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Fish Slicer

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Abstract: Fish cutting machine is used to slice fish into smaller pieces, and the machine varies from a single blade machine to multiple blades machine. The fish slicing machine that is available in the market is heavy and has a low level of portability, therefore it is mainly used in a big scale fish supply industry. The Fish Slicer is designed to be light in weight and has a small portable body frame compared to other machines available in the market. The machine is built-in with a single motor that runs the fish slot that holds the fish before entering the multiple cutting blades that slice the fish into a similar size length. A test is performed, with average rotations per minute for fish cutter and fish slots are 3168 and 154 respectively. As a result, Fish Slicer fish slicing productivity is greater than traditional cutting methods. In short, the Fish Slicer is a portable machine and time saving that benefits the fish market retailer and seafood restaurants by increasing fish slicing productivity.

Keywords: Fish Cutting Machine, Fish Slicer, Fish Cutter, Portable Machine

1. Introduction

Fish cutting machine is a machine that processes fish by slicing it into smaller pieces. The machine is operated by a cutter or blades that will cut through the fish body according to the size that has been specified [1]. This machine focuses to increase productivity rate and minimizing work to slice fish, compared to the traditional method of cutting fishes using knives [2]. In general, the variation of fish cutting machines in the market use single blade cutting machine and multiple blades cutting machine. Single blade cutting machine as in **Figure 1** needs an individual to handle and specify the size of fish slices, whereas multiple blades cutting machine as in **Figure 2** operates by inserting fish into fish slots before the multiple blades sliced the fish into similar size.

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Figure 1: Single Blade Cutting Machine

Figure 2: Multiple Blades Cutting Machine

In general, traditional fish cutting using knives took 45 to 50 seconds for one fish to be processed. The situation will cost a loss in time and profits for the fish retailers. Also, traditional fish cutting using knives has no specified sizes of cuts, as the individual that cuts the fish decides the sizes of the slices. Therefore, the sizes of cuts are different. In order to solve the problems, the objectives of the project are to design the component of a portable fish slicer machine equipped with multiple cutting blades and fish slots. As for the type of cut, the project is specified for Darne and Troncon cut. Darne cut as in **Figure 3** is a type of cut for round-shaped fish, whilst Troncon cut, in **Figure 4** is a type of cut for flat-shaped fish [3]. Next, to build a different speed of shafts that uses a single motor. The benefit of the project is to be able to increase fish slicing rate, produce fish slices of similar size and is portable enough to be carried by consumers.

Figure 3: Darne Cut [3]

Figure 4: Troncon Cut [3]

2. Methodology

2.1 Project Background

The fish slicer machine is a project where one of the main components is designed and built to solve the problems of users of small-scaled fish cutting users such as fish market retailers or in a seafood restaurant. Fishes with a length of 25 cm excluding the head with a width of 6 cm in dimension are able to cut using this machine, producing the type of cuts of Darne and Troncon (Steak-shaped cut). This machine is suitable to be used in small-scale production because it comes in lighter weight and smaller size. Moreover, this machine is designed in a simple way where only one motor is being used to rotate two different speeds of a shaft in an opposite rotation.

A European company introduced a fish cutting machine, in **Figure 5**, weighted 260 kg to cut fish in slice cut, strip cut and cube [4]. The groove knife in this machine is adjustable. Next, a company from China built a fish cutting machine as in **Figure 6**, weighted 200 kg with multiple blades to cut the fish into steak-shaped cut [5]. There is a build-in fish tray to adjust the cut. Meanwhile in Russia, a 600 kg machine as in **Figure 7**, with multiple blades to produce steak cut equipped with a rotating fish tray is designed [6]. All three designs shared the same concept of fish cutting, where it is semi-automatic; human is still needed to place the fish into the slot. Moreover, the machine concept of multiply blades are being used to cut the fish is being used to innovate and design the fish slicer in this project. However, these three designs are only suitable for large-scaled fish cutting industry such as frozen fish manufacturers as they need higher power input to run, designed in huge size and very heavy in weight. The came up solutions to these problems are to build a lower input power fish cutting machine by designing a simpler system, with a smaller dimension. Lastly, to build a more practical and lighter in weight machine.

