https://doi.org/10.48047/AFJBS.7.4.2025.782-789

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

RESEARCH, DESIGN AND MANUFACTURING A PROTOTYPE OF NIPA FRUIT CUTTING MACHINE USING PNEUMATIC CYLINDER

Huynh Minh Phu, Tran Minh Tri , Ngo Thi Ngoc Diu

[1]Institute of Engineering and Technology, Thu Dau Mot University, Binh Duong province, Vietnam
[2]Central Tech Binh Duong, Central Tech Co., Ltd, Binh Duong province, Vietnam
[3]Institute of Information Technology, Digital Transformation, Thu Dau Mot University, Binh Duong province, Vietnam
[*]Corresponding author: phuhm@tdmu.edu.vn

Volume 7, Issue 4, Apr 2025

Received: 15 Feb 2025

Accepted: 05 Mar 2025

Published: 05 Apr 2025

doi:10.48047/AFJBS.7.4.2025.782-789

ABSTRACT

This paper presents a study on design and manufacturing a prototype of a nipa fruit cutting machine. Nipa fruit is the fruit of the nipa palm tree, a kind of tree that grows along rivers and canals in Vietnam, especially in the South of Vietnam. Currently, cutting (splitting) the nipa fruit to get the nipa fruit endosperm is done manually, by using a knife to split each fruit one by one. This study shows a method to mechanize the process of the nipa fruit cutting using a pneumatic cylinder. Energy from the compressed air source will be used to supply to the pneumatic cylinder, create kinetic energy to push the cutting blade down and cut the nipa fruit. Experimental results show that the model can work, and help to increase work productivity for workers compared to cutting nipa fruit manually.

Keywords: Nipa fruit, nipa palm fruit cutting, nipa fruit splitting, nypa fruticans cutter, nipa endosperm.

1. INTRODUCTION

Nipa palm is one of the most common trees grown in South Asia and Southeast Asia. It grows in Australia, Papua New Guinea, Philippines, Thailand, India, Bangladesh, Sri Lanka, Burma and Vietnam (Md. Farid Hossain and Md. Anwarul Islam, 2015). In Vietnam, nipa palms grow in swampy areas along river banks (Figure 1), or coastal areas with high and

low tides and slow-flowing water that accumulates silt. Naturally, nipa palms will spread and proliferate according to the flow of the river.

Figure 1. Napa palms in Vietnam

People often harvest the nipa fruit when they see the nipa bunches drooping down. After picking, nipa bunch are separated to be each fruit, then use a knife to split the nipa fruit in two halves as in Figure 2 and take out the nipa endosperm inside, so that it can be used to eat directly or dried for storage. Nipa endosperm can be eaten with ice and sugar, which has a very good refreshing and cooling effect.

In Vietnam, to take nipa endosperm, people often use a knife and cut the nipa fruit at the middle, and seperate the nipa into two parts then take its endosperm. This process takes a lot of time and effort of the worker, especially in big companies which sell a lot of nipa endosperm. On the other hand, the work productivity of this process is very low. The time to manually split nipa fruit to get an endosperm takes about 5 seconds to 10s.

Figure 2. Splitter nipa fruit by knife to take nipa endosperm in Vietnam

Currently in Vietname and the world, there are some studies related to nipa palm trees and fruits. Lawrence S. Halminton and Dennis H. Murphy (1988) published an overview of the use and management of nipa palm trees in Asia, Oceania, and Africa. (M. J. C Regalado et al., 2018) researched a bioethanol distiller from water secreted from nipa palm trees to use as a biofuel source. (James Paul T. Madigal et al., 2020) have proposed a design to collect water from the chamber of nipa palm trees. (Nagendra Prasad et al., 2013) studied the anti-toxic ability of nipa meat with a study conducted in Malaysia. (H. Hermato et al., 2020) presented the potential of nipa fruit, as a natural antioxidant source. In Vietnam, (Vy T Nguyen et al., 2023) researched a method to reduce graphene oxide/cellulose microfiber hybrid from the Vietnamese Nipa palm tree.

