To Investigate the Possibility of Threshing Pepper Spikes and Removing of Pepper Skin by Mechanical Mean

by

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Dedicated to my beloved wife; Rosemary Siret, and children; Eustace Rolius & Euston Rolius for their continuing support and encouragement.
Acknowledgement

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20th October, 2000
Abstract

In this thesis, the threshing of pepper spikes and the deskining of pepper berries using a mechanised system was performed and the effect of varying the speed on the quality of thresh and deskining, in term of effectiveness is discussed. The first aim was to investigate the possibility of using rubber laminated roller as thresher to thresh pepper spikes and the effects of varying the speed on the quality of thresh. The second aim was to investigate the possibility of using a motorised deskiner to replace the water-retting method for producing white pepper and the effects of varying the speed on the quality of deskined berries. The third aim was to compare the effectiveness of motorised thresher to the traditional method of threshing pepper. Finally, to compare the effectiveness of motorised deskiner to traditionally processed white pepper by water-retting. The knowledge obtained can aid in the cost-effective design of a mechanised thresher-deskiner system to replace the traditional method of production, to reduce production cost of white pepper, by reducing the overall processing time.
Abstrak

Dalam tesis ini, peleraian buah lada dan pengupasan kulit biji lada menggunakan satu sistem yang bermotor dijalankan dan kesan perubahan kelajuan terhadap kualiti peleraian dan pengupasan, dari segi keberkesanan dibincangkan. Objektif yang pertama ialah untuk menyiaskan kemungkinan menggunakan penggolek yang disalut dengan getah sebagai pelerai untuk melerai buah lada dan kesan perubahan kelajuan terhadap mutu peleraian. Objektif kedua ialah untuk menyiaskan kemungkinan menggunakan pengupas bermotor menggantikan kaedah "rendam dalam air" untuk menghasilkan lada putih dan kesan perubahan kelajuan terhadap mutu biji lada yang dikupas. Objektif ketiga ialah untuk membandingkan keberkesanan melerai menggunakan motor dengan kaedah tradisi untuk melerai buah lada. Terakhir, untuk membandingkan keberkesanan pengupas bermotor dengan kaedah "rendam dalam air" untuk memproses lada putih. Pengetahuan yang diperolehi dapat membantu dalam merekabentuk sistem pelerai-pengupas yang kos-efektif untuk menggantikan kaedah lama dalam menghasilkan lada putih, iaitu untuk menurunkan kos pemprosesan dengan meminimakan tempoh pemprosesan secara keseluruhannya.
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Chapter 1
Introduction

1.1 Background

Pepper, *Piper Nigrum* L., is referred to as 'king of spice', has a strong aromatic smell, and is widely used as condiment for food seasoning.

Pepper, is a perennial climbing vine originated from southern India, was first planted in Sarawak in the mid of 1800. Today Sarawak is a major pepper producer of the country, which account for 95% of the total production of which Johor and Sabah account for the balance of 5%. Malaysia is one of the leading producer and exporter of pepper. Other producing countries are India, Vietnam, Indonesia, Brazil, Sri Lanka, Thailand, China and Madagascar. The production and export for the period 1989-1998 is as shown in Table 1 [3]. Low pepper price as happened in 1990, despite its high maintenance cost such as labour, fertilizer, weedicides, and diseases and pest control, have burdened the pepper cultivators and made pepper cultivation an unattractive farming activity. As a consequence, this resulted in low production in 1995.

