

## Performance Evaluation of Vertijack (Jackfruit Opener) for Commercial-scale Fresh-cut Fruit Industry

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### Abstract

*The market of fresh-cut jackfruit is increasingly popular, due to current lifestyle that prefer quality fresh fruit and ready to eat. The preparation of fresh-cut jackfruit is a time consuming, labour intensive and complicated due to the inherent nature of the fruit. Skilled operators are needed to avoid bulb damaged and tissue injury that subsequently leads to quality deterioration. For commercial or export markets the edible bulb needs to be presented in good shape. To overcome the problems mention above, Vertijack was developed to cater commercial scale processing of jackfruit. The machine functions is to aid the opening of the fruit whilst minimizing injury to the edible bulb by removing the core and then splitting open the fruit. The average damaged bulbs due to mechanical injuries during splitting of fruit manually compared to the machine is reduced by half i.e. 34% and 16% respectively. Furthermore, the processing time needed for Vertijack is about 73s per fruit, which is 3 times faster than manual operation. The core removing efficiency is only 49 to 70% depends on the fruit size and their core shape.*

Keywords: Jackfruit, fresh-cut, jackfruit opener

### Introduction

Jackfruit (*Artocarpus heterophyllus*) is the largest edible fruit in the world belongs to the family Moraceae. Jackfruit can be eaten fresh or process into chip, juice, jam, pickles and canned. There are about 5097 hectares of jackfruit was grown in Malaysia with annual production of 28,042 metric tons per year (Department of Agriculture Malaysia, 2017). Fresh jackfruit has the potential to penetrate the China and USA market.

Clone J33 also known as Tekam Yellow or Honey Jackfruit is the most popular variety for local and export market. J33 has the best quality value because of its sweetness, crispy, golden-yellow color, strong sweet and fruity aroma, and longer shelf life compare to other varieties (Norhashila & Bisant, 2013). Jackfruit usually market in the form of whole fruit or fresh-cut fruit as minimally processed fruit. The fresh-cut or ready to eat form has greater market compare with the whole fruit because of their large size, difficulty in peeling and risk in obtaining poor-quality bulbs.

The fruit has oval shape with spiny and thick rind and may weight from 5 to 50 kg. The fruit consists of 50 to 100 edible bulbs embedded between center core and inner skin. The bulbs are covered with thin strips of epidermal cells and cuticle layer (Latifah et al., 2016). The process of separating the edible bulbs is difficult and unpleasant as the fruit contain gummy latex that stick to the hands and knives. Skilled workers are needed to separate the bulbs from the

fruit to avoid tissue injury during processing. Tissue injury will fasten the deterioration process due to the increase of respiration rate, ethylene synthesis, enzymatic browning and microbial growth (Latifah et al., 2016). Furthermore, the process of opening the fruit manually is time consuming.

Seeing the need by the industry, a jackfruit opener (Vertijack) was developed to aid large scale processing of fresh-cut jackfruit. The simplicity of the design would enable unskilled operator to operate it. The machine functions to aid the opening of the fruit whilst minimizing injury to the edible bulb by removing the core and then splitting open the fruit. The aim of this study is to evaluate the performance of jackfruit opener.

### Materials and methods

#### Materials

Jackfruit of the variety Tekam Yellow (honey jackfruit J33), of weight in the range of 9 to 14 kg, was obtained from Pasar Borong Selangor, Seri Kembangan, Selangor and DRS Trading Sdn. Bhd. Jackfruits with maturity at index 3 were used for this study. Jackfruits at index 3 have the following characteristics: 1) Fruit color turns into green or greenish yellow; (2) the fruit spines become less sharp and widely spaced; (3) an aromatic adour develops (FAMA).

#### Vertijack prototype

The prototype consists of hollow shaft for removing the center core, two sets of blade for cutting the jackfruit rind, a pusher to split the jackfruit, a holder to hold the fruit and pneumatic system to provide compression force for coring and splitting action. The overall structure of the prototype is made of stainless-steel.

To operate the prototype, operator has to place jackfruit into the holder and push the start button. The hollow shaft would penetrate at the stem end of the jackfruit until required depth for coring operation. Simultaneously, the blades would moved downward and penetrate the rind for cutting process. After that, the pusher would pushed to split the jackfruit.



Figure 1: Vertijack



Figure 2: Cutting and splitting process by Vertijack

#### Prototype evaluation

The evaluation was conducted by comparing the performance of the jackfruit opener versus manual cutting on the basis of time taken to complete the cutting and removing the core. After each operation, the edible bulbs were sorted and the percentage of damaged bulbs will be calculated. The bulbs with visual cut and tear were considered as damaged. The percentage of damaged bulbs was calculated by the following equation (1):

$$\text{Damaged bulbs (\%)} = \frac{W_d}{W_t} \times 100\% \quad (1)$$

Where;

$W_d$  = Weight of damaged bulb (kg)

$W_t$  = Total weight of bulb separated (kg)

The efficiency of the prototype in term of percentage of core removing was determined using the following equation 2:

$$\text{Core removing efficiency (\%)} = \frac{W_{cr}}{W_{tc}} \times 100\% \quad (2)$$

Where;

$W_d$  = Weight of core removed (kg)

$W_t$  = Total weight of bulb separated (kg)



Figure 3: Splitting jackfruit and core from Vertijack

#### Results and discussion

##### Performance comparison between Vertijack and manual method

From the results presented in Table 1, it is very clear that jackfruit opener is capable for coring and splitting the jackfruit 3 times faster than manual. The time indicate for jackfruit opener is inclusive of the time needed to loading and unloading the jackfruit from the holder. Therefore, the actual coring and splitting process is very much less than that is recorded.

Table 1: Performance comparison between Vertijack and manual method

Performance parameter	Method	
	Jackfruit opener	Manual
Processing time (s)	72.7 ± 21.7	219 ± 34.9
Damaged bulbs (%)	16.2 ± 3.5	34.9 ± 4.1

Table 1 also shown that the percentage of damaged bulbs. The percentage of damaged bulbs for Vertijack and manual are 16% and 34% respectively. Thus, it is clearly shows that by using Vertijack, the damaged bulbs can be reduced by almost half compare to the manual method. The damage was due to mechanical injury from cutting (flesh cut) and splitting (flesh tear) process.

##### Core removing efficiency

The core removing efficiency of Vertijack was about 49 to 70%. From the observation, the core removing efficiency was higher for small size fruits compare with large size fruits. This probably because the large size fruits have bigger core diameter compare with

small size fruits. Thus, a part of the core remained because the diameter of the hollow shaft was smaller than the fruit core diameter. If using hollow shaft with bigger diameter, it will cut some of the edible bulbs during coring action especially for small size and medium size fruits. Thus, will increase the percentage of bulb damage.

Furthermore, some of the fruits have uneven core shape, thus increase the possibility of incomplete core removing process, thereby reduce the core removing efficiency. The uneven core shape also cause the increase in percentage of damaged bulbs due to flesh cut during coring action.

### Conclusions

The Vertijack manage to speed up the jackfruit coring and splitting process by about 3 times faster compare to manual. Furthermore, the percentage of bulb damage reduce from 34 to 16% when using Vertijack. This show that Vertijack can significantly reduce the processing time and losses due to mechanical injury. However, the core removing efficiency is low especially for large size fruits and fruits with uneven core shape. Therefore, further improvement is needed to increase the performance of Vertijack.

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