

INFLUENCE OF BLADE DISTANCE ON ONION CUTTING MACHINES

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Abstract

The high demand for shallots is driving innovation in post-harvest technology to improve efficiency, iris quality, and reduce material loss. This study aims to explore the effect of variations in spacing between blade blades in shallot cutting machines on slice quality, production capacity, and onion breakage. Although various onion cutting machines have been developed, research that systematically addresses the impact of knife spacing on iris quality is still limited, especially in the context of households and MSMEs. Therefore, this study investigated the effect of blade spacing of 0.5 mm, 0.7 mm, and 0.9 mm on onion cutting machines. The results showed that the greater the distance between the blades, the higher the production capacity achieved, with an increase from 48 kg/h at a distance of 0.5 mm to 73 kg/h at a distance of 0.9 mm. Although the production capacity is increasing, the quality of the slices remains consistent with a thickness of 0.8-1.1 mm. This research makes a new contribution by identifying optimal blade spacing to improve the efficiency and quality of the slice in the context of an economical onion cutting machine, especially for the household and MSME scale

Abstract

Keywords: mesin pemotong, jarak pisau, kapasitas produksi.

Permintaan bawang merah yang tinggi mendorong inovasi dalam teknologi pascapanen untuk meningkatkan efisiensi, kualitas iris, serta mengurangi kehilangan material. Penelitian ini bertujuan untuk mengeksplorasi pengaruh variasi jarak antar bilah pisau pada mesin pemotong bawang merah terhadap kualitas iris, kapasitas produksi, dan kerusakan bawang. Meskipun berbagai mesin pemotong bawang telah dikembangkan, penelitian yang secara sistematis membahas dampak jarak pisau terhadap kualitas iris masih terbatas, khususnya dalam konteks rumah tangga dan UMKM. Oleh karena itu, penelitian ini menyelidiki pengaruh jarak pisau 0,5 mm, 0,7 mm, dan 0,9 mm pada mesin pemotong bawang. Hasil penelitian menunjukkan bahwa semakin besar jarak antar pisau, semakin tinggi kapasitas produksi yang dicapai, dengan peningkatan dari 48 kg/jam pada jarak 0,5 mm menjadi 73 kg/jam pada jarak 0,9 mm. Meskipun kapasitas produksi meningkat, kualitas irisan tetap konsisten dengan ketebalan 0,8-1,1 mm. Penelitian ini memberikan kontribusi baru dengan mengidentifikasi jarak pisau yang optimal untuk meningkatkan efisiensi dan kualitas iris dalam konteks mesin pemotong bawang yang ekonomis, khususnya untuk skala rumah tangga dan UMKM.

INTRODUCTION

The high demand for shallots has driven the need for technological innovation in the post-harvest process to improve the efficiency, quality of the slices, and reduce material losses during further processing [1][2][3]. The quality of onion slices is a crucial factor because it affects the maturity, deliciousness, and yield of the final product [4][5]. Various onion cutting machine designs have been developed, from rotating disc blade systems to cylindrical blade configurations, with key factors such as blade sharpness, rotation speed, operational pressure, and blade pitch playing an important role in determining the thickness and uniformity of the iris [6][7][8]. However, studies on the effect of knife blade spacing on iris quality are still lacking, especially in the context of household applications and Small and Medium Industries SMEs, so a study that focuses on knife spacing variables as the main design parameter to improve iris quality, production capacity, and potential onion damage is needed [9][10]. This study aims to investigate the effect of variations in spacing between blades on shallot cutting machines on (i) iris quality which includes iris thickness and uniformity, (ii) production capacity, and (iii) the percentage of post-cutting onion damage [11][12]. In addition, this study seeks to identify the optimal knife distance for application at the household and MSME/IKM scales, so that a balance is obtained between the quality of the slice, production rate, and the impact on onion damage [13].

