

Vegetable Slicing Machine

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Abstract — In food processing industries and small-scale kitchens, vegetable cutting is generally performed manually. This method requires more time, labor effort, and may lead to non-uniform slicing. To overcome these limitations, a vegetable slicing machine was designed and developed. The aim of the project is to reduce manual effort and increase productivity in vegetable cutting operations. The machine consists of a 0.5 HP electric motor operating at 1300 rpm, a shaft supported by bearings, a slicing blade mechanism, belt and pulley transmission, and a stainless-steel body. The motor power is transmitted to the shaft through a belt and pulley arrangement to obtain the required speed for slicing. The rotating blade cuts vegetables into uniform slices with higher efficiency. The shaft was designed considering bending and torsional loads. Calculations showed that a theoretical shaft diameter of 10 mm was sufficient, but for safer operation a diameter of 20 mm was selected. The developed machine improves cutting speed, provides uniform slices, reduces manual effort, and increases productivity in food preparation processes.

Keywords: Vegetable Slicing Machine, Food Processing, Shaft Design, Productivity, Automation

I. INTRODUCTION

In modern food processing and kitchen environments, efficiency and productivity are very important. Vegetables are widely used in households, restaurants, hotels, and food processing industries. A large amount of time and effort is required to cut vegetables manually using traditional tools such as knives. Manual cutting not only requires skilled labor but also results in uneven slicing and slower production rates. In small-scale food processing units and commercial kitchens, large quantities of vegetables need to be sliced quickly and uniformly. Manual cutting becomes inefficient and tiring for workers when dealing with large volumes. It may also lead to safety issues such as accidental injuries and inconsistent slice thickness.

To overcome these problems, mechanical vegetable slicing machines are used. These machines use rotating blades driven by an electric motor to cut vegetables into uniform slices. Such machines reduce human effort, increase production speed, and improve the consistency of the sliced vegetables.

The present project focuses on the design and development of a vegetable slicing machine that is simple, economical, and suitable for small-scale applications. The machine uses a 0.5 HP electric motor, belt and pulley system, shaft, bearings, and slicing blades. The rotating blade mechanism slices vegetables efficiently while maintaining uniform thickness. The use of stainless steel in the machine body ensures hygiene, corrosion resistance, and durability.

The main objective of this project is to reduce manual effort, improve slicing efficiency, and provide a cost-effective solution for vegetable cutting operations in small kitchens and food processing units.

II. PROBLEM STATEMENT

Vegetables are widely used in households, restaurants, hotels, and food processing industries. In many cases, vegetables are still cut manually using knives or traditional cutting tools. Although this method is simple, it requires significant time, physical effort, and skilled labor. Manual cutting becomes especially difficult when a large quantity of vegetables needs to be prepared within a short period of time. Workers may experience fatigue, which reduces productivity and efficiency in food preparation processes.

Another major limitation of manual cutting is the lack of uniformity in vegetable slices. When vegetables are cut by hand, the thickness and size of the slices often vary depending on the skill of the person performing the task. Non-uniform slices can affect the appearance, cooking time, and quality of the final food product. In commercial kitchens and small food processing units, maintaining uniformity in slicing is important for both presentation and cooking consistency.

Manual vegetable cutting also involves certain safety risks. Continuous use of sharp knives can lead to accidental injuries or cuts to the operator. In busy kitchen environments where workers need to prepare vegetables quickly, the chances of accidents increase. Therefore, improving safety while maintaining efficiency is an important consideration.

In small restaurants, canteens, catering services, and food processing units, large quantities of vegetables such as potatoes, onions, carrots, cucumbers, and other vegetables must be sliced regularly. Performing this task manually consumes valuable time and labor, which can increase operational costs and reduce overall productivity. As a result, there is a need for a mechanical solution that can simplify the slicing process.

To overcome these challenges, the development of a simple, efficient, and economical vegetable slicing machine is required. Such a machine should be capable of reducing manual effort, increasing slicing speed, and producing uniform slices of vegetables. It should also be safe to operate, easy to maintain, and suitable for small-scale food processing applications.

Therefore, the main objective of this project is to design and develop a vegetable slicing machine that improves efficiency, reduces labor effort, enhances safety, and provides consistent slicing quality for vegetables used in kitchens and food processing environments.

