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A Study on Durian Processing Technology and Defleshing Machine

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Abstract— In food processing industry, durian flesh contains many nutrients as raw material for the production of cakes, ice cream, and flavoring, etc. Recently, the durian pulp units are separated from husk and durian defleshing have also been done by hand-craft devices which has low productivity and is not ensure production and food safety. This paper presents the research results of designing and manufacturing the durian defleshing machine and proposed durian flesh processing technology. The machine separates durian husk automatically and durian defleshing by means of centrifugation. Experimental testing shows that the principle of centrifugal horizontal cage for defleshing might be applied and get good result. The productivity of the machine operates at about 30-40 kg / hour with the percentage of pulp separation can be reached at 90% and the one for defleshing is over 95% at the cage rotation is 500 rpm. The machine also passes the requirements of food safety.

Keywords—***Pulp durian; defleshing machine; food processing, food safety.***

INTRODUCTION

Durian is one of the tropical fruits which growth and develop in many tropical zones. Each durian fruit weights around 1 to 3 kilograms. Its husk is covered with spines, hard and tough. Each durian has four or five locule and each one has some pulp units Fig.1. Durian flesh contains many nutrients such as carbon hydrate, protein, lipid, and minerals with very high contain and high calories compared to other fruits. However, the vitamin contains only at average levels (Michael, 1997). In Viet Nam, durian has been mostly planted at Mekong river delta, Southern-Eastern provinces, and High land with around 5000 ha. Recently, the market demand of durian supply for food processing and consumers at local and export market enhances sharply (SOT, 2013).

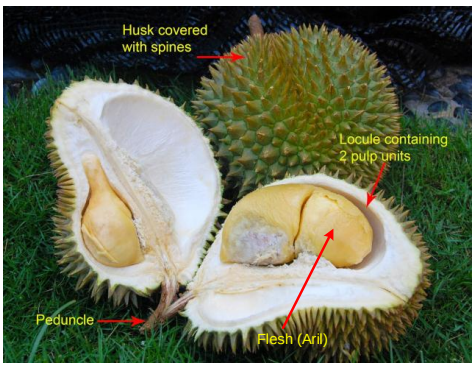


Figure 1. Different parts of an opened durian (Durian info, 2011)

In Viet Nam, the processing procedure of the durian defleshing has been done by hand-craft then the flesh is stored in the refrigeration for using during the year in food processing and supply for local consumers. Therefore, the durian flesh has unstable quality which strongly effects on the quality of production processing such as confectionary and cream, and so on.

In some countries which produce many durian productions like Thailand, Malaysia, Indonesia, The Philippines, and India the durian defleshing have also been done by handicraft. For example, figure 2 presents the durian husk opening devices used hand which is manufactured by the Weligent Company, Malaysia (Weligent, 2013). Its works is very simple. Using hand forces the point to the durian so that the husk is partly separated [Fig.2a] or fully separated (Dean, 2013).

a) Durian husk partly opener

b) Durian husk fully opener

Figure 2. The handicraft durian husk opener

It is noted that the point of the device shown in Fig. 2a shapes as pyramid and is control by the pneumatic (Tn Hj et al., 2013).

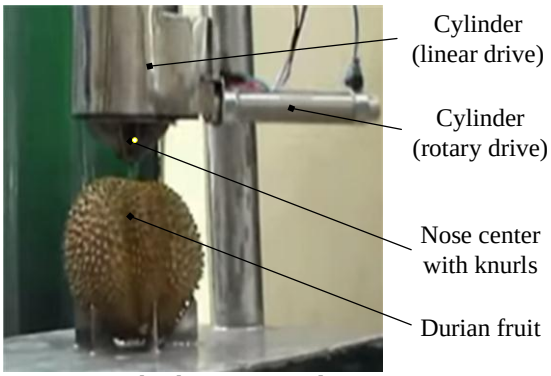


Figure 3. Durian husk opener used pneumatics

The reviews have shown that the durian husk opening might be done by semi-automatically such as using pneumatic. However, the pulp unit taking off from durian and the remove flesh out of pulp still be done by handicraft. Designing and manufacturing durian flesh device is need and would contribute to the enhancement of Viet Nam fruit economic efficiency production. This paper presents the study results of designing and manufacturing the durian defleshing machine with capacity of 30 – 40 kg/h and proposed technology processing for durian flesh.