State Of The Art

A review of the literature shows that onion cutting machines generally use a rotating disc knife mechanism with multiple blades, where factors such as blade sharpness, rotation speed, operational pressure, and blade pitch affect the depth and thickness of the iris as well as the uniformity of the iris [14][15][16]. The blade pitch variation has been raised as a key parameter to control the iris thickness and cutting capacity of the machine [3]; Some previous studies have also emphasized the need

to evaluate the spacing between blades to improve the quality of iris in the context of other plant materials and provide a methodological basis for further studies [17][18]. In general, the design of the onion cutting machine shows that the combination of machine structure, knife material, and operational parameters contributes significantly to the quality of the slice as well as the production efficiency [19].

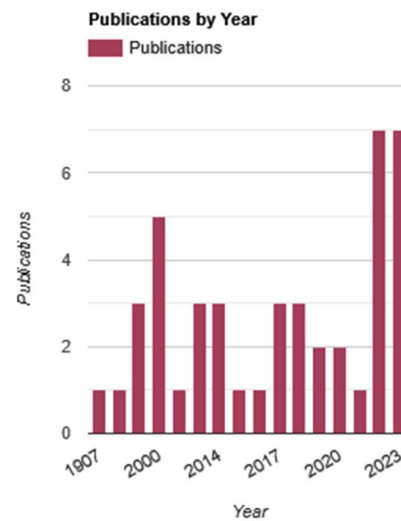


Figure 1 Year-to-Year Publications

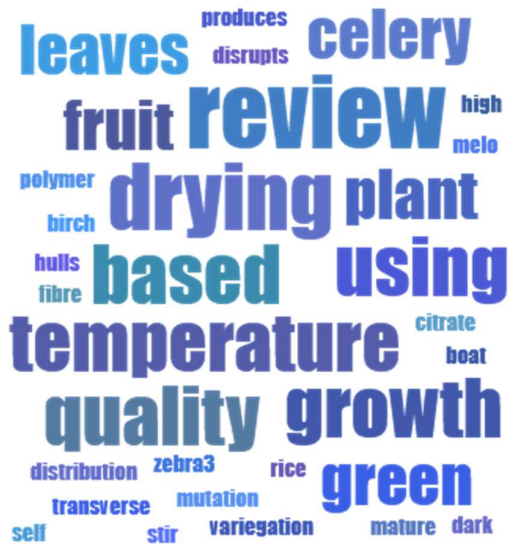


Figure 2: Keywords paradigm influence of blade distance on onion cutting machines

Research Gap

Although there are a number of studies on onion cutting, there is still limited research that systematically discusses the effect of variations in spacing between blades on slice quality, production capacity, and onion damage in a consistent series of experiments [20]. In addition, the literature lacks emphasis on the application of study results to the household and MSME/SME scales, where the need for practical operational parameters and economical design is often not the main focus of previous research [21].

Research Novelty

This study offers a new contribution through an experimental evaluation of the impact of blade spacing on three specific spacing variations namely 0.5 mm, 0.7 mm, and 0.9 mm on shallot cutting machines. Measurements were made against key indicators, namely iris thickness, iris uniformity, kg/h production capacity, and onion damage percentage. It is hoped that the results of this study will provide a practical understanding of the trade-offs between production capacity and iris quality and produce design recommendations that can be implemented on a household and MSME/SME

scale. More broadly, this study also closes the gap in the literature related to the relationship between knife distance and the quality of shallot slices in the context of economically and technically relevant cutting machine design.

RESEARCH METHODS

The research was conducted in a mechanical engineering laboratory with three variations in blade distance measured using a mm scale. The slicing machine used a three-blade vertical rotary knife, with 5 kg of shallots per sample, three times. Primary data were obtained directly from the research site [22]

Onion slicing machine

The image of the onion-slicing machine that will be made is shown in Figure 3.

