLEDGEMENT

First of all, I would like to take this opportunity give thank to Associate Dr. Mohammad Omar bin Abdullah for his guidance and support in this study and his patience, which enable the project to run smoothly. His teaching and encouragement brought me to the emerging world of mechanical.

Beside that, I would also like to express gratitude to University Malaysia Sarawak, all lectures from Faculty of Engineering especially Mr. Nazeri Abd. Rahman for his advice and supportive comment during accomplishment of this project. All staffs and technician in mechanical lab, Mr. Masri, Mr. Ruzaini, Mr. Rhayer and others technician which has given me a lot of valuable suggestions and guidelines that has eased the system development process.

Not forget to all my friends and all the individuals who contributed to the production of this thesis through their moral support, advice, guidance and participation either directly or indirectly.

Lastly, my "endless" thanks to my family for their love, moral support and advice that have keep me going...
ABSTRACT

The food processing sector accounts for about 10% of Malaysia's manufacturing output. In terms of numbers, small and medium-sized firms dominate the food industry in Malaysia. Food processing involves any type of value addition to agricultural or horticultural produce. Food markets are constantly evolving, and it was driven by changes in consumer demand. So, the purpose of this project development is to improve the current technology to help the small and medium industries entrepreneur especially the local farmer to increase the food production.

In this study, local farmer was produce snack in small-scale and wanted to increase the production rate to meet the market demand. The developments of this machine began with identify the problem based on the previous design of the cutting machine followed by problem solving. Then materials are selected for fabrication. The last step is testing the machine which is finished fabricated and fully working. From the testing result, all the problems arise during testing are analyze. Thus, recommendations are given to improve the design for the future. The development of this project have an objective of production cost saving and manpower. Cost saving are in terms of low cost and suitable materials for fabrication, manufacturing process and simple design. The prototype was designed, built and tested in Universiti Malaysia Sarawak. Also, it had been further tested for actual industrial used namely in the village of Sadong Jaya and found to be satisfactory. The overall price of the prototype is cheaper than other yam/banana cutting machines.
**ABSTRAK**

CONTENTS

Borang pengesahan status tesis .......................... i
Approval sheet ........................................... ii
Title page ................................................... iii
Dedication .................................................. iv
Acknowledgment ......................................... v
Abstract .................................................. vi
Abstrak .................................................... vii
Contents ................................................... viii
List of figures ........................................... xi
List of tables & charts ................................... xii

CHAPTER 1: INTRODUCTION ................................ 1
1.0 Introduction .......................................... 1
1.1 Chips Production ..................................... 1
1.2 Problem Statements .................................. 3
1.3 Project Objectives .................................... 3
1.4 Following Chapter Overview ....................... 4

CHAPTER 2: LITERATURE REVIEW ......................... 7
2.0 Introduction .......................................... 7
2.1 Yam (vegetables) ..................................... 8
   2.1.1 Nutritional benefits of yam .................. 10
2.2 Banana .............................................. 13
   2.2.1 Nutritional benefits of banana ............... 15
2.3 Type of Cutting Machine ........................... 17
   2.3.1 Banana and Yam Cutting Machine .......... 17
   2.3.2 Banana Slicer .................................. 19
   2.3.3 Multipurpose Slicer/Cutter ................. 20
   2.3.4 Vegetables Cutter and Slicer ............... 21
2.4 Operations of Cutting and Slicing Machine
   2.4.1 Generals Operations of Cutting and Slicing Machine
   2.4.2 Required Knowledge for Cutting and Slicing Machine Operator and Tenders
   2.4.3 Cutting and Slicing Skills
   2.4.4 Cutting and Slicing Activities

CHAPTER 3: METHODOLOGY
3.0 Introduction
3.1 Project Flow
3.2 Machine Design
   3.2.1 Machine Components and Specification
   3.2.2 Design Software
3.3 Material Selection
   3.3.1 Aluminum 6061
   3.3.2 Stainless Steel 304
   3.3.3 Mild Steel
3.4 Selection for Manufacturing
3.5 Fabrication
   3.5.1 Milling Process
   3.5.2 Lathe Process
   3.5.3 Joining Process
   3.5.4 Painting/coating
   3.5.5 Assembly
3.6 Machine Testing

CHAPTER 4 RESULTS AND DISCUSSIONS
4.0 Introduction
4.1 Machine fabricated
   4.1.1 Machine working principle
4.2 Actual testing results
   4.2.1 Banana
   4.2.2 Yam
4.3 Discussion of testing result
4.4 Discussions
  4.4.1 Operation of machine
  4.4.2 Manufacturing cost