Figure 5: European Fish Cutting Machine [4]

Figure 6: China Fish Cutting Machine [5]

Figure 7: Russian Fish Cutting Machine [6]

2.2 The Design of Fish Slicer

The components of the fish slicer are divided into two; gear and pulley systems and cutter component. The frame of the machine is formed by using steel bars. After the measurement process, a required lengths of steel bars are obtained by using the chop saw machine and angle grinder. Next, the steel bars are welded using the concept of the shape of triangle. Welding is a good choice for permanent joint since it is lower in cost yet produces strong joint. By using this concept, a sturdier machine is obtained because it has stronger base to provide immense support. After the welding process, a drill is used to make few holes to place the bearing and shaft. The bearing will be mounted on the frame by using the adjustable spanner. Bearing is used in this project to hold and provide support for the shaft without producing too much friction. Then, the edges will be smoothened by using angle grinders and sandpaper. Lastly, the frame will be coated with paint to prevent it from rusting.

The shaft of the motor is connected to shaft A, with a mounted chain drive sprocket on it, via a timing chain located at the lower part of the machine. The same shaft is mounted with a 70T timing pulley and a 15T timing pulley. All the pulleys are tightened onto the shafts by using hex key. By using a timing belt, the 70T timing pulley will connect to shaft B located at the upper back part of the machine with a 15T timing pulley mounted on it, together with a 35T spur gear. Next, the 35T spur gear will be meshed to a smaller 20T spur gear, to rotate shaft C. The spur gears are tightened onto the shaft by using hex key. The reason for a larger driver to a smaller driven being used is to increase the rotational speed significantly so that the blades will rotate faster to cut the fish. The spur gears are also being used to change the direction of rotation of shaft C, therefore changing the direction of rotation of the blades. Few mounting boards are shaped into blade-shaped as mock-ups to replace the actual blades. To mark the length between each blade, centimetre ruler is used. The length between each blade is 2.5 cm (approximately 1 inch) to obtain the average measurement for Darne and Troncon cut.

Another 15T timing pulley will be connected to 70T timing pulley via a timing belt to rotate the upper front shaft D. To decrease the speed of rotation, the smaller driver to larger driven is used. Shaft D is being used to attach fish slots so it needs to rotate much slower than shaft C to achieve the desired speed ratio. Polystyrenes are used as mock-ups to replace the actual fish slots. To measure the width and depth of the fish slots, thread, and centimeter ruler are used and to design V-shaped slots. The V-shaped fish slots will secure the fish in place while the fish cutting process take place.

Figure 8 shows the finalized drawing design of the Fish Slicer before the machine is built. The dimension of the machine is 0.47 m (H) x 0.30 m (W) x 0.43 m (D). This machine is built in a simpler way as possible to lower the cost. The machine is only powered with a direct current (DC) motor with 350-Watt power as the main motor. With only one motor, the shafts are rotated in different speeds and rotations. The motor is mounted on the steel bar at the bottom of the machine.