Table 1 Production, hectage and export of pepper from Sarawak for the period 1989-98. *Source Sarawak Gazette Vol cxxvi No. 1540 Dec 1999 Issue.*

<table>
<thead>
<tr>
<th>Year</th>
<th>Area (ha)</th>
<th>Production (tonnes)</th>
<th>Export (tonnes)</th>
<th>Export value (RM'000)</th>
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<tbody>
<tr>
<td>1989</td>
<td>10,672</td>
<td>28,000</td>
<td>26,476</td>
<td>165,450</td>
</tr>
<tr>
<td>1990</td>
<td>11,207</td>
<td>31,000</td>
<td>29,266</td>
<td>117,128</td>
</tr>
<tr>
<td>1991</td>
<td>10,998</td>
<td>29,000</td>
<td>26,853</td>
<td>85,079</td>
</tr>
<tr>
<td>1992</td>
<td>9,930</td>
<td>26,000</td>
<td>23,093</td>
<td>52,639</td>
</tr>
<tr>
<td>1993</td>
<td>8,880</td>
<td>17,600</td>
<td>16,768</td>
<td>60,205</td>
</tr>
<tr>
<td>1994</td>
<td>10,332</td>
<td>16,000</td>
<td>23,267</td>
<td>121,267</td>
</tr>
<tr>
<td>1995</td>
<td>10,166</td>
<td>15,500</td>
<td>15,252</td>
<td>104,438</td>
</tr>
<tr>
<td>1996</td>
<td>9,806</td>
<td>16,000</td>
<td>20,424</td>
<td>129,094</td>
</tr>
<tr>
<td>1997</td>
<td>10,178</td>
<td>18,000</td>
<td>26,269</td>
<td>304,307</td>
</tr>
<tr>
<td>1998</td>
<td>10,400</td>
<td>19,000</td>
<td>18,669</td>
<td>360,370</td>
</tr>
</tbody>
</table>
In the state, pepper is considered as the second most important cash crop, most pepper gardens are concentrated in the Kuching, Samarahan, Sri Aman and Sarakei Divisions. They are planted mainly by small holders in garden with an average farm size of between 0.5-2.0 hectares with about 200-400 vines [3]. As pepper is a climber plant, belian post, a local hardwood with very high resistant to decay, is used as a medium of support (Figure 1).

![Pepper Vines](image)

Pepper vines are stripped of flowers during its first two years of planting to prevent premature fruiting [1]. As such, the first crop is normally taken in the third year. The flowering-to-ripening period is about seven months. The presence of one or more red berries indicates that the berries are mature and harvesting can be done (Figure 2). For black pepper production, normally they are harvested when at least one of the berries has turned red otherwise at least 75% ripen if they are for white pepper production [4]. Both black and white peppers are the product of the same plant [1].
The current method of harvesting is performed by hand plucking. The plucked spikes are temporarily filled into a small basket before transferring into bigger baskets, plastic bags or gunnysacks. Ladder is used to pluck the higher spikes.

Normally the threshing is done at home. The spikes are placed on a rattan mat or on a raised wire mesh platform. For the former, a wire mesh sieve is used to separate the berries from stalks and leaves whilst for the later the berries are collected on a rattan mat placed underneath the platform. This traditional method of threshing involves the stepping of spikes in a forceful twisting manner so as to break the stems. The berries are then separated from the stalks and leaves by using wire mesh sieve. Average harvest per person per day will take about 1 hour for a person to complete the above task. Therefore this method of threshing is time consuming and tiring. In addition, the berries may contain some impurities such as leaves and stalks.

The berries are then dried under the sun for about 7 to 10 days [1]. The berries (mesocarp) will turn black when dried and thus its name, the black berries as shown in Figure 3.
On the other hand, the fully matured and ripen berries are required for the production of white pepper [1]. As such, the spikes are specially selected prior to threshing. The berries are then filled into jute gunnysacks and soaked in running water, i.e in a stream or river though stagnant water can be used as an alternative such as in tank or pond, for about 7 to 14 days so that the skin (mesocarp) will decay (Figure 4) [5]. This is then followed by washing of the berries in rattan basket and sun-drying for 2 to 3 days. The berries appear white when dried as shown in Figure 3.
In the State, The Sarawak Pepper Marketing Board (PMB) is a statutory body responsible to regulate, promote and improve the marketing of Sarawak pepper besides value-added pepper and pepper products [3]. As such, apart from producing black and white pepper, green pepper is also produced of which some of them are green pepper sauce and green pepper pickle. Other products processed from pepper are pepper perfume and pepper candies to name but a few [6]. And for research and development, the Department of Agriculture of Sarawak plays a major role. Other agencies or institutions involve are Malaysia Agriculture Research and Development (MARDI), Malaysia Institute for Nuclear Technology (MINT) Universiti Kebangsaan Malaysia (UKM), Universiti Putra Malaysia (UPM) and Universiti Malaysia Sarawak (UNIMAS) [3].