MATERIAL AND METHODS

Kho Qua Xanh Durian – SR KQX is used for testing in this study. The durian has been planted mainly in Ngũ Hiệp Hamlet, Cai Lậy District, Tiền Giang province and in the other province like Bến Tre, Cần Thơ, Vĩnh Long, and Đồng Nai province (SOT 2013, FAO, 2004)

The durian shapes as ellipse geometry, green color, and has around 6 to 12 pulp units per durian fruit. The survey has been done in Ho Chi Minh city market shown the dimension of durian as (Fig. 4):

- Durian diameter: D = 155 ±10mm
- Height: H = 195 ±15 mm

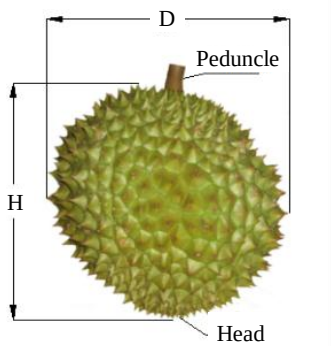


Figure 4. The size of the *Kho Qua Xanh* durian

Proposed Technology for durian defleshing

The proposed technology for durian flesh peeling might include three stages as husk separation (dehusking), take off pulp units, and flesh peeling (defleshing). The durian husk is quite difference with some fruits such as spikes so it is difficult to cut with a knife and can only use sharp objects to oblique, separation based on slots, weakness in the husk. Durian after separation could pry vertically, using vibration or centrifugation to remove the flesh from the pulp. Finally, the pulp is put into centrifuged tank to separate the grain and flesh. Technology process for durian defleshing is proposed as follows (Fig. 5):

-Husk separation by using pyramid point.
- Vibration / shake or centrifuged to separate the durian pulp unit peel off husk.
- Centrifuge to separate the durian flesh and seeds

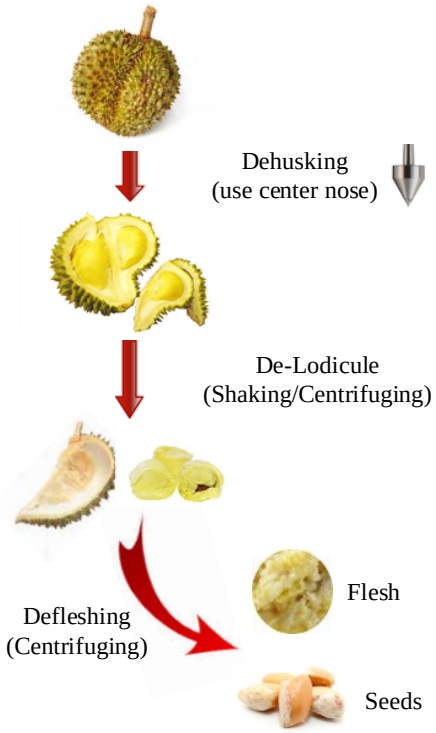


Figure 5. Proposed technology for the durian defleshing

RESULT AND DISCUSSION

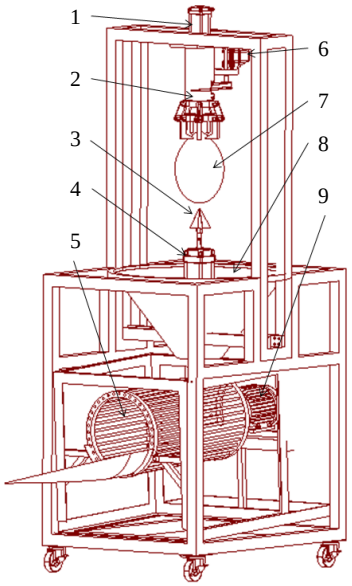
MACHINE DESIGNING

The durian flesh separator mainly uses for food processing so the separator is designed with the following parameters:
- Defleshing yield is around 30-40 kgs / hour
- Durian pulp unit is feed by hand
- There are two operating modes: manual and automatic mode
- Ensure food safety.

The durian defleshing machine model is designed to work in semi-automatic which includes three main groups: grip, hulling and pulp separating, fleshing and grain separator as shown in Fig. 6.

Gripper group: grip holder is responsible for durian operate under the principle of the lever (Fig. 7). After the feeding, cylinder (9) moves backward translation (Retract) bearing joints (5) and shaft (6) on up through the lever (4) as the lugs (8) clamped to clamping and holding durian. The shaft (6) connected with coupling (5) and the lever by the bearings (7). To take off the durian fruit and pulp units which are separated the husk from the gripper, we control clamp cylinder (9) forward and the lugs (8) operating in the opposite direction.

Husking and pulp unit peeling group: The spearhead 60^0 cone (2) is used and is located below and coaxial with the gripper. Controlling the cylinder (3) so that it can move upwards and will split nose pierced 1/4 - 1/2 durian (1) to separate the durian fruit (Fig. 8). At the same time, the gripper is tightly controlled to expand spin around creating the centrifugal force.