Although there have been some studies related to nipa palm trees and nipa fruits, studies related to nipa fruit cutting machines have not been found. Therefore, a solution for a nipa fruit cutting machine was proposed in this study.

2. MATERIALS AND METHOD

Based on the research on manual splitting of nipa fruit to get nipa endosperm, the principle diagram of the nipa fruit cutting machine is shown in Figure 3.

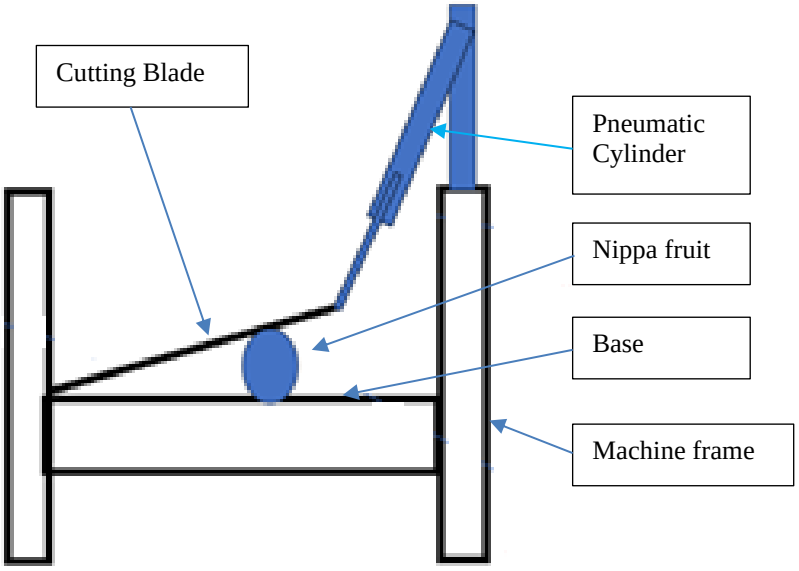

Figure 3. The principle diagram of the nipa fruit cutting machine

The solution consists of a steel machine frame, on which a pneumatic cylinder is placed. A cutting knife is connected to the piston of the pneumatic cylinder, below the machine frame there is a platform to place the nipa fruit. The user will place the nipa fruit on the base and then press the button to control the pneumatic source to the pneumatic cylinder. At that time, the piston of the pneumatic cylinder carries the cutting blade to go down and cut the nipa fruit and then the piston automatically goes up thanks to the action of the limit switch, finishing the stroke. Using compressed air to split the nipa fruit makes this spliting happen quickly and saves time and effort for users.

Based on the principle diagram of the nipa fruit cutting machine. An experiment was conducted to determine the necessary cutting force to cut a nipa fruit. Experiment using a knife with a long lever arm to create cutting force as shown in Figure 4. There is a load cell applied under the knife to measure the force.

