The development of lemongrass slicing machine

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Abstract. This research was aimed to design, fabricate, and evaluate the lemongrass slicing machine which can slice on both perpendicular and inclination to lemongrass stem, within less than 4.0 mm of thickness. The machine was fabricated by stainless steel of 740 x 740 x 830 mm sized, and consisted of 3 main parts of feeding slots, slicing knives, and a releasing slot. The machine functions by manual feeding a bunch lemongrass into the feeding slot one by one. The testing result revealed that perpendicular slicing condition was 48.9 kg/h and 98.6 % of working capacity, and working efficiency. Inclination slicing condition was 35.0 kg/h and 98.8 % of working capacity, and working efficiency respectively.

1. Introduction

The lemongrass slicing process is completed both by hand and machine. The hand slicing was studied by Reongchai Chukline et al.[1] which was found working capacity was 4.8 kg/h. While Boonphon Angkanasangmanee et al.[2] studied from 13 worker of farmer cluster revealing that mean working capacity was 10.0 kg/h. As a result hand slicing was only 4.8 – 10.0 kg/h. Even if the advantage of hand slicing is that the lemongrass is perfectly clear cut, it has a low capacity and inadequate to 500 – 1000 kg of order per day. As a result, this drives the farmer cluster to gathering at least 10 -20 workers to work 8 hour.

However, Reongchai Chukline et al.[1] who fabricated and tested their perpendicular slicing machine found that working capacity was 7.6 kg/h. While Boonpol Angkanasangmanee et al.[2] tested their perpendicular sliced machine showed 13.3 kg/h of working capacity. These results revealed that working capacity of the slicing machine were 7.6 – 13.3 kg/h. However, the advantage of machine was that it uses a small amount of labour while giving a higher capacity. While disadvantages of the machine involve difficulty of establishing, movement, and that it can slice only perpendicular to stem even though the farmer cluster needs to slice in inclination pattern.

Researchers would like to develop the lemongrass slicing machine from only perpendicular pattern to slice in both perpendicular and inclination pattern in one machine.

2. Materials and method

2.1. Study of physical properties of manual sliced lemongrass

These studies used sampling sliced lemongrass from normal slicing practice of the Vegetable and Thai Herb Processing Women-cluster at Tumbon Tha-Sao, Sai-yok District, Kanchanaburi province and aimed to discover a sliced thickness as figure 1, sliced angle as figure 2, angle of friction as figure 3, and appearance bulk density. The bulk density was studied by used a plastic box which was 200 × 250 × 100 mm of width, length, and depth. The box was filled with sliced lemongrass, and weighted. Then
the bulk density was calculated its weight divided by its volume. These data are used for designs such as feeding slot, and releasing tray of machine.

![Image](image1.jpg)

**Figure 1.** The sliced thickness measurement.

(a) perpendicular pattern   (b) inclination pattern

**Figure 2.** Sliced patterns.

**Figure 3.** Angle of friction tested of sliced lemongrass.

2.2. *Study of spacing gap between slicing knife to feeding slot*

This study aimed to study the appropriate gap between the four slicing knives to feeding slot (figure 4 and figure 5) with 5 steps of 0.5, 1.0, 2.0, 3.0, and 4.0 millimeter on selected speed of 600 rpm. The working capacity and working efficiency were considered.
2.3. Study of rotating speed of slicing knife
The rotating speed of slicing knife was studied on 50, 100, 300, 500, and 700 rpm where the speed is controlled by an inverter (figure 6). The working capacity and working efficiency were considered.

2.4. Designed, fabricated and evaluated the slicing machine
The result of 2.1 – 2.3 above were used for designing and fabricating the machine. Once the machine fabricated the working capacity as equation (1), working efficiency as equation (2), and power consumption were evaluated. The power consumption was measured by clamp meter Fluke 324.
Working capacity = \frac{\text{weight of products (kg)}}{\text{working time (h)}} \quad (1)

Efficiency = \frac{\text{weight of good products (kg)}}{\text{weight of all products (kg)}} \times 100 \% \quad (2)

3. Results and discussion

3.1. Physical properties of sliced lemongrass

The results of normal cultural practice of farmer were as follows (table 1); working capacity of perpendicular slice was 2.89 kg/h while inclination slice was 2.99 kg/h, the acceptance lemongrass sliced thickness on perpendicular pattern was 3.6 millimeter and inclination pattern was 3.4 millimeter. These data will be used as the datum of machine performance. The bulk density and angle of friction will be used for design the size and angle of releasing tray of machine.

|                | perpendicular pattern | inclination pattern |
|----------------|-----------------------|---------------------|
| Working capacity (kg/hr) | 2.89                  | 2.99                |
| Thickness of sliced lemongrass (mm.) | 3.60                  | 3.40                |
| Moisture content (%wb)     | 82.60                 | 82.80               |
| Bulk density (kg./m³)      | 240.00                | 160.00              |
| Angle of friction (degree) | 24.00                 | 45.00               |

3.2. The result of spacing gap factor

The five levels of spacing gap were studied on both perpendicular and inclination pattern. Subsequently, working capacity, working efficiency, and power consumption were investigated. The results were as figure 7 – figure 9. The effect of spacing gap to working capacity showed that working capacity increased when increasing the spacing gap, but when the spacing gap is more than 2 millimeter, the working capacity tend to decrease. While the effect of spacing gap to working efficiency that was considered from sliced lemongrass showed the parabola curved meant on smaller gap, a sliced lemongrass tends to pulpy instead of sliced. On other hand on wider gap the lemongrass tends to fold instead of cut. However, the effect of spacing gap to power consumption was shown in the hyperbola graph. On working observation, it can be concluded that when the smaller gap is used, the abrasive effect of lemongrass plant to slicing disc tends to brake the slicing disc causing a high power consumption, while a wider gap causes uncut of lemongrass plant and wrap around disc.

Figure 7. The effect of spacing gap to working capacity.
Figure 8. The effect of spacing gap to working efficiency.

Figure 9. The effect of spacing gap to power consumption.

Considering these results, the 2 millimetres of spacing gap will be designed/chosen for the slicing machine.

3.3. The effect of knife speed factor

The knife speed affects the machine performance as shown in figure 10 – figure 12. The increase of speed is the increase of working capacity. However, on higher speed the working capacity tends to steady. Due to the very high speed, the lemongrass plant faces a difficulty of push to knife. On the other hand, the higher knife speed, the less working efficiency and power consumption. Because high knife speed tends to pulpy sliced lemongrass, cause reducing the efficiency.

Figure 10. The effect of knife speed to working capacity.
3.4. The prototype of slicing machine and its evaluation result

Once the factor data have been analyzed, the prototype of slicing machine was fabricated by stainless steel. The machine consisted of 3 main parts: 1) feeding slots, 2) slicing knives set, and 3) lemongrass releasing tray with 740, 740, and 830 millimeter of width, length, and height respectively (figure 13). The machine worked by manual batching feed on 15 plants.

Figure 11. The effect of knife speed to working efficiency.

Figure 12. The effect of knife speed to power consumption.

Figure 13. The prototype of slicing machine.
The evaluation of prototype slicing machine revealed that working capacity of perpendicular slicing pattern and inclination slicing pattern were 48.9 and 35.0 kg/h. The working efficiency of perpendicular slicing pattern and inclination slicing pattern were 99.5% and 98.9% respectively.

4. Conclusion
Regarding to the results researcher would like to recommend that should using spacing gap of knives in the range of 1.5 – 2.5 millimetres and knives speed should in the range of 300 – 500 rpm. These conditions will give a high machine performance.

References
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