III. OBJECTIVES

- 1) To design and develop a vegetable slicing machine.
- 2) To reduce manual effort in vegetable cutting.
- 3) To achieve uniform slicing of vegetables.
- 4) To improve productivity in food preparation.
- 5) To design a safe and economical slicing mechanism.

IV. LITERATURE SURVEY

Several researchers have studied vegetable cutting machines and food processing equipment to improve efficiency, reduce manual labor, and increase productivity.

Singh and Sharma (2018) studied the design and development of a vegetable cutting machine for small-scale food industries. Their research highlighted that mechanical slicing machines can significantly reduce manual labor and improve production speed. They also emphasized the importance of proper blade design to achieve uniform slicing.

Patel et al. (2019) developed a motorized vegetable slicing machine that used a rotating blade mechanism. Their study showed that the machine reduced cutting time and improved the consistency of slices compared to manual cutting. They also concluded that simple mechanical designs are suitable for small food processing units.

Kumar and Gupta (2020) analyzed different types of food processing machines used for slicing and chopping vegetables. Their research showed that automation in vegetable cutting increases productivity and reduces worker fatigue. The study also highlighted the importance of hygienic materials such as stainless steel for food processing equipment.

Reddy and Rao (2021) focused on the design of shaft and power transmission systems in small food processing machines. They explained that proper shaft design and bearing support are necessary to ensure smooth and safe machine operation. Their work supports the importance of engineering calculations in machine design.

Deshmukh and Patil (2022) studied low-cost food processing machines designed for small businesses and rural industries. Their research concluded that compact vegetable cutting machines can help improve food preparation efficiency while reducing operational costs.

From the above literature survey, it is observed that vegetable slicing machines play an important role in improving productivity and reducing manual effort. Proper design of blades, shafts, and transmission mechanisms is essential to ensure efficient and safe operation. The present project focuses on developing a simple and economical vegetable slicing machine suitable for practical applications.

V. METHODOLOGY

The development of the vegetable slicing machine was carried out in several stages to ensure proper design and functionality.

1) Study of Existing Methods

Initially, the traditional manual method of cutting vegetables was studied. The limitations such as increased time consumption, uneven slices, and higher labor effort were identified.

2) Concept Development

Based on the identified problems, a machine concept was developed that uses a rotating blade powered by an electric motor. The vegetables are fed through a slot and sliced by the rotating blade.

3) Selection of Components

The main components required for the machine were selected:

- Electric motor (0.5 HP, 1300 rpm)
- Shaft and bearings
- Slicing blade
- Belt and pulley system
- Stainless steel body frame

4) Design Calculations

The shaft was designed considering combined bending and torsional loads produced by the rotating blade and transmitted power. Calculations were performed to determine the safe shaft diameter.

5) CAD Modeling

The machine components such as blade plate, shaft, body frame, and supporting structures were designed using CAD software.

6) Fabrication

The components were manufactured using common workshop processes and assembled to form the final machine.

7) Testing

The assembled machine was tested by slicing vegetables and observing its performance, slicing quality, and operational stability.

VI. MANUFACTURING PROCESSES USED

The fabrication of the vegetable slicing machine involved the following manufacturing processes:

1) Cutting

Metal sheets and rods were cut to the required dimensions using cutting machines.

2) Drilling

Holes were drilled in the plates and brackets for mounting bolts, shaft, and bearings.

3) Turning

The shaft was machined on a lathe machine to obtain the required diameter and surface finish.

4) Welding

Different steel parts of the frame were joined using welding to form the machine structure.

5) Grinding and Finishing

Grinding operations were performed to remove sharp edges and provide smooth finishing.

6) Assembly

All the components such as motor, pulley, shaft, bearings, and blade were assembled properly to ensure smooth operation.

VII. DESIGN AND FABRICATION

A. Design of Vegetable Slicing Machine:

The vegetable slicing machine was designed to reduce manual effort and improve the efficiency of vegetable cutting operations. The design focuses on simplicity, reliability, and economical manufacturing so that the machine can be easily used in homes, restaurants, and small food processing units.