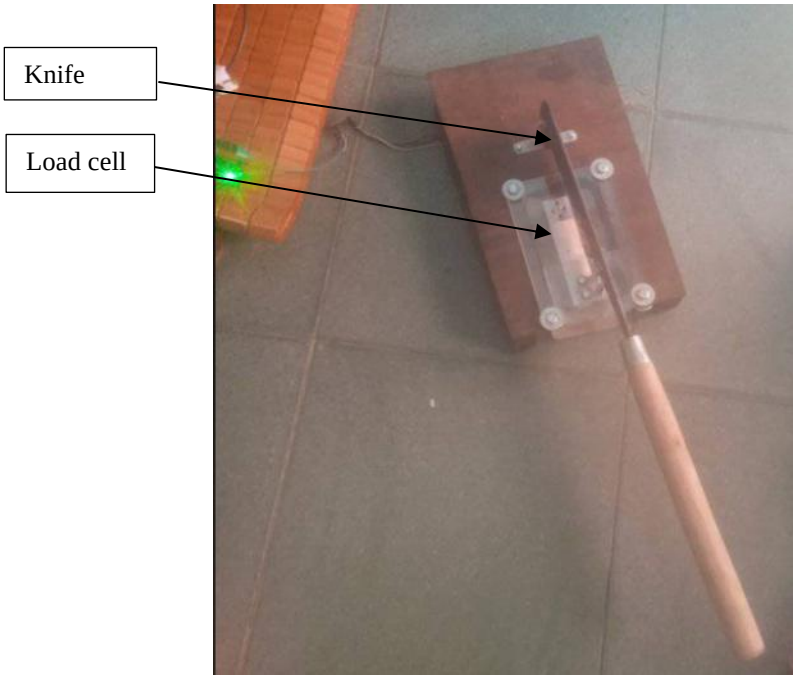

Figure 4. The device to measure cutting force for nipa fruit

Signal from the load cell is transferred to Arduino Uno R3 board to convert to force and display to the computer screen. Experimental results as shown in Figure 5. It can be seen that the force required to cut a nipa fruit is about 45285g to 49381g, equivalent to 500N. This is the important parameter for calculating the pneumatic cylinder.

Based on the measured cutting force, the diameter of the pneumatic cylinder is calculated. An air compressor with a relative pressure of 8 bar is used to supply compressed air to the pneumatic cylinder to create cutting force for nipa fruit. This air compressor has the advantage of being compact, easy to move, and low cost. Choose a cutting safety factor of 3 so that the prototype can cut the nipa fruit easily. It means that the necessary force for cutting is 1500N, the cylinder diameter is calculated according to the following formula:

$F=p.\ S$ (1)

$S=F/p$ (2)

$S=\pi.D^2/4$ (3)

Here, p is the compressed air pressure, S is the cylinder cross-section, D is the cylinder diameter. Then the cylinder cross section is calculated as follows:

$S=F/p = 1500/0.8 = 1875\ (mm^2)$

$D=\sqrt{4S/\pi}= 48.8\ (mm)$

Based on calculations, a pneumatic cylinder with parameters SC50x200 from Airtac company with a cylinder diameter of 50mm and a cylinder stroke of 200 mm was selected as the pneumatic cylinder to create cutting force for the model.

