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DEVELOPMENT OF A MANUALLY-OPERATED MECHANICAL VEGETABLE CHOPPER

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ABSTRACT

This paper presents the development of a manually-operated mechanical vegetable chopper. The fabricated device consists of a pusher assembly, blade assembly and base assembly. The device was designed to address the challenges of time consumption, hygienic problem and contamination, and injuries associated with the manual process of chopping vegetables using knife. Comparative study on the performance of the mechanical vegetable chopper and manual operation showed considerable differences in cutting time and the quality of the output. Hence, the proposed device helps in saving time and effort in chopping vegetables, ensures safety to the users, and is environment-friendly due to absence of electricity and of noise to the operating environment.

Keywords: vegetables, blade assembly, vegetable chopper, manually-operated.

INTRODUCTION

Since time immemorial, knife and cutting board have been used in slicing and cutting vegetable items such as cucumber, tomato, carrot, onions, and others. However, slicing vegetables with a knife requires a great deal of skill and practice. Otherwise, the sliced vegetables may be uneven and aesthetically unpleasing and also result to uneven cooking. Manually slicing vegetables with a knife is very time consuming. Moreover, slicing with knife is known to be hazardous, increasing the number of people who gets hurt while using knives in slicing their vegetables (Cliver *et al,* 1994). Due to these concerns, technology has been devised to address such problems towards easing the working operation of chopping vegetables. Researchers have tried to find new and more efficient ways of achieving similar goal while saving time and preventing associated hazards caused by knife usage. Diverse works have been carried out relevant to slicing and cutting devices for vegetables. Some proponents have designed and developed slicing and cutting devices for vegetables utilizing an electric motor such as those of Agbonkhese, K.A. *et al* (2020), Aji, I.S. *et al* (2018), Alias, T. *et al* (2019), Ezeanya, N.C. *et al* (2020), Julius, E.U. and Kingsley, O. (2020), Pawar, K.R. *et al* (2020), among others. On the other hand, manually operated vegetables slicing/ cutting/ chopping devices have also been developed by Kamaldeen O.S. and Awagu, E.F. (2013), Ikpoza, E. *et al* (2021), Hoque, M.A. and Saha, K.K. (2017), Manjunath, S. and Radha, K.K. (2017). Most of the existing manual vegetable choppers and slicers cannot perform multiple operations. They are designed only for one specific use, like for example; tomato slicer is intended only for tomato. Moreover, such choppers have only one blade design; hence, one cannot chop in varying or desired thickness. Besides, the blade assembly is mounted fixed as well as the pusher so it is difficult to clean.

To address these disadvantages, an innovative operated mechanical vegetable chopper was designed and developed that can perform multiple operations by designing removable two set of blades assembly for the desired thickness and removable pusher assembly for easy cleaning process. With this innovative device, it is expected to make chopping operation in preparing food safe, comfortable and less time consuming for households and for mass production in restaurants and fast food chains. It must be emphasized that it is operated manually which takes care of power failure problems, and can be used in rural areas where there is limited or no supply of electricity.

MATERIALS AND METHODS

Designing the Device

Figure-1 shows the perspective view of the mechanical vegetable chopper which consists of base assembly, pusher assembly and blade assembly. All parts of the chopper are made of local and secondary food grade materials specifically stainless steel. Figure-2(a) shows the perspective view of the pusher assembly which can be removed in the base assembly for easy cleaning, Figure-2(b) shows the perspective of the blade assembly that is also removable and the base assembly which has T-slots for the guide of the pusher assembly and blade assembly support where the blade assembly is inserted, is shown in Figure-2(c).

Figure-3(a) shows the exploded view of the device. In one swift motion, the whole vegetable can be totally cut by pressing the pusher forward on vegetable resting on the blades. It is designed with removable blades assembly for desirable thickness of vegetable to be cut and a removable pusher assembly for easy and fast cleaning process. Food grade materials, specifically Type 304 stainless steel, was used for food safety due to its high versatility and high resistance to corrosion thus preventing food contamination. As shown in Figure-3(b), the chopper has a total length of 222 mm and a total width of 94 mm. It is also designed for the safety of the user with the blade

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assembly inclined at 65 degrees. A blade guard is also provided toavoid exposure and hand contact. The frame was also overlapped with 5 mm to prevent hand contact of the blade during removal and installation of blades. The bottom of the base was installed with rubber to prevent slippage and drifting, hence, providing high stability during chopping of the vegetables. The availability of the materials and its cost effectiveness were also considered in designing this device by using materials that are highly available in the local market.