To summarise the above, the facts about black and white pepper production are:

- Most cultivators prefer to produced black pepper
- Traditional method of threshing is slow
- The threshed pepper contains impurities such as leaves, stems and stalks
Matured berries, whether partially or fully ripen, are required for white pepper production. Hence, the matured spikes are specially selected prior to threshing and/or soaking.

Traditional method of producing white pepper by water-retting method is time consuming, i.e., between 7 to 14 days to destroy (decay) the mesocarp of the berries before it can be washed away.

The slow production process, apart from unstable price, high maintenance cost, have burden the cultivators and made pepper cultivation an unattractive farming activity.

1.2 Objectives

The objectives of this thesis are:

- to investigate the possibility of using the mechanised thresher to thresh pepper spikes to replace the traditional method and the effect of varying the speed on the quality of thresh
- to investigate the possibility of using the mechanised scrapper to deskin the berries to replace the traditional water-retting method and the effect of varying the speed on the quality of deskined berries
- to design and build a prototype that comprises the thresher and deskiner unit

This system is required to replace both the traditional method of threshing pepper spikes and water retting of berries. That is, if successful, will be able to perform the threshing job and removing of pepper skin in much shorter time. As a consequence, it will make pepper cultivation a more attractive and profitable farming activity by reducing some of the “muscle power” required for the process.
1.3 Scope Of Work

The scope of work involved the following activities:

- literature survey; information from Internet [6], books, journals, pamphlets, Sarawak Pepper Marketing Board (PMB), and Department of Agriculture Sarawak
- physical examination of pepper spikes and berries; to get their dimension
- trial & error experiment; trampling of pepper spikes using hands (press and rolled between palms) and the removing of pepper skin by pressing and rolling the berries between 2 flat surfaces to study the minimum rolling path (length) of the berries before their skin break and separate
- conceptual development & selection of best design
- survey on available material; “door shopping” to hardware shops
- material selection ( and purchasing)
- testing model construction
- conducting experiment
Mohd. Zohadaie, Wan Ishak Wan Ismail and Desa Ahmad in *Kejuruteraan Petanian Malaysia* [4] reported that threshing work consumed about 43% of the total pepper processing time. They found that the average force required for threshing green mature and red ripen berries are 220.5 g and 158.0 g respectively. It was also stated that several methods of threshing had been experimented such as using air-suction, vibration and a separator called “seedburo”. They found that threshing using the principles of air-suction and vibration was unsuccessful and cannot be employed. For the third experiment, i.e by using “seedburo”, they observed that at the speed range of 600-1600 rpm, about 98.8% of the spikes were successfully threshed but nearly 50% was damaged (crushed). This shows that, although the threshing was successful, it depleted its purpose as it damaged half of the pepper berries which is undesirable. Such failure implies that the mechanical properties of pepper berries need to be well understood and considered in the design of the mechanised thresher.

According to H.F Macmillan in *Tropical Planting & Gardening* [1], 100 kg of mature berries (not ripen) will produce between 33-37 kg of black pepper while 100 kg of ripen berries produces 25-28 kg of white pepper. This shows that there is a loss of about 8-9 kg in every 100 kg of mature pepper berries if it processed as white pepper instead of black pepper. As such, if the price of 90 kg of white pepper could not outweigh the price of 100 kg of black pepper by at least 30%, then for obvious reason, production of black pepper is preferred.