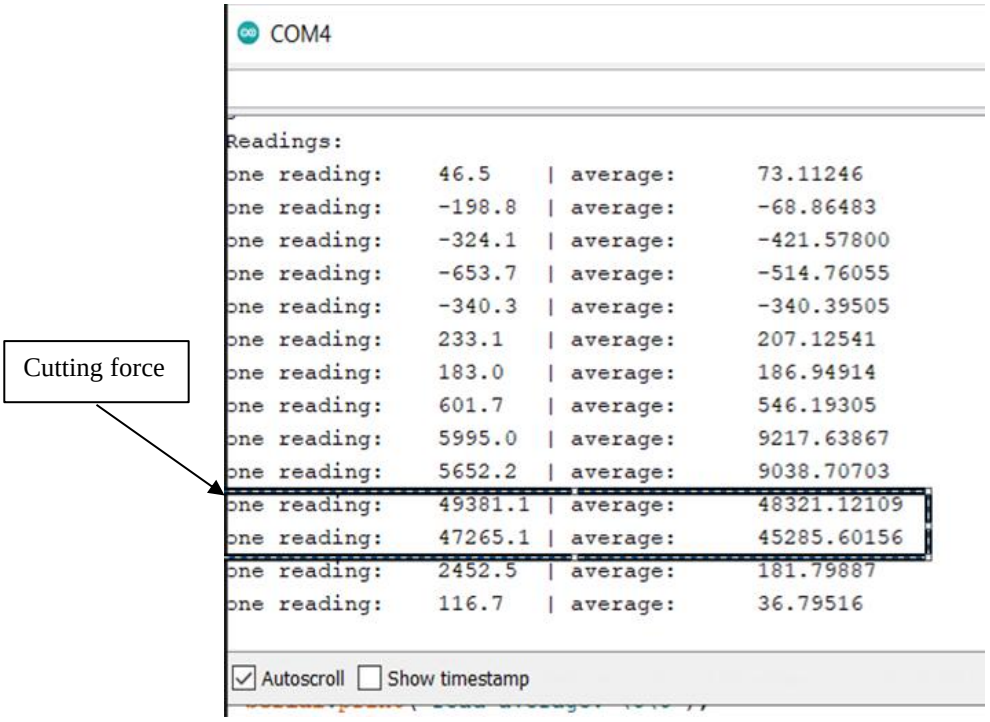

Figure 5. The result of an experiment when cutting nipa fruit measured by a force sensor with an Arduino board.

3. RESULTS AND DISCUSSION

After calculation, a 3D model is designed in SolidWorks software as shown in Figure 6. Based on the 3D design, a prototype of nipa cutting machine is manufactured as in Figure 7. The prototype includes a pneumatic cylinder which creates cutting force for the system. The maximum cutting force can be reached to 1500N by using a 50 mm diameter pneumatic cylinder. There is a place to put the nipa fruit for cutting. The control system of the prototype is shown as in Figure 8. It includes a 24V supplied source, a start button, a 5/2 pneumatic valve, and a magnetic limit switch.

The control system is performed as following procedure: firstly, the nipa fruit is placed into the cutting blade, then the start button is pressed and the 5/2 valve controls the compressed air flow to create the cutting force from the pneumatic cylinder to cut the nipa fruit. After the piston of the pneumatic cylinder completes its stroke, signal from magnetic limit switch is transferred to the 5/2 valve to change the direction of the compressed air flow to retract the piston. The cutting stroke is completed. This process will be repeated to every nipa fruit.