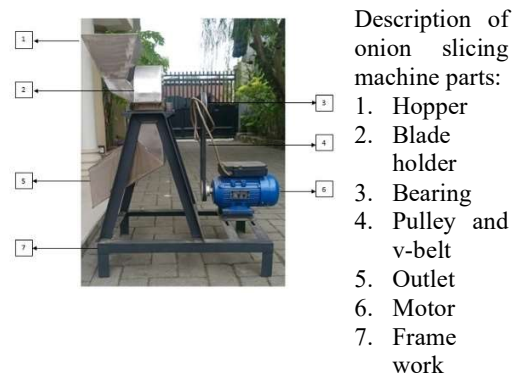


Figure 3: Onion Slicing Machine

Table 1. Dimensions and Specifications

Component	Technical Specifications
Tool Name	Onion Cutting Machine.
Function	Slicing/chopping agricultural materials such as shallots.
System Cutting	Horizontal rotating disc with three symmetrical straight blades.
Hopper	The top hopper is where the shallots are placed. It measures 18 cm long, 17.5 cm wide, and

	15.5 cm high, with a 130° tilt angle. It's made of stainless steel.
Eye Seat Knife	The blade holder serves as a mounting point for the rotating blade used to slice onions. The circular shape has a diameter of 30 cm, a 3 cm diameter hole, a thickness of 12 mm, and a length of 12 cm. The blade is made of stainless steel. The blade is made of a 0.3 mm-thick stainless steel plate, and is 13 cm long and 3.5 cm wide.
Number of Blades	3 pieces (stainless steel)
Distance Between Blades	7 cm
Bearing	Bearings keep the engine rotating on its axis. They are made of chromium steel.
Pulleys and V-Belts	The pulley and V-belt transmit the electric motor's rotation to the blades. They are made of rubber.
Outlet	The outlet is where the shallots exit after being sliced. It measures 32 cm long, 17.5 cm wide, and 27.5 cm high, with an angle of 105°. Made of stainless steel.
motor	An electric motor converts electrical energy into mechanical energy: power 1 hp, speed 1440 rpm.
Production Capacity	48–73 kg/hour

Tool Dimensions	Height ± 110 cm; width ± 50 cm; length ± 60 cm
Frame	The frame supports all the components of the slicing machine. Made of angle iron measuring 29.5 cm long, 40.5 cm wide, 63 cm high.

Testing procedures

1. Preparation of tools and materials to be used
2. Test 500 grams of onion slices for each speed variation.
3. Iris time measurement and capacity estimation (kg/hour)
4. Visual evaluation of slice quality (uniformity of size, degree of damage)

The test material used was 5 kg of shallots. Testing was conducted with three blade spacing variations: 0.5 cm, 0.7 cm, and 0.9 cm. The quality of the slices was assessed visually, with attention to the uniformity of the cut size. Productivity was calculated in kg/hour based on the time required to slice 1 kg of onions. All stages of the research are arranged systematically and structured to ensure the validity, reliability, and accuracy of the results.

The machine's working mechanism is as follows: an electric motor drives a pulley connected by a V-belt. When the motor is operating, the motor shaft rotation is transmitted to the main shaft, where the knife disc is mounted. As the disc rotates, the knife also rotates, thereby slicing the onions fed through the upper hopper. The sliced onions are then released through the outlet, which acts as the onion outlet.

ANALYSIS AND EVALUATION

Figure 2 shows the onion slicing machine blade used for testing. Figure (a) shows the physical shape of the cutting machine

blade, while Figure (b) shows the shallots that will be used in the test.



Figure 4: Test materials

In this study, to obtain data on the quality of sliced onions and the duration of the shallot cutting process, several test devices and materials were used. The device used was an onion-slicing machine, and the test materials consisted of 1.5 kg of shallots as the research sample. The slicing machine served as an aid in systematic data collection, analysis, and interpretation. The onion slicing procedure was

carried out in several stages, as described below:

1. Preparation of ingredients
 - a. 1.5 kg of shallots
 - b. Clean the outer skin of the onion.
2. Measuring the blade distance
3. Testing the onion slicing machine
4. Checking the quality of the onion pieces

Based on data from the shallot slicing process using a cutting machine, it can be concluded that this machine significantly speeds up and simplifies the slicing process. The quality of the cut results is greatly influenced by the machine's rotation speed and the blade's sharpness. Therefore, optimal cutting results depend heavily on the condition and sharpness of the slicing blade. [23]. The test results and onion cuts obtained with this machine are shown in Table 2.