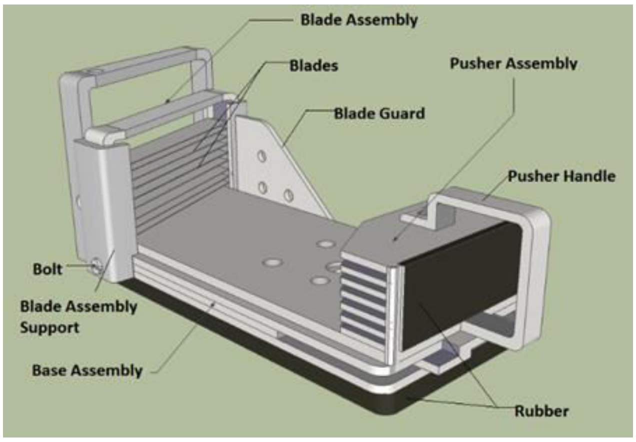

Figure-1. Perspective view of the innovative mechanical vegetable chopper.

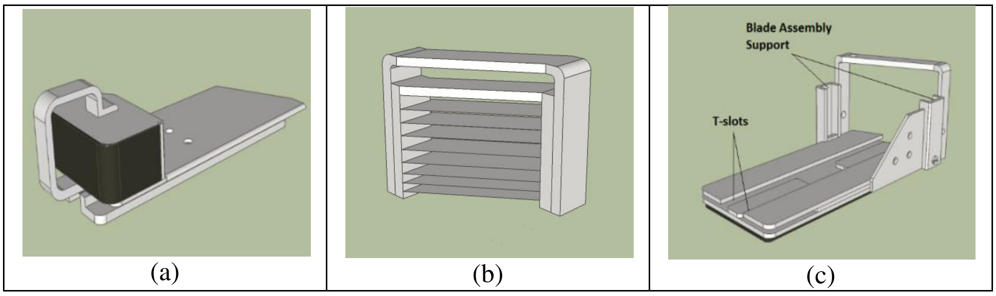

Figure-2. Perspective views of (a) Pusher assembly; (b) Blade assembly; and, (c) Base assembly.

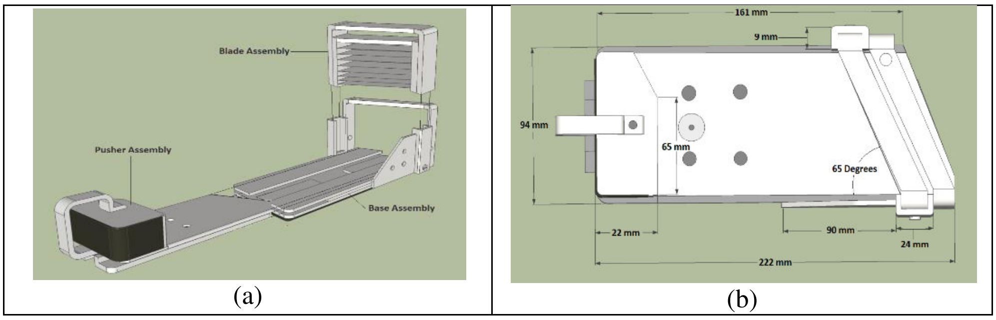

Figure-3. (a) Exploded view of the device; (b) Top view of the device and its dimensions.

Figure-4(a) presents the left side view of the device where the division of plates that push the vegetable towards the blade assembly is shown. The blade assembly support is bolted in the base as shown in Figure-4(b). Figure-4(c) shows the front view of the device with a total height of 127 mm. As shown in Figure-5, the blade clearance to the pusher is 1.0 mm with blade thickness of 0.3 mm. The thickness of each plate of the pusher is 1.898 mm.

Figure-6 shows the blade assembly of the mechanical vegetable chopper that can cut a maximum diameter of 60 mm. The mechanical vegetable chopper is designed with removable blades. There are two sets of blade assembly that can be used for different applications and desired thickness. Figure-6(a) shows the blade assembly 1 which has a blade to blade distance of 6.0 mm and composed of 8 blades. This is normally used for slicing cucumber, cabbage, lettuce and other vegetables and fruits. In Figure-6(b), the blade assembly 2 is shown. This has a blade-to-blade distance of 3.0 and composed of 12 blades and is normally used for chopping onion, garlic and other vegetables that needs to be cut in thin stripes. The blade assembly has a width of 105 mm and a height of 78 mm. As shown in Figure-6(c), the blade frame was inclined by 65 degrees.