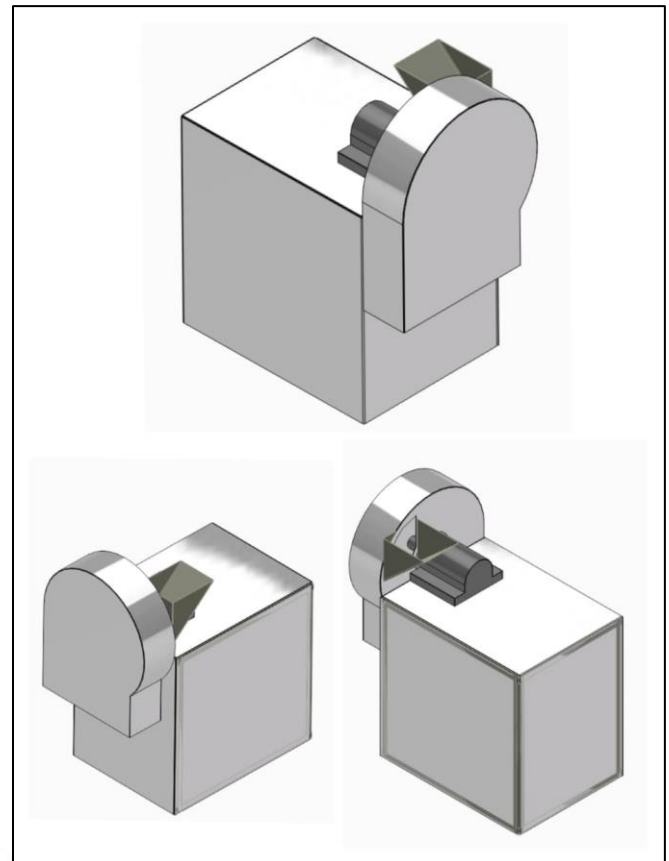
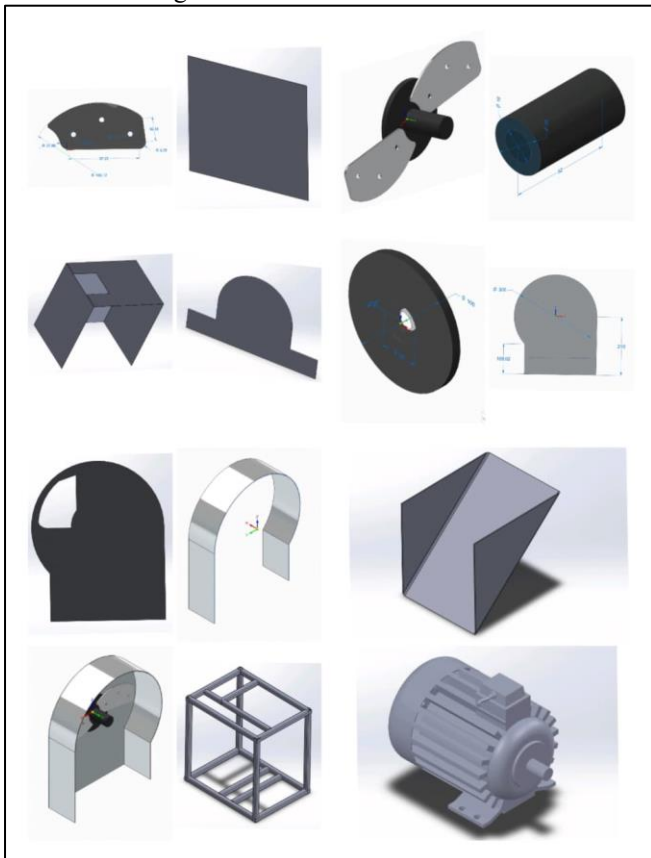
The machine mainly consists of an electric motor, shaft, slicing blade, bearings, belt and pulley system, and a supporting frame. The electric motor provides the required power to rotate the slicing blade. A 0.5 HP motor operating at 1300 rpm was selected for the machine because it provides sufficient power for slicing vegetables efficiently.

The power from the motor is transmitted to the rotating shaft through a belt and pulley mechanism. This arrangement reduces the motor speed to the required shaft speed and ensures smooth power transmission. The shaft supports the slicing blade and transfers rotational motion from the motor to the blade.