CHAPTER 5 CONCLUSION & RECOMMENDATIONS
  5.1 Introduction
  5.2 Achievements
  5.3 Conclusions
  5.4 Recommendations
    5.4.1 The material
    5.4.2 Machine control
    5.4.3 Use of CNC machine

References
Appendix I (Technical Drawing)
Appendix II (Fabrication Process)
Appendix III (Machine Basic Parts)
Appendix IV (Fabrication cost and Motor Specification)
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURES</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Banana Chips</td>
<td>2</td>
</tr>
<tr>
<td>2.1 A type of tropical Yam</td>
<td>8</td>
</tr>
<tr>
<td>2.2 Banana fruit</td>
<td>13</td>
</tr>
<tr>
<td>2.3 Banana and Yam cutting machine</td>
<td>18</td>
</tr>
<tr>
<td>2.4 Banana slicer</td>
<td>19</td>
</tr>
<tr>
<td>2.5 A type of multipurpose slicer</td>
<td>21</td>
</tr>
<tr>
<td>2.6 Vegetable cutter</td>
<td>22</td>
</tr>
<tr>
<td>3.1 Feeding chute</td>
<td>29</td>
</tr>
<tr>
<td>3.2 Stainless steel cutting wheel</td>
<td>30</td>
</tr>
<tr>
<td>3.3 Mild steel frame and stand</td>
<td>35</td>
</tr>
<tr>
<td>3.4 upper view of the upper feeding chute</td>
<td>36</td>
</tr>
<tr>
<td>3.5 End-mill process</td>
<td>37</td>
</tr>
<tr>
<td>3.6 Lathe process</td>
<td>38</td>
</tr>
<tr>
<td>3.7 Stick welding process</td>
<td>40</td>
</tr>
<tr>
<td>3.8 View of finish Banana and Yam cutting machine (Autodesk software)</td>
<td>42</td>
</tr>
<tr>
<td>4.1 Machine constructed</td>
<td>45</td>
</tr>
<tr>
<td>4.2 Internal component of machine</td>
<td>46</td>
</tr>
<tr>
<td>4.3 Comparison of the previous machine with the new improved machine for banana.</td>
<td>48</td>
</tr>
<tr>
<td>4.4 Comparison of the previous machine with the new improved machine for yam.</td>
<td>49</td>
</tr>
</tbody>
</table>
# LIST OF TABLES & CHARTS

## TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 In Depth Nutritional Profile for yam</td>
<td>10</td>
</tr>
<tr>
<td>2.2 Nutrient composition as per 100 gm of edible portion</td>
<td>16</td>
</tr>
</tbody>
</table>

## CHART

<table>
<thead>
<tr>
<th>Chart</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Project flow chart</td>
<td>28</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

1.0 Introduction

In this chapter, the background study on banana and yam snacks production is introduced. Banana and yam are two types of food that related to this final year project title. This chapter also discusses problem statements in section 1.2. The objectives and primary aims of the current project are discussed in section 1.3 and outline of the structure of the following chapters in section 1.4.

1.1 Chips production

Fried products are popular as snack foods. These are prepared from a variety of raw materials and vary in size, shape and composition, but all are prepared by deep fat frying in vegetable oils and have relatively large proportions of fat/oil. They have a very low moisture content and can therefore be stored under ambient conditions (Sharma, Semwal et al., 1996). Banana and yam are one of the important fruits for making chip snacks in Malaysia. They are considered as a rich source of energy producing food. It is
consumed in several varieties of preparations and forms. Major share of banana and yam production in the country is consumed in the fresh form. A small percentage of it is exported.

![Figure 1.1: Banana chips.](image)

Chips are the age-old snacks and fast foods in Malaysia (Figure 1.1 shown a type of banana chips in the market). They are used as snack food both in domestic as well as in fast food centers and restaurants.
1.2 Problem statements

There has been considerable interest in developing a market for banana and yam chips as a snack item. Because of growth in the snack food industries, the potential of bananas and yams for processing into chips has become important in Malaysia (Ammawath, Man et al., 2001). Nowadays there are several machines or equipment been developed in order to increase the production rates. However most of the equipment out there are still expensive and for local farmers they cannot afford even to have one. The problem here is there are still a few development of equipment or technology in this country which can be taken up for increasing production rate, reduce the production cost and most important is the machine that affordable enough to local farmers. The local farmers are still using conventional hand-cutting or simple cutting machine method due to the high cost of the advanced cutting machine. With this outdated technology, local farmers are not able to produce enough amounts of snacks to meet the market demand. Therefore they also cannot increase their salary because of this limitation. It will take them to spend more hours to increase the production rates.