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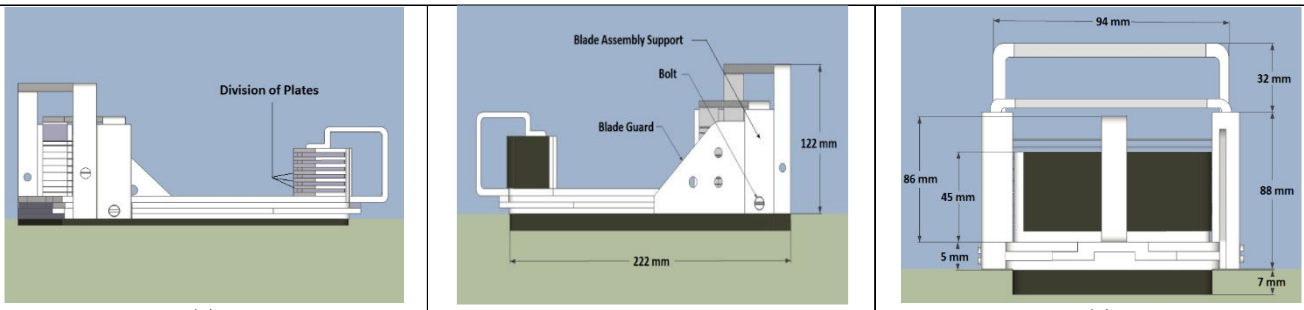


(a) (b) (c)

Figure-4. (a) Left side view, (b) Right side view, and; (c) Front view of the device.

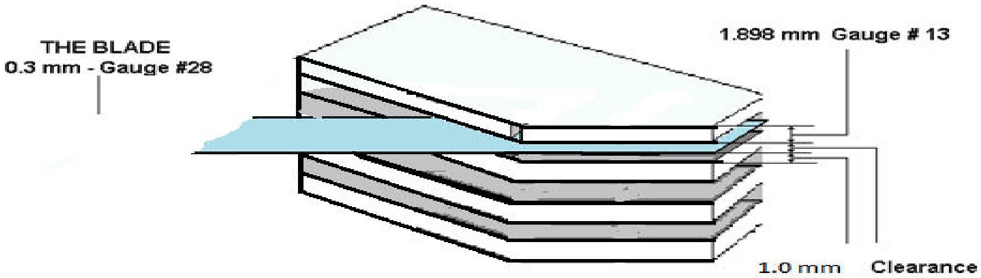
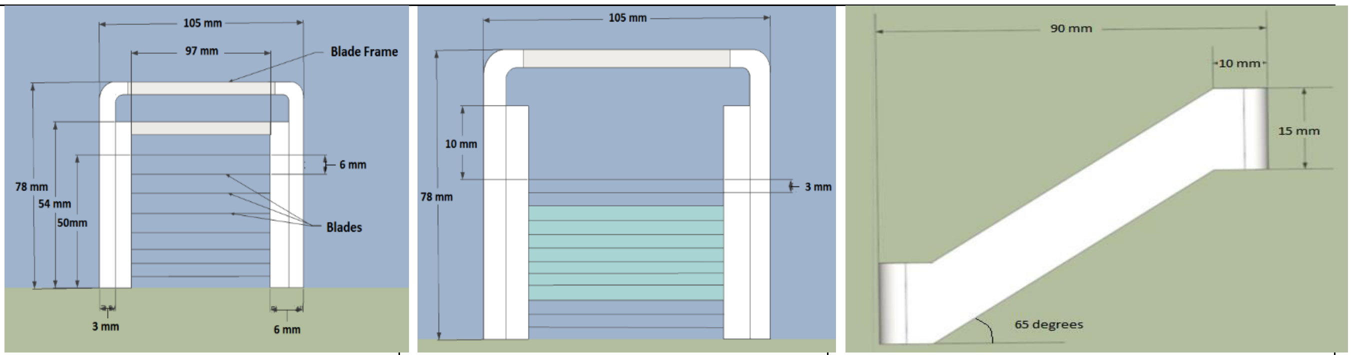


Figure-5. Blade clearance with respect to the pusher.



(a) (b) (c)

Figure-6. (a) Blade assembly 1, (b) Blade assembly 2, (c) Top view of the blade assembly.