The slicing blade is mounted at the end of the shaft. When the shaft rotates, the blade cuts the vegetables into slices. The shaft is supported by bearings to reduce friction and ensure smooth rotation.

A rigid frame structure was designed to support all the components of the machine. Stainless steel and mild steel materials were used in the machine body because they provide strength, durability, and corrosion resistance. Stainless steel is also suitable for food processing applications due to its hygienic properties.

Machine Cad Figures:-



B. Design Procedure

The design of the vegetable slicing machine was carried out by following a systematic engineering procedure. The important design steps are described below.

1) Selection of Motor

The motor is the main power source of the machine. A 0.5 HP electric motor with a speed of 1300 rpm was selected because it provides sufficient power to rotate the slicing blade while maintaining compact machine size, low power consumption, and safe operation.

Given Data: -

Power of motor
 $P = 0.5 \text{ HP} = 0.373 \text{ kW}$

Motor speed

$N_m = 1300 \text{ rpm}$

Required shaft speed

$N_s = 400 \text{ rpm}$

Blade weight

$W = 276 \text{ g} = 2.71 \text{ N}$

Length of shaft

$L = 200 \text{ mm}$

Material of shaft

Mild Steel

Yield stress

$\sigma_y = 250 \text{ MPa}$

Factor of safety

$FOS = 6$

2) Calculation of Blade Load

The load acting on the shaft due to the blade weight was calculated using the following equation:

$$W = m \times g$$

Where

$m = \text{mass of blade} = 0.276 \text{ kg}$
 $g = \text{acceleration due to gravity} = 9.81 \text{ m/s}^2$
 $W = 0.276 \times 9.81$
 $W = 2.71 \text{ N}$

3) *Bending Moment on Shaft*

Since the blade is mounted at the end of the shaft, the shaft behaves like a cantilever beam.

Bending moment:

$$M = W \times L$$

Where

$W = 2.71 \text{ N}$

$L = 200 \text{ mm}$

$M = 2.71 \times 200$

$M = 542 \text{ N}\cdot\text{mm}$

4) *Twisting Moment on Shaft*

The torque transmitted by the shaft was calculated using the power transmission equation:

$$T = (P \times 60) / (2\pi N)$$

Where

$P = 0.373 \text{ kW}$

$N = 400 \text{ rpm}$

$T = 8.90 \times 10^3 \text{ N}\cdot\text{mm}$

5) *Design Consideration*

It is observed that the bending moment due to blade weight is very small compared to the torsional moment. Therefore, the effect of bending stress is negligible, and the shaft design is primarily based on torsion.

6) *Shaft Diameter Calculation*

Using torsion equation:

$$T = (\pi/16) \tau d^3$$

The calculated shaft diameter was approximately 10–12 mm. However, to ensure safe operation, handle shock loads, and increase strength, the final shaft diameter selected was:
 $d = 20 \text{ mm}$

C. *Fabrication of Vegetable Slicing Machine:*

The fabrication of the vegetable slicing machine was carried out using standard workshop manufacturing processes. The required materials such as metal plates and steel rods were first selected according to the design requirements.

Cutting operations were performed to obtain the required dimensions of the plates and structural members. The shaft was manufactured using lathe turning operations to obtain the required diameter and surface finish. After machining, the shaft was inspected to ensure dimensional accuracy.

Holes were drilled in the plates to mount bearings, bolts, and other components. The bearings were fitted on the shaft to support smooth rotation and reduce friction during operation.

The frame structure of the machine was fabricated using welding processes to join different metal parts. After welding, grinding operations were performed to remove sharp edges and improve surface finish.

Finally, all components such as the motor, shaft, blade, belt and pulley system, and frame were assembled carefully. The assembled machine was tested by slicing vegetables to check its performance and stability. The machine operated smoothly and produced relatively uniform slices.

VIII. RESULTS AND DISCUSSION

The vegetable slicing machine was successfully designed and assembled. The rotating blade driven by the motor was able to cut vegetables efficiently. The belt and pulley mechanism helped reduce the motor speed to the required shaft speed.

The shaft design ensured that the machine could operate safely under combined bending and torsional loads. The stainless steel body provided durability and corrosion resistance, which is important for food processing equipment.

The machine produced relatively uniform slices and reduced manual effort significantly compared to traditional cutting methods. It was observed that