Lau & Tiong in *Pepper Industry Problems and Prospectus* [2] reported that berries are separated from the stalks by motorised thresher to overcome microbial contamination and to ease threshing job. The motorised thresher is as shown in Figure 5.
The traditional method of white pepper processing, as reported by H.F Macmillan [1], by water-retting of mature (ripen) berries will take about 7-14 days for the mesocarp to decay before it can be cleaned by washing them in rattan basket.
Chapter 3

The Concept Of The Threshing And Deskining System

3.1 The Process Flow Chart Of Black & White Pepper Production

![Process Flow Chart of Black & White Pepper Production](image)

Figure 6 Process Flow Chart of Black & White Pepper Production
3.2 **The Concept of Black and White Pepper Production**

The conceptual design of the system for the mechanised production of black and white pepper is based on the proposed process flow chart as illustrated on the previous page. The output of the thresher can either be processed into black pepper by sun-drying or alternatively as white pepper by allowing the berries to go through the deskiner unit to undergo the deskinging process.

After the berries have undergone the deskinging process, the berries are required to go through the water-retting and cleaning process to wash away the remains of the skin. Finally, the cleaned cores are sun-drying for 2-3 days as white pepper.

3.3 **System Component**

The system component comprises the thresher unit, deskiner unit and the driver unit.

3.3.1 **Thresher Unit**

This unit is placed above the deskiner unit so that the pepper berries can be fed into the deskiner unit smoothly due to force of gravity.

3.3.1.1 **Feed Bin (Hopper)**

This is where the pepper spikes are fed into the thresher.
3.3.1.2 Thresher

This is a chamber where the pepper spikes are threshed. It comprises of 2 main component; the thresher rotary scrapper and thresher fixed scrapper. A motor in the driver unit, via a v-belt and pulley system, drives the rotary scrapper. When the thresher rotates, it pulls the pepper spikes over and forces it to pass through a narrow passage between the rotary scrapper and the stationary scrapper. As such, when the shaft rotates, due to friction that acts similar to the forceful twisting of the feet in the traditional method, the stems break and the berries are thus separated from the stalks. The mechanics of threshing pepper spikes is as illustrated in Figure 7.

Figure 7 Schematic diagram showing the mechanics of threshing pepper spikes
3.3.1.3 Stalk Separator

The stalk separator is located right below the thresher. The berries will pass through the sieve and fall into the deskiner unit while the stalks and leaves are trapped and are removed manually (Figure 7).

3.3.2 Deskiner Unit

This unit comprises the deskiner fixed scrapper and deskiner belt scrapper.

3.3.2.1 Deskiner Fixed Scrapper

The fixed scrapper is located above the belt scrapper. When the berries fall on the belt scrapper, as it is traveling from one end to the other, they are carried towards the driver pulley end through a passage where it is gradually getting narrower. As such, the berries will roll on its way through this passage. In such a manner, the mesocarp (skin) of the berries will be cut and/or polished off upon reaching the exit point.

3.3.2.2 Belt Scrapper

The belt scrapper is a spiky surfaced flat belt driven by a pulley at one end and follower at the other end. The upper part is supported by a thin plat so that it can withstand the force exerted by the berries as it pass through the narrow passage between the belt and the fixed scrapper. The driver pulley is driven by a motor, the same motor used to drive the thresher, via a belt and pulley system.
When the berries fall on the belt scraper, as it is traveling from one end to the other, they are carried towards the driver pulley end through a passage, which is gradually getting narrower. In such a manner, the berries will roll on its way through this passage and the mesocarp (skin) of the berries will be cut and/or polished off upon reaching the exit point due to abrasive effect of the spiky belt scraper. The mechanics of pepper deskining process is as illustrated below (Figure 8).

![Diagram of pepper deskining process](image)

Figure 8  Schematic diagram showing the mechanics of deskining pepper berries

### 3.3.3 Driver Unit

A 1/2hp single-phase motor is used to drive the thresher and the deskiner unit. A double groove pulley is used, i.e., one groove for the thresher and deskiner unit respectively.
Chapter 4

Material And Method

4.1 Testing Model Design

The testing model design, as shown in Figure 9, was selected from the best conceptual design of the thresher-deskiner system.

Figure 9 Testing Model Design