1. Cylinder 1
2. Gripper component
3. Point (Pyramid shape)
4. Cylinder 2
5. Rotation cage
6. Motor 1
7. Durian fruit
8. Gutter
9. Motor 2

Figure 6. Prototype of the durian defleshing machine

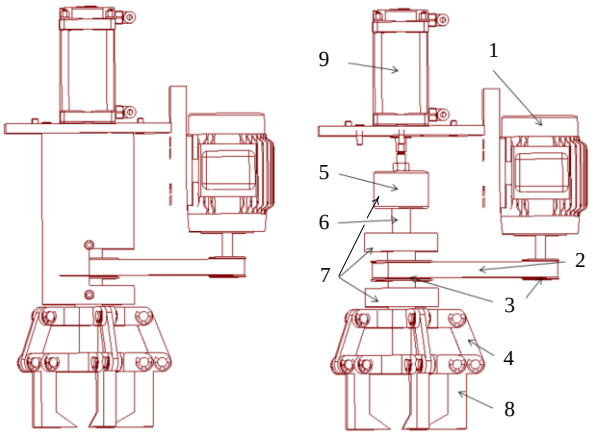


Figure 7. Gripper

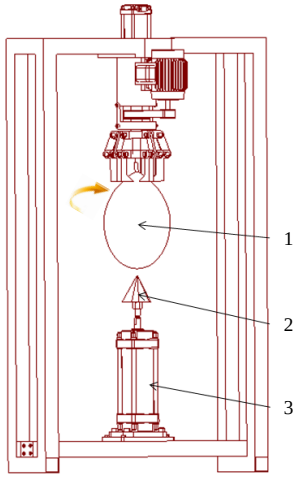


Figure 8. Husking and pulp unit separator

Defleshing and seed separator group: This group is worked under the principle of centrifugal horizontal (Zeki Berk. 2009). All separated durian pulp units from durian would be moving to the cage rotation (2) (Fig. 9). When the pulp have enough, the electric motor (1) is on and the cage (2) turns round. Due to centrifugal force, durian flesh will be separated and went out through the openings in the cage (2) to moving out via the gutter (3).

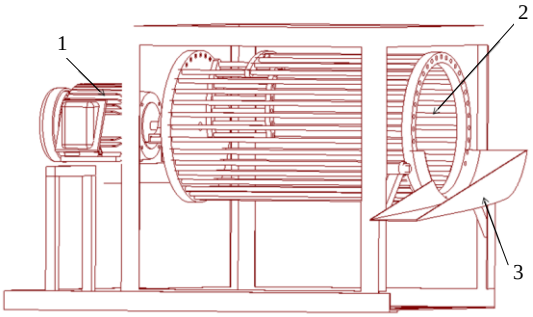


Figure 9. Defleshing and seed separator group

Machine manufacturing results

The designed durian defleshing machine has been manufactured successful and presented in Figs. 10-12.

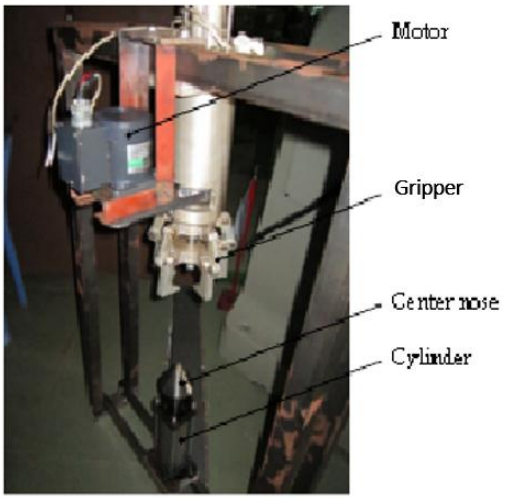


Figure 10. Manufactured Husking and pulp unit peeling devices

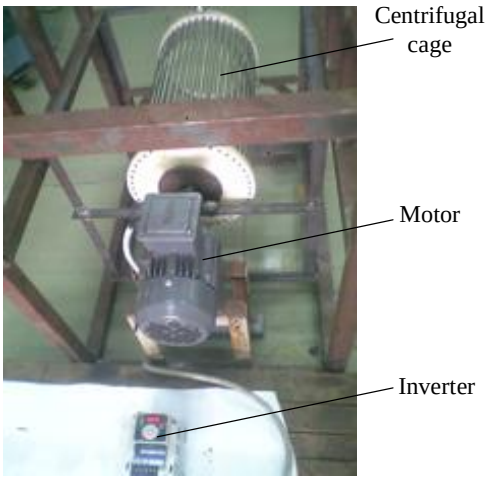


Figure 11. Manufactured defleshing and seed separator devices

Figure 12. Manufactured semi-automatics durian defleshing machine

Experimental testing

Figure 13 illustrates the capacity of durian gripper. The durian fruit used for the testing is as above (material section). The result indicates that the force to gripper is strong enough to keep the durian fruit for husking separation step which shown in Fig. 14.

