Design of Equipment Machine for Separating Seeds and Pulp of Mangosteen (Garcinia mangostana L.)

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Abstract—The objectives of this research were to design the equipment machine for separating seeds and pulp of mangosteen and to test the performance of machine tools. The separation of the parts of the mangosteen fruit currently is still done traditionally. By increasing the export volume of mangosteen, it needs some efforts to develop this product due to the low quantity, quality and sustainability of production. Method of data collection was done by direct measurements during the process of separation of the components of the mangosteen fruit. The design of separator machinery equipment is successful to separate the seeds and pulp of mangosteen. Separation of seeds and pulp of mangosteen produces several levels of quality seeds and pulp. Capacity of equipment machinery for separating pulp of mangosteen is 50 kg h⁻¹ and the engine efficiency is 68.54%.

Index Terms—traditional, mechanization, fruit, seed

I. INTRODUCTION

The separation of the parts of the mangosteen fruit currently is still done traditionally. Separation technique conducted traditionally is by putting pressure on the fruit by hand until broke and then consumed. While the separation of seeds and fruit flesh (pulp) has not done mechanically and systematically. If further review, it is necessary the system of separation of pulp and seeds to produce mangosteen juice and seeds can be directly used for seeding. Each 100g of fruit flesh (pulp) mangosteen contains 0.6 g protein, 0.6 g fat, 15.6 g carbohydrates, 6 mg calcium, 12 mg phosphorus, 0.8 mg iron, 70 g of water and 53 calories [1].

Mangosteen (Garcinia mangostana L.), which earned the nickname “Queen of Tropical Fruits” (Hume, 1974) is the second largest fresh fruit after bananas exported Indonesia, thus including the main export commodities. Indonesian mangosteen exports increased from 4743 tons in 1999 to 8176 tons in 2003 in the markets of Taiwan, Hong Kong, Middle East, Singapore, and Japan. Increasing the volume of export demands some efforts to increase the development of this product due to the low quantity, quality and sustainability of production [2], [3]. The export contribution of mangosteen fruit is very large in order to increase foreign exchange and income of farmers [4]. The percentage of mangosteen exports based on the Central Bureau of Statistics in 2010 was only 9.46% of the total production [5]. The mangosteen taste from Indonesia was highly preferred by consumers in China [6].

The characteristics of Mangosteen were upright tree-shaped, green and 6-25 meters high, sturdy stems, symmetric branches forming crown. The position of leaf is dealing with short petiole (1.5-2 cm). Leaf blade are oval, elliptical or ellipse with size 15-25 cm length x 7-13 cm wide, shiny, thick and stiff, tip tapered leaf (acuminate) and smooth (glabrous) [7].

Mangosteen fruit consists of components such as fruit seeds, fruit flesh (pulp) and fruit skins. Currently mangosteen fruit is served in fresh food. In developed countries the use of the mangosteen fruit is not just limited to pulp but also the skin and seeds. Mangosteen fruit skins and seeds widely used for pharmaceutical products. This led to the increasing economic value of mangosteen include, skins, seeds and pulp. Therefore, this is needed some efforts to develop farm mechanization to overcome this problem. It is expected to develop creative industries of mangosteen juice. One effort to solve this problem is to create equipment machine to separate mechanically seeds and pulp of mangosteen. The objectives of this research were to design and create separator of mangosteen pulp and seeds, to test the performance of mangosteen seeds and pulp separator equipment [8], [9].

II. RESEARCH METHOD

This research phase begins with the planning of machine design, then conducting a literature study. Further modifications and machine design were made. Once the machine was finished, it was tested on a machine to know that the machine has been working according to plan. If the results of these tests indicate that
the machine has not worked as planned then it be modified and re-testing. Method of data collection was done by direct measurements during the process of separation of the components of the mangosteen fruit. The data is taken directly from observation in the Field. Primary data needed include: (i) the amount of raw material (kg); (ii) the amount of output seeds, pulp and fruit skin (kg); (iii) time (min); (iv) the driving engine speed (rpm); (v) the peeler cylinder rotational speed (rpm); (vi) the blower rotational speed (rpm); (ii) component separation capacity of seeds and pulp of the mangosteen fruit (pieces / hour).

The machine work process is as follows. Seeds and pulp of mangosteen are inserted into the hopper. They will apart from friction of the rotating cylinder, the pulp will come out through the holes in the wall. Pulp that comes out through the hole in the wall, and going out through the door to the mangosteen fruit seed output container shelter. Seeds that have been separated from the pulp mangosteen will be pushed out due to centripetal force and exit through the output seed fruit (pulp) mangosteen. Completion of engineering is done when the machine tool testing phase, there is a problem or deficiency in seeds and pulp mangosteen, so that the machine can function as planned. Performance test seeds and pulp separator machine mangosteen after pulping machines seeds and pulp of the mangosteen is formed according to plan, then performed the testing process. From the results of the performance test can be known whether the performance of the machine in accordance with the plan or not. Testing the performance of the machine consists of the following two methods. Functional test is carried out to determine the function and mechanism of action parer seeds and pulp mangosteen. The goal is to determine whether the results of design can function in accordance with the expected design. Tests were carried out by using seeds and pulp mangosteen.