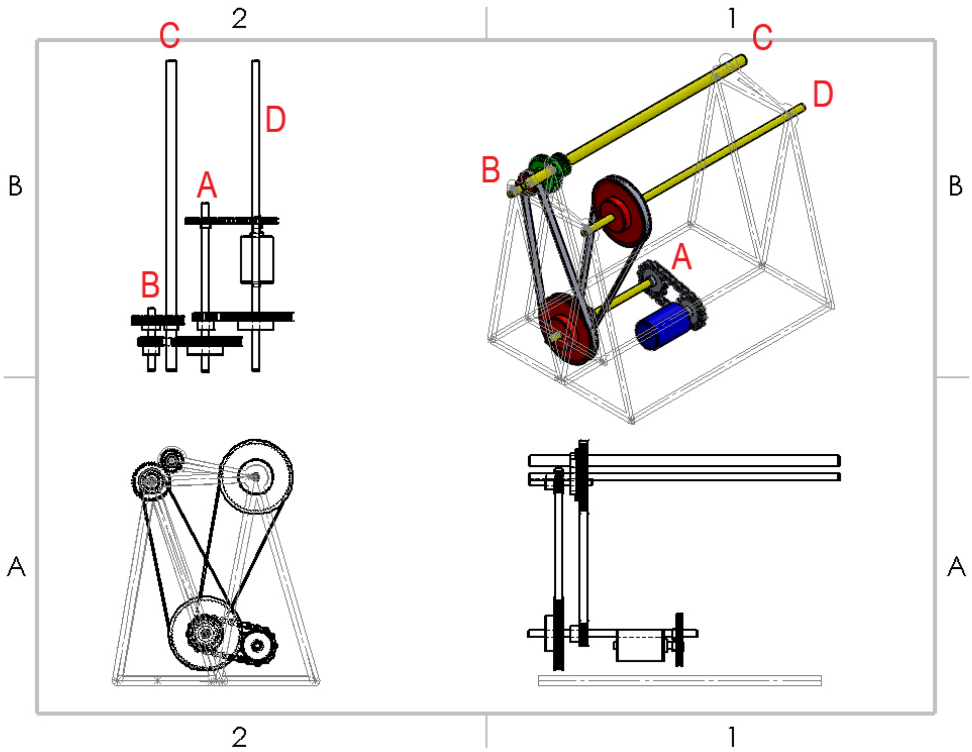

Figure 8: Drawing of Fish Slicer Design

2.3 The Process of Fish Cutting

When the switch is turned on, it will provide current to the motor. As the shaft of the motor rotates, the timing chain will rotate shaft A. Shaft A is connected to shaft B and shaft B is connected to shaft C. Therefore, shaft C will rotate together with the blades to cut the fish. Shaft A is also connected to shaft D, eventually rotating the fish slots. When the fish slots start to rotate, each fish is placed into the slot. The blades and the fish slots will rotate into the centre of the machine in different speeds, cutting the fish into slices. Thus, the slices of fish will fall under between the blades and fish slots, and they are ready to be collected. After the machine is used, turn off the switch to stop the motor.

2.4 Equations

Equation 1 is used to determine the speed ratio of gears and pulley system:

$$Speed\ Ratio = \frac{Driven\ Gear\ or\ Pulley}{Driver\ Gear\ or\ Pulley} \qquad \textbf{Eq. 1}$$

Equation 2 is used to calculate the speed ratio of fish slots and cutter:

$$Speed\ Ratio = \frac{Rotations\ of\ Fish\ Slots\ per\ Minute}{Rotations\ of\ Cutter\ per\ Minute} \qquad \textbf{Eq. 2}$$

3. Results and Discussion

The final product of the project is shown in **Figure 9**. The data was taken by using two methods; number of rotations without turning on the motor, and number of rotations with the motor turned on. For the manual rotation, the culet taped is used to mark the starting point of the rotation. The fish slot is being rotated using hand for one full rotation. At the same time, the rotations of cutters are being recorded. The readings are taken three times before calculating the average number of rotations. This method is being used to collect the rotation ratio of fish cutter and fish slots. As for the data with the motor turned on, a digital tachometer is used to obtain the rotations of the cutter and fish slots in one minute. **Table 1** shows the rotation ratio of cutter and fish slots by rotating the system manually by hand.

Table 1: Data for Manual Rotations

Number of Trial	Fish Slot Rotation	Cutter Rotation	Rotation Ratio of Cutter and Fish Slot
First	1	38	
Second	1	38	38:1
Third	1	38	

3.1 Data of Fish Cutter Rotations

According to **Table 2**, the number of fish rotations in 10 seconds were 500 rotations, 468 rotations and 616 rotations, respectively. Each of the trial data are multiplied by 6 to obtain rotation in one minute. On the first trial, the rotations counted per minute were 3000 rotations per minute, whereas the second trial was counted at 2808 rotations per minute and the last 3696 rotations per minute for the third trial. The number of rotations calculated per minute of each trial was summed and divided by 3 to obtain the average rotation per minute of the fish cutter. The average rotation per minute for the fish cutter obtained was 3168 rotations per minute.