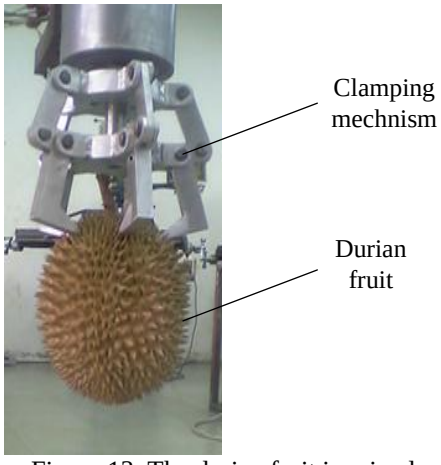


Figure 13. The durian fruit is griped.

The durian is separated from husking is shown in Fig.14 which clearly presents the husk of durian is easy to separate. The husking separation is tested with 7 durian fruits which are not similarly in terms of size. The testing result for durian husking separation is shown in table 1. The result indicate all durian fruits are easy to separate yet the pulp removing is not perfect. It shown that the pulp separated from husking is maximum around 90%.

Figure 14. Durian husking separation testing

Table 1. Durian husking separation results

Testing No.	Pulp unit/fruit	Ratio of pulp removing (%)
1	5	80 %
2	5	95 %
3	5	85 %
4	6	70 %
5	4	80 %
6	5	85 %
7	5	90 %

The experimental testing and results might conclude that the durian husking separator and pulp peeling devices can work well following the physical mechanism as the designing study indicated above. The classification durian fruit before separation would contribute to enhance the ratio of pulp removing from durian fruit.

The durian defleshing is also experimented by using the device shown in Fig.11. The pulp durian are put in cages centrifugation. The inverter is applied to adjust the rotation of the centrifugal cage. When the cage turns around, flesh are separated from seeds by centrifugal force through the grooves of the cage and seeds removed on vertical axis. The experiment is done in 6 times with each one repeated three times. The proportion of defleshing is determined by photoresist and presents in Table 2.

Table 2. Durian defleshing results

Testing No.	Rotation (RPM)	Time (s)	Ratio of defleshing (%)
1	100	30	35
2	200	30	50
3	300	30	65
4	400	30	80
5	500	30	95
6	600	30	95

The results specify that the horizontal rotation cage would create the centrifugal force might be right to apply for defleshing. The experiment also find out that the ratio of

during defleshing might pass to 95% at the cage rotation is 500 rpm.

CONCLUSION

The durian defleshing machine with durian griping and opening, husking separation, and flesh peeling has been designed and manufactured successful. The proposed technology for durian opening, pulp separation and flesh peeling is feasible. The principle of centrifugal horizontal cage for defleshing might be applied and get good result. Flesh and seeds are collected separately. The productivity of the machine operates at about 30-40 kg / hour with the percentage of pulp separation can be reached at 90% and the one for defleshing is over 95%. Moreover, the machine has a simple structure, easy to manufacturing and maintenance.

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REFERENCES

Michael J. Brown, 1997. Durio, a Bibliographic Review, International Plant Genetic Resources Institute.

FAO, 2004. FAO Corporate Document Repository. Fruits of Viet Nam, 2004. ISBN: 974-7946-63-7. 3. Potential Fruits. 3.1 Durian. Website [Online] http://www.fao.org/docrep/008/ad523e/ad523e04.htm

SOT (Statistical Office of Tien Giang Province), 2014. Statistical Yearbook Tien Giang Province 2013, pp. 137 - 212

Zeki Berk, 2009. Food Process Engineering and Technology, Academic Press, ISBN 0123736609, pp. 217 – 230

Durian Info, 2011. The Common Durian: Botany, Durian Infomation - A Durian Blog Devoted To "The King of Fruits", Website [Online] http://durianinfo.blogspot.com/p/origin-and-botany-of-durian.html

Weligent Sdn. Bhd., 2013. Product Catalogue, Portable Manual Durian Opener, Malaysia

Dean Martin, 2013, Durian Opener, BS in Agricultural Engineering, Website [Online] www.youtube.com/watch?v=TfWK8wiXQkk

Tn Hj Norman Bin Kusin, Tn Hj Abdul Rahim Bin Md Tahir, Tengku Muhamad Elnojuri Bin Tungku Bidin, 2013. Mesin Pengopek Durian Automatik (Durian Opener (automatic)), Pertandingan Kreativiti & Teknologi Inovasi (CITEC) 2013, Malaysia