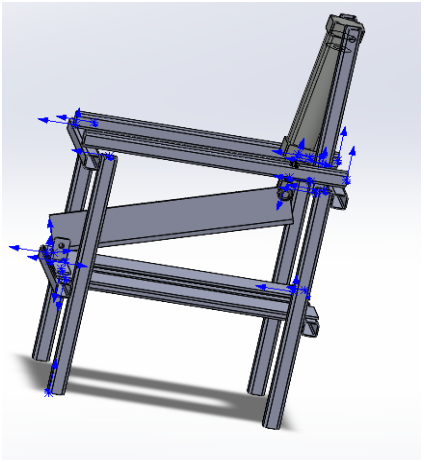

Fig. 6. The 3D model of the prototype designed in SolidWorks software

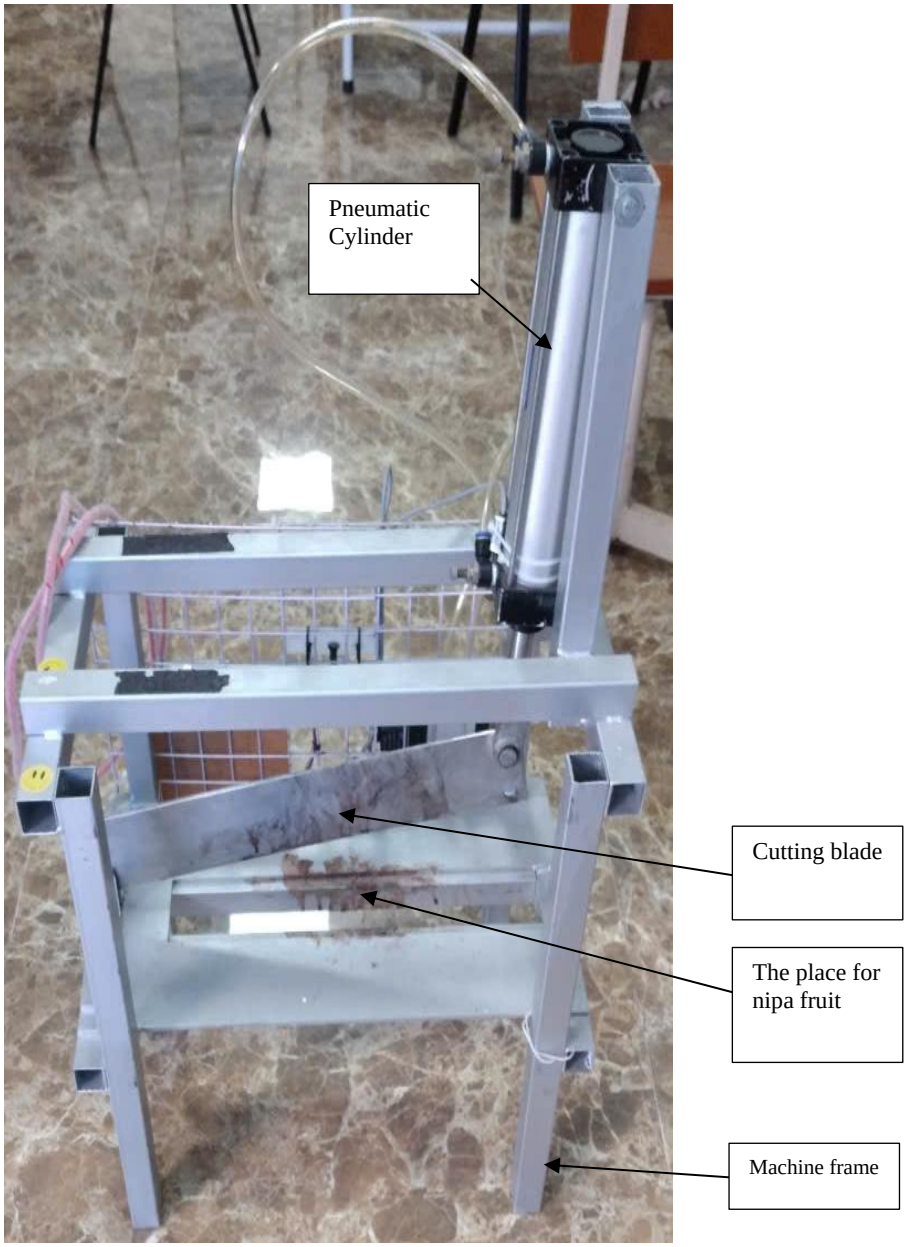

Figure 7. The front side of the prototype

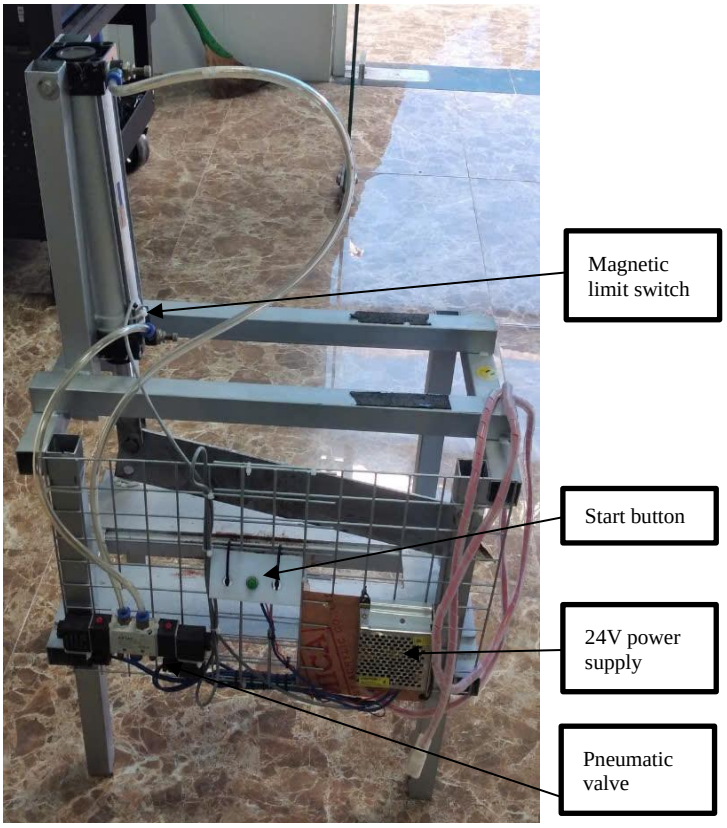

Figure 8. The back side of the prototype

Figure 9.The nipa fruit is placed for cutting.

4. **CONCLUSION**

When supplied by an air source of 8 bar pressure, the prototype can cut the nipa fruit. Tested with 10 different nipa coconuts, the average time to cut a nipa coconut is about 1 second. Figure 9 shows the placement of the nipa fruit when cutting. The current blade is made of C45 steel, however in the next versions it will be upgraded to use stainless steel blades. Figure 10 shows many nipa fruits after being cut by the prototype. It can be seen that the cutting knife can cut the nipa fruit in half to get the nipa meat inside. In the future the prototype is also used for simultaneous cutting 2 or 3 nipa fruit for enhancing work productivity.

Figure 10. Nipa fruit after cutting.

ACKNOWLEDGEMENTS

The authors would like to express highest gratitude to Thu Dau Mot University for providing financial assistance for the project

REFERENCES

1. Hossain, Md. F. and Islam, Md. A. (2015). Utilization of Mangrove Forest Plant: Nipa Palm (Nypa fruticans Wurmb), 3(4), 156-160. American Journal of Agriculture and Forestry. https://10.0.45.128/j.ajaf.20150304.16