The capacity of the separation (KP) of seeds and pulp of mangosteen fruit was

\[ KP = \frac{BBT}{t} \]

where \( KP \) = weight of a separate material (kg), \( BBT \) = total weight of the mangosteen, \( t \) = time (hours). The yield = \( KA / KTA \times 100\% \) where \( KTA = \) seed / pulp skinless mangosteen (kg), \( KA = \) pulp skinless mangosteen (kg). Power Machines eff = (power output) / (power input) \times 100\%. Eff = engine power efficiency (%), Input power = power available at the source of power (watts), Output power = engine power used (watts). Input power is required engine power in order to work optimally in accordance with the specifications of the motor. Output power is power that is used to rotate the motor cylinder engine peeler obtained by measurement using a multimeter.

Determination of the level of ergonomics on this tool will be influenced by the weight of the tool, and the operator of the inlet height of the material. Parts of the body that will feel the impact of the tool is not ergonomic shoulder, upper back, lower back, elbow and wrist. To determine the physical condition of the tool by the respondents conducted a question and answer directly to the operator or user of this machine design in this study.
Separator plate is made of stainless so safe for food. Separator plate is shaped plates with a length of 90 cm and a thickness of 0.2 cm. This plate has a height of 8 cm and is supported by the buffer tube at 1.5 cm. Height of separator plate is divided into 2 categories: height 11 cm and 6 cm. All parts and buffer separator plate is made of stainless. Plate separation distance can be set its height. It is intended to be used in a variety of sizes mangosteen fruit. However, the application of this arrangement is very difficult, because it must conduct to 16 parts manual settings in order to produce the desired distance. Separator plate with a low thickness will tend to be sharp and may damage and scratch the mangosteen fruit seeds. Therefore, a thicker plate separator is feasible to be used to minimize damage to the seeds.

Transmission is used to continue the rotary power of the motor shaft to the separator plate. The materials used to transmit power are using v-belt and pulleys. RPM measurement is performed using 2 methods. The first method is direct measurement using a tachometer. The second method is to use a method of calculation. The RPM is observed when the engine RPM without materials and using materials. Transmission system usage is using pulleys and v-belt has advantage economically than transmission system using chain and gear. The weakness of the system transmission pulley and v-belt is possibility of slippage is greater than the use of the transmission system and gear chain. Result of design of equipment machine for separating seeds and pulp of mangosteen is shown in Fig. 1.

![Separator plate](image)

Figure 1. The equipment machine for separating seeds and pulp of mangosteen

Functional test is performed to determine whether the machine can work equipment in accordance with the expected goals. In the functional assay showed that machinery equipment successfully separated the seeds and pulp of mangosteen. This separation process takes place due to the friction between the mangosteen fruit and friction with the inside of the cylinder peeler. Based on this functional testing, centrifuge seeds and pulp of mangosteen is functioned as expected which separates the seeds and pulp of mangosteen. This separation process takes through tiny holes on the cylinder paring output and exit through the door that has been designed for pulp of mangosteen. The mangosteen fruit seeds pushed toward the output is designed for fruit seeds mangosteen. From this functional test results obtained the data that the machine can work according to the function that is to separate the seeds and pulp of the mangosteen fruit.

The mangosteen fruit crops are usually mixed in a variety of sizes. Both small, medium large dan. The classification is based on the diameter and weighs wrap. The mangosteen fruit is divided into several components, namely the eyelids, skin, pulp and seeds of the mangosteen fruit. The percentage of each component part, as presented in Table I.

![Mangosteen](image)

Figure 2. First quality meat in containers

![Mangosteen](image)

Figure 3. Image of second quality meat in containers

![Mangosteen](image)

Third quality meat is left on the outside of the separator tube. This meat has the highest viscosity. The image of third quality meat is presented in Fig. 4.

<table>
<thead>
<tr>
<th>No.</th>
<th>Fruit Weight</th>
<th>Eyelids</th>
<th>Seeds &amp; Pulp</th>
<th>Skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1024.6 g</td>
<td>22.5 g</td>
<td>335.5 g</td>
<td>665.0 g</td>
</tr>
<tr>
<td>2</td>
<td>1022.2 g</td>
<td>26.7 g</td>
<td>355.8 g</td>
<td>637.8 g</td>
</tr>
<tr>
<td>3</td>
<td>1004.5 g</td>
<td>30.4 g</td>
<td>345.3 g</td>
<td>627.3 g</td>
</tr>
<tr>
<td>4</td>
<td>1021.0 g</td>
<td>29.8 g</td>
<td>324 g</td>
<td>666.1 g</td>
</tr>
<tr>
<td>5</td>
<td>1027.6 g</td>
<td>23.9 g</td>
<td>338.6 g</td>
<td>663.6 g</td>
</tr>
<tr>
<td>6</td>
<td>1021.4 g</td>
<td>25.8 g</td>
<td>360.1 g</td>
<td>664.9 g</td>
</tr>
<tr>
<td>7</td>
<td>1020.9 g</td>
<td>25.0 g</td>
<td>393.3 g</td>
<td>655.6 g</td>
</tr>
<tr>
<td>8</td>
<td>1024.1 g</td>
<td>31.4 g</td>
<td>359.6 g</td>
<td>630.1 g</td>
</tr>
<tr>
<td>9</td>
<td>1039.4 g</td>
<td>25.2 g</td>
<td>348.5 g</td>
<td>664.8 g</td>
</tr>
<tr>
<td></td>
<td>9205.7 g</td>
<td>240.7 g</td>
<td>3150.7 g</td>
<td>5854.3 g</td>
</tr>
<tr>
<td></td>
<td>1022.9 g</td>
<td>26.7 g</td>
<td>350.0 g</td>
<td>650.4 g</td>
</tr>
<tr>
<td></td>
<td>2.61%</td>
<td>34.22%</td>
<td>63.59%</td>
<td></td>
</tr>
</tbody>
</table>