Prototype Development

Based on the design of the vegetable chopper, it was then fabricated in a machine shop laboratory. Cutting, grinding, filing and welding of the metal parts were performed. Jigs and fixtures were used in cutting the set of blades in uniform measurement. Necessary tools and equipment used in the fabrication of the device were also available in the laboratory. After assembling the device, it was then tested and fine-tuned to ensure that the chopper must work as expected during the actual chopping of vegetables.

Evaluation of Performance of the Device

The performance of the device was evaluated by conducting comparative experiments in chopping of vegetables manually and by using the fabricated device. Time differences and the quality of its output or the quality of chopped vegetable were then evaluated and compared. The time percentage difference was calculated by subtracting the time consumed of manual cutting with that of the device .The difference was then divided by the time (manual) and multiplied by 100 %, or:

Time percentage difference = Time (Manual) - Time (Device) / Time (Manual) x 100 %

RESULTS AND DISCUSSIONS

Development of the Innovative Mechanical Vegetable Chopper

Figure-7 shows the actual photos of the innovative mechanical vegetable chopper assemblies and some of its parts. In Figure-8, some of the actual photos on the utilization of the device are shown.

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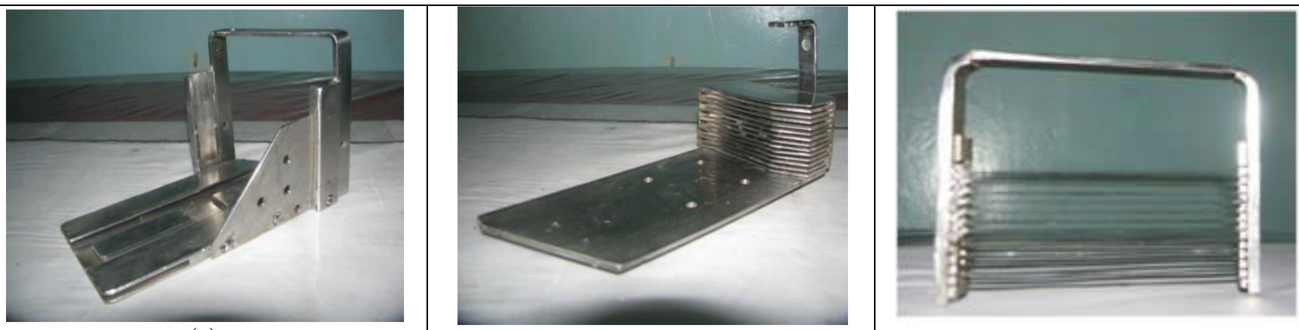
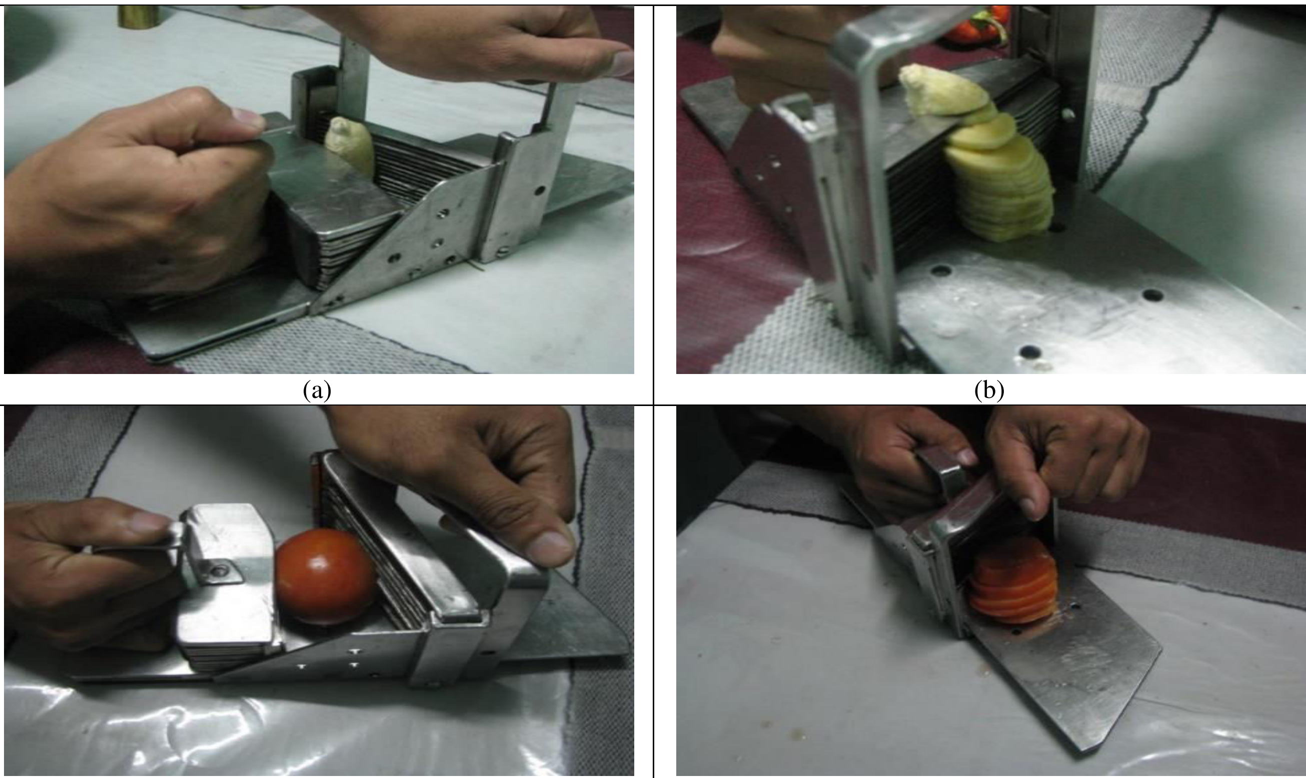