Table 2. Test result data

Yes	Blade distance	Sample	Initial weight	Final weight	Time	Capacity
1	0.5mm	500 gr	500 gr	420 gr	76 sec	48 kg/hour
2	0.7 mm	500 gr	500 gr	420 gr	56 sec	65 kg/hour
3	0.9 mm	500 gr	500 gr	420 gr	50 sec	73 kg/hour



(a) (b) (c)
Figure 5: Sample testing results 1

It can be seen in Figure 3, namely the results of the sample 1 test, where a) is the distance of the blade, b) is the test material with an initial weight of 500 gr, and c) is the result of the slices from the onion cutting machine (420 gr). In Figure 3, the results for cuts with a capacity of 500 g of shallots required 76 seconds, resulting

in a capacity of 48 kg/hour with a maximum cutting quality of 85%.



(a) (b) (c)
Figure 6: Sample testing results 2

It can be seen in Figure 6, namely the results of the sample 2 test, where a) is the distance of the blade, b) is the test material with an initial weight of 502 gr, and c) is the result of the slices

from the onion cutting machine (420 gr). In Figure 4, the results for cuts with a capacity of 500 g of shallots took 56 seconds. The test on the 2nd sample was faster than the previous test, yielding a capacity of 65 kg/hour with a maximum cutting quality of 85%.



(a) (b) (c)

Figure 7: Sample testing results 3

It can be seen in Figure 7, namely the results of the sample 3 test, where a) is the distance of the blade, b) is the test material with an initial weight of 504 grams, and c) is the result of the slices from the onion cutting machine (420 grams). In Figure 5, the results for cuts with a 500-gram shallot capacity require 50 seconds. The test on the 3rd sample is the fastest of the previous tests, achieving a capacity of 73 kg/hour with a maximum cutting quality of 85%.

Figure 7 shows a graph of the relationship between slicing capacity and blade pitch. The graph shows that slicing capacity increases with blade pitch, from 48 kg/h at 0.5 mm to 65 kg/h at 0.7 mm, and then to 73 kg/h at 0.9 mm.

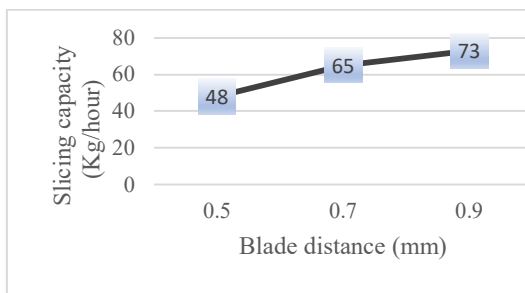


Figure 8: Graph of the relationship between slicing capacity and blade distance

The graphic shown in Figure 8 illustrates that different blade spacings greatly affect cutting capacity and quality. A blade pitch of 0.5 mm can produce a cutting capacity of 48 kg/hour of onions, and a blade pitch of 0.7 mm increases the cutting capacity to 65 kg/hour. A blade pitch of 0.9 mm produces a cutting capacity of 73 kg/hour. From the overall test results, it was concluded that the greater the distance between the blades, the greater the impact on slicing capacity and slice uniformity. The slices produced by each blade were relatively uniform, with a thickness of 0.8-1.1 mm.

CONCLUSION

Based on the results of research on the effect of blade distance on onion cutting machines, the following conclusions can be drawn:

- The larger the blade pitch, the higher the machine's production capacity. At a pitch of 0.5 mm, the production capacity is only ± 48 kg/hour, increasing to ± 65 kg/hour at 0.7 mm, and reaching a maximum of ± 73 kg/hour at 0.9 mm.
- The quality of the sliced results was relatively uniform across the various blade spacings. The thickness of the onion slices ranged from 0.8 mm to 1.1 mm, indicating that the results were quite consistent despite the different blade spacings.
- Cutting efficiency increases with increasing blade pitch. The time required to slice an onion sample decreases with a wider blade pitch, thus supporting increased productivity without significantly reducing cut quality. Overall, this study shows that a wider blade spacing (0.9 mm) provides optimal performance in terms of capacity and efficiency, while maintaining acceptable slice quality. These findings can serve as a reference in the design and development of

onion cutting machines for both household and small and medium-sized industries (IKM).

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