In the process of separation of seeds and flesh of the mangosteen fruit was produced some quality pulp and seeds. On the separation of pulp, there are 3 quality categories of the meat produced that are first quality meat, second meat quality and third meat quality. The three quality types specific explanation is as follows:

- First quality meat is meat that has the lowest viscosity. Meat quality of this flow continues until the container shelters. The image of first quality meat is presented in Fig. 2.
- Second quality meat is meat that has the higher viscosity than first quality. The image of second quality meat is presented in Fig. 3.
- Third quality meat is left on the outside of the separator tube. This meat has the highest viscosity. The image of third quality meat is presented in Fig. 4.
The seeds of mangosteen are separated out through output door. The quality of the produced seeds is divided into four categories:

- Seeds slimy. Seed is produced in a state of glassware and still with a little mucus. These seeds have the highest percentage compared to other qualities. The images of slimy seeds is presented in Fig. 5.

- Seeds are not slimy. These seeds have a state of glassware but there is already a separate mucus well. The image of unslimy seeds is presented in Fig. 6.

- Whole seeds are slimy. These seeds have the form of a piece but it is still shrouded in a bit of mucus. Image of intact slimy seeds is presented in Fig. 7.

- Whole seeds are not slimy. These seeds are optimal result of the separation process. The quality of the produced seeds intact and has been completely separated from the flesh of the mangosteen fruit so it is no more slime left. But the percentage is very small seeds of this research. The image intact seeds is not slimy presented in Fig. 8.

Aspects of Ergonomics Engineering Equipment

Ergonomic aspect is very important in the process of making machine related equipment to make good use of both long and short time. This allows the use of the machine equipment does not interfere with the health of a temporary or permanent basis. Anthropometric Data used to determine the shape, size, exact dimensions associated with equipment designed, and the people who will operate the machine equipment.

Interviews directly on operator conducted to determine the level of comfort and ease of machining equipment during operation. The number of users machine equipment required to try as well as providing input to the convenience machinery equipment as much as two people. Mr Sugeng 43 years old with height 157 cm and Mr. Hendri 47 years old with a height of 160 cm. Trial use of machinery equipment is carried on the process of filling the tube separator materials and processes. Data were asked questions about the level of comfort and ease of use of the machine in this research is to high machine equipment is too high so that the process of filling material is less so comfortable for 10 repetitions. As for the operator of the process is quite easy. But even better if you use a socket.

Design of machinery equipment separated the seeds and pulp of mangosteen. Separation of seeds and pulp of the mangosteen fruit produce some level of quality seeds. Gin and pulp of mangosteen need improvement, because there are still obstacles that occur when the performance test. Some of these obstacles is the damage mangosteen fruit seeds and incomplete separation of seeds and flesh of the mangosteen fruit produced. This machine can be used for process of separating the seeds and pulp of the fruit which has a specification resembles the mangosteen fruit.

The design of separator machinery equipment is successful to separate the seeds and fruit flesh (pulp) of mangosteen. Separation of seeds and pulp of mangosteen produces several levels of quality seeds and pulp. Capacity of equipment machinery for separating pulp of mangosteen is 50 kg.h⁻¹ and the engine efficiency is 68.54%.

REFERENCES

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Hamid Ahmad was born in Surabaya on Ferbruari, 27, 1955. He Graduated from Agricultural Faculty of Jember University in 1981. He is a senior lecturer in Agricultural Technology in Jember University. He was had many training experiences such as Training P3LPT (DIKTI) in 1983, Training P3LPT in Bandung Technology Institute in 1984, Post Harvest Training in Brawijaya University in 1985, Preparation soil training in Brawijaya University in 1983, Tractor Training in PT.Rutan Machinery Trd.Co. in 1982, Training about Testing of tool and agricultural machinery in Bogor in 2009 etc. He is a Head of Agricultural Machinery Laboratory in Agricultural Technology Faculty, 2014-present. He is a senior of agrotechnopreneurship in Jember especially about cultivation of watermelon fruits. He worked as Mechanic for MITSUBISHI in 1982. His specialization is a soil science and agricultural machinery.