(a) (b) (c)

Figure-7. (a) The base assembly which has t-lots for the alignment of the pusher, (b)The pusher assembly, (c) And the blade assembly.



(a) (b) (c) (d)

Figure-8. Actual photos of the mechanical vegetable chopper during slicing of vegetables, (a) The banana before chopping, (b) The banana after chopping, (c) The tomato before chopping, (d) and after chopping.

Evaluation of Performance of the Device

The performance of the device was evaluated by conducting comparative experiments in chopping of vegetable using the manual method (knife) and the fabricated device. The time consumed between the manual method and that of the device was determined and the time percentage difference was then calculated. Table-1 shows the time consumed in chopping various vegetables by manual and by using the device at several trials. The time percentage differences for cutting the various vegetables are also shown. The quality of the chopped vegetables (Non-uniform/ uniform) is also presented. The comparative study shows the huge time differences between manual operation and using the device. Also, the quality of the chopped vegetables using the device is in uniform thickness as compared to those produced by the manual operation.

CONCLUSIONS

The design and fabrication of the innovative vegetable chopper was successfully carried out. Results of the comparative experiments showed huge time differences between the manual operation (knife) and using the device. Also, it was observed that the chopped vegetables using the device are in uniform thickness, hence present better quality. This mechanical device is very useful to the households for fast, easy and safe operations in chopping vegetables for household as well as for food chains and restaurants for mass production.

Table-1. Comparative study of time differences and quality of sliced vegetables between manual operation and using the cutting device.

Type of vegetable	Trial no.	Time consumed in Seconds (s)		Time percentage difference (%) (Average)	Quality of chopped vegetables	
		Manual	Device		Manual	Device
Tomato	1st	2.84 s	1.86 s	45%	Non-uniform	Uniform
	2nd	3.04 s	1.92 s			
	3rd	2.66 s	1.00 s			
Cucumber (4'' height)	1st	5 s	1.78 s	67%	Non-uniform	Uniform
	2nd	5.45 s	1.54 s			
	3rd	5.20 s	1.88 s			
Eggplant (4'' height)	1st	4.63 s	1.25 s	74%	Non-uniform	Uniform
	2nd	5.10 s	1.15 s			
	3rd	4.89 s	1.33 s			
0nion	1st	6.58 s	1.28 s	77%	Non-uniform	Uniform
	2nd	5.67 s	1.45 s			
	3rd	5.51 s	1.34 s			
Banana	1st	3.74 s	1.00s	71%	Non-uniform	Uniform
	2nd	3.52 s	1.09 s			
	3rd	3.96 s	1.14 s			
Ginger	1st	3.31 s	1.00 s	57%	Non-uniform	Uniform
	2nd	3.19 s	1.13 s			
	3rd	2.83 s	1.06 s			
Ube	1st	8.61 s	4.68 s	46%	Non-uniform	Uniform
	2nd	8.45 s	4.54 s			
	3rd	8.28 s	4.38 s			

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