1.3 Project Objectives and primary aims

The purpose of this project is to study the previous design (Hiong, 2007) and make improvement to the design. Then, construct the machine design in order to come up with a better banana and yam chips manufacturing machine. This is important to help local farmer increase the production rates for making snack and be affordable enough for them to buy. The banana and yam cutting
machine constructed is designed to cut whole raw of bananas and yams into desired and consistent thickness slices for frying in the form of banana or yam chip. The new features are added to the design such as changeable cutting plate and the blade can be adjustable (Hiong, 2007). This design also provides good safety measure for keeping the operators hands away from the sharp elements of the cutter when it is being operated. Besides that, the machine also features friendly user and easy to do maintenance.

The primary aim of the current project therefore is to redesign and construct an electrically powered cutting machine that can produce the sliced bananas and yam to make them readily available for cooking or for further processing to produce snacks.

The machine will be able to cut or slice banana and yam crosswise with desired thickness for further processing. The machine also can used to slice the different size of banana and yam. Besides that, the machine will also be able to cut or slice the banana and yam in square shape such as French fries. Moreover, this machine can be used to cut various types of food other than banana and yam such as carrot, cucumber and potato.

1.4 Following Chapter overview

The second chapter is literature review. This chapter overview the history of banana and yam and also reviews different types of cutting machine; such banana and yam cutting machine, banana slicer, multipurpose slicer/cutter and vegetable cutter whether it manual or electrically powered with different cutting
method in order to get an idea how to improve the previous design. Moreover, this chapter also overview general operations and skills required for different types of cutting machine.

The third chapter is methodology. This chapter briefly describe all methodology used to complete this project starting from the concept to the finished product. This will give the reader an overall understanding of all steps involves in the process to carry out this project. Once again the concept of this new design was given by the farmer at Sadong Jaya. From the concept given, this project begins with studying the previous design and make the improvement on its in order to comes up with better machine in food technology especially for small-scale production such as home usage and production for village area. The following steps are the machine design, material selection, fabrication, testing the machine and analysis for performance.

Chapter Four is result and discussion. This chapter represents the result which gained from the new design and the fabrication of the cutting machine. The testing is carried out from the cutting machine prototype after it is fully fabricated. The chapter also discuss the purpose of the test implementation is to ensure that the accuracy, precisions and successful was the machine that is made performing and the result from the performance testing on two types of material used for testing, hard and soft material test with different speed. The results obtained from the testing is analyze and used as a guideline to design for the future research.

The last chapter is conclusion and recommendation for future work. This chapter represents the conclusion, highlight the finding from the testing on the machine and overview some possible relevant in recommendation for future
work and as a guideline and continuous study to improve the design of the machine. The chapter followed by summarizes the major achievement of this research work and highlight the principle difficulties encountered during the research process. The chapter also concludes with some suggestions about possible future enhancement of this work.
CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Development of automatic or electrically powered cutting/slicing machine is necessary to increase the production rate and also to increase profit. People are trying to improve efficiencies of machine to reduce cost of operations (Salvage, 2005). They are looking to maximize the yields through their equipment. Existing machine may need improvements in durability, efficiency, weight, speed or cost (Burr and Cheantham, 1995). Based on the previous design, there are lots of improvements can be done to the design in order to come up with a better machine design. This chapter wills overview the history of banana and yam and also reviews different types of cutting machine; manual or electrically powered with different cutting method in order to get an idea how to improve the previous design.
2.1 Yam (vegetable)

Yams are one of the most popular and widely consumed foods in the world. They play a staple role in the diets of many different countries, notably those in South America, Africa, the Pacific Islands, and the West Indies. Yams are one of the oldest food plants known. They have been cultivated since 50,000 BC in Africa and Asia (Foundation, 2001).

Yams are members of the Dioscoreae family. Depending upon the yam variety, of which there are about 200, its flesh may be of varying colors including white, ivory, yellow or purple while its thick skin may either be white, pink or brownish-black. Their shape is long and cylindrical (oftentimes having offshoots referred to as "toes") while their exterior texture is rough and scaly. Yams have a very starchy and slippery texture and when cooked, will either be creamy or firm, depending upon the variety. Their taste is earthy and hardy, with most varieties having minimal, if any, sweetness.

![Figure 2.1: A type of tropical Yam.](image)

Yam is a very easily grown plant that succeeds in most fertile well-drained soils. It prefers a position in full sun, though it will also succeed in semi-shade. The edible root can be up to 1 meter long and weight 2 kilos or more if it is...
grown in a good deep soil. Once when get it out, the root has a very nice flavor with a floury texture when baked, but it is not as tasty as a sweet potato (Plants For A Future, 1997). It makes an excellent staple food and, since yams are now becoming a more common food in Malaysia, it has a very good potential as a commercial crop here.