2. Lawrence, S. H. and Dennis, H. M. (1988). Use and Management of Nipa Palm: a review. Economic Botany, 42(2), 206-213. https://www.jstor.org/stable/4255066
3. Regalado, M. J., Belonio, A. T., Villota, K. C., Rafael, M. L. and Castillo, P. R. (2018). Design, testing, and evaluation of a hydrous bioethanol distiller for the production of fuel-grade alcohol from nipa sap (nypa fruticans). American Society of Agricultural and Biological Engineers, 34(5), 759-765. https://doi: 10.13031/aea.12759
4. Madigal, J. P. T., Calixto B. G. S., Duldulao, M., Ubiña, T. D. and Agrupis, S. C. (2020). Development of nipa (nypa fruticans) sap closed collection vessel. Agro Bali: Agricultural Journal, 3(2), 108-117. https:// 10.37637/ab.v3i2.611
5. Prasad, N., Yang B., Kong, K. W., Khoo H. E., Sun, J., Azlan, A., Ismail, A. and Romli, Z. B. (2013). Phytochemicals and Antioxidant Capacity from Nypa fruticans Wurmb. Fruit. Evidence-Based Complementary and Alternative Medicine, 2013. http://dx.doi.org/10.1155/2013/154606
6. Hermanto, H., Mukti, R. C. and Pangawikan, A. D. (2020). Nipah (Nypa fruticans Wurmb.) fruit as a potential natural antioxidant source. IOP Conf. Ser.: Earth Environ. Sci. 443 (2020) 012096
7. Nguyen, V. T., Tran, T. N., Huynh, T. L., Le, D. VH. and Hoang, D. Q. (2023). Reduced graphene oxide/cellulose microfiber hybrid from the Vietnamese Nipa palm tree: Synthesis, properties, and applications for preparation of poly(methyl methacrylate) composite. Jour. of Thermoplastic Composite Materials, 36(1), 253-273, http://doi: 10.1177/08927057211001910