Table 2: Data of Fish Cutter Rotations

Trial	Rotation in 10 Second	Rotation per Minute (rpm)	Average Rotation per Minute (rpm)
First	500	3000	
Second	468	2808	3168
Third	616	3696	

3.2 Data of Fish Slot Rotations

Bases on **Table 3**, the total rotations of the fish in 10 seconds were 27 rotations, 24 rotations, and 26 rotations, respectively. Tachometer is used to obtain the number of rotations in 10 seconds. Each of trial data is then multiplied by 6 to obtain rotation in one minute. On the first trial, the calculated speed were 162 rotations per minute, 144 rotations per minute on the second trial and 156 rotations per minute on the third trial. The number of spins counted per minute is summed and divided by 3 according to the number of attempts. As a result, the average rotation per minute for a fish slot is 82 rotations per minute.

Table 3: Data of Fish Slots Rotations

Number of Trial	Rotation in 10 Second	Rotation per Minute (rpm)	Average Rotation per Minute (rpm)
First	14	84	
Second	13	78	82
Third	14	84	

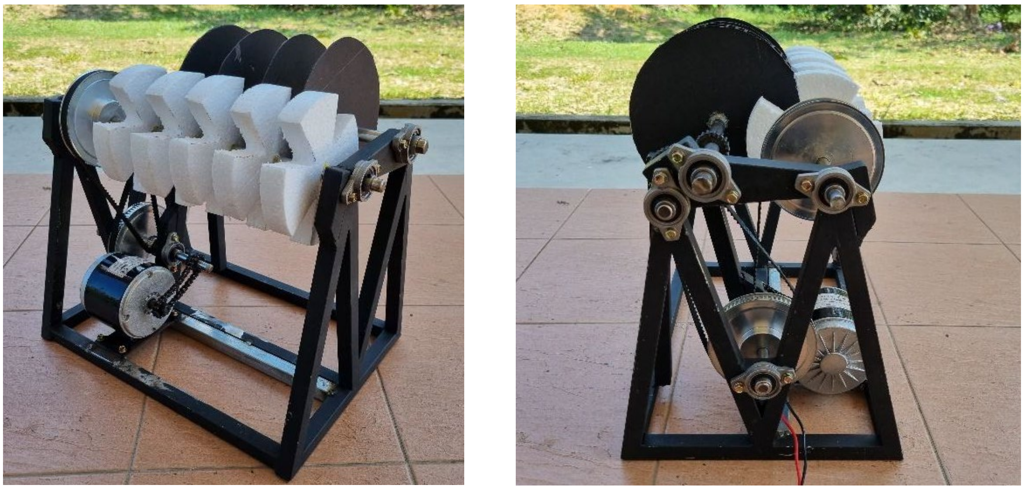

Figure 9: Photo of Final Product

3.3 Discussions

The rotation ratio of the cutter and fish slots is 38:1, obtained by the first method. This means that one complete rotation of fish slots is equal to 38 complete rotations of the cutter. For the second method, after the average rotation per minute of the fish cutter and fish slots have been obtained, the ratio is calculated. The average rotation per minute of the fish cutter is divided by the average rotation per minute of the fish slot to get the ratio of 38:1.

To calculate the speed of both the fish cutter and fish slots, the ratio of 38:1 can be used as a guideline. Assume the speed of the fish slot is 30rpm, the speed for the fish cutter will be 1140 rpm. This can be obtained by multiplying the speed in rev/min of the fish slot by 38. The process may be reversed to calculate the speed of the fish slot if the fish cutting speed is stated [7].

4. Conclusion and Recommendations

The fish slicer machine comes with improvements in terms of size and portability compared to the existing fish cutting machine in the global market. Fishes can be sliced into similar size pieces with the multiple cutter design. The fish slot acts as the fish holder as the fish slicing process proceed. The fish slicer machine is convenient for user as it increases fish processing production rate in a compact and portable design.

As for recommendations, better gear and pulley systems can be equipped on the machine for better performance. By improving the gear and pulley systems, friction problems may be reduced, resulting in lower noise being produced by the machine. Secondly, further project designer might want to consider setting an optimum speed for the machine to improve the productivity rate. Lastly, future project designer should consider building a body housing for safety purposes and to complete the machine development.

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