The tubers can be boiled, baked, fried, mashed, grated and added to soups. They store well and for a long time. They contain about 20% starch, 75% water, 0.1% vitamin B1, 10 - 15 mg % vitamin C (Plants For A Future, 1997).

Yam is not a commonly allergenic food, is not known to contain measurable amounts of goitrogens, oxalates, or purines, and is also not included in the Environmental Working Group's 2003 report "Shopper's Guide to Pesticides in Produce" as one of the 12 foods most frequently containing pesticide residues.

The Table 2.1 shows the nutrients for which this food is either an excellent, very good or good source. Next to the nutrient name you will find the following information: the amount of the nutrient that is included in the noted serving of this food; the %Daily Value (DV) that that amount represents (similar to other information presented in the website, this DV is calculated for 25-50 year old healthy woman); the nutrient density rating; and, the food's World's Healthiest Foods Rating. Underneath the chart is a table that summarizes how the ratings were devised (Foundation, 2001).
### Table 2.1: In Depth Nutritional Profile for Yam

#### 2.1.1 Nutritional benefits of yam.

Yams are a good source of Vitamin B6. Vitamin B6 is needed by the body to break down a substance called homocysteine, which can directly damage blood vessel walls. Individuals who suffer a heart attack despite having normal or even low cholesterol levels are often found to have high levels of homocysteine. Since high homocysteine levels are significantly associated with increased risk of heart attack and stroke, having a good supply of vitamin B6 on hand makes a great deal of sense. High intakes of vitamin B6 have also been shown to reduce the risk of heart disease (Foundation, 2001).
Yams are a good source of potassium, a mineral that helps to control blood pressure. Since many people not only do not eat enough fruits and vegetables, but also consume high amounts of sodium as salt is frequently added to processed foods, they may be deficient in potassium. Low intake of potassium-rich foods, especially when coupled with a high intake of sodium, can lead to hypertension. Dioscorin, a storage protein contained in yam, may also be of benefit to certain individuals with hypertension. Preliminary research suggests that dioscorin can inhibit angiotensin converting enzyme, which would therefore lead to increased kidney blood flow and reduced blood pressure (Foundation, 2001).

Yams do contain some unique substances called steroidal saponins, and among these substances are chemicals called diosgenins. Because of similarities between some forms diosgenin and progesterone, questions were initially raised about the ability of our body to convert diosgenin into progesterone, but research has shown that the answer here is clearly no. Diosgenin does, however, have an impact on hormonal patterns in studies involving animals, and may be helpful in lowering risk of osteoporosis, although we don't as yet have any human studies in this area (Foundation, 2001).

Wild yam also has some history of traditional use in herbal medicine, especially Chinese herbal medicine, as a botanical that can affect organ system function. While the focus here has been on kidney function, wild yam (or Chinese yam) has also been used to support the female endocrine system. For example, there has been traditional use of this root in conjunction with lactation. We've only seen one high-quality, peer-reviewed research study in which women were actually given wild yam (in the form of a topical cream) to determine the impact of this plant on menopausal symptoms. Although this
research showed some very limited benefits from the wild yam cream - and no side effects - none of the symptom changes were statistically significant. In summary, we'd say that there's no research evidence to support the claim that yam has special benefits when it comes to menopause, but that more research is needed in this area because there is a clear connection between yam, diosgenin, and endocrine function that is not yet understood (Foundation, 2001).

Vitamin B6 has been an especially popular supplement with respect to premenstrual syndrome (PMS) in women, especially in conjunction with the depression that can be triggered by PMS. Some companies have also advocated the use of this vitamin for menopausal symptoms. One cup of baked cubed yam contains 24% of the Daily Value for B6, and we rank yam as a "good" source of vitamin B6 for this reason. In research studies, however, the dose of vitamin B6 required for help with PMS depression is about 50-100 milligrams - many, many times the Daily Value level of 2.0 milligrams. So if you're a woman, even though yam might be a food well-worth including in your meal plan in conjunction with PSM, the amount of vitamin B6 that you'd be getting from this food would be insufficient (by itself) to reach the therapeutic level shown to be helpful in research studies.

Yams' complex carbohydrates and fiber deliver the goods gradually, slowing the rate at which their sugars are released and absorbed into the bloodstream. In addition, because they're rich in fiber, yams fill you up without filling out your hips and waistline. And one more benefit, yams are a good source of manganese, a trace mineral that helps with carbohydrate metabolism and is a cofactor in a number of enzymes important in energy production and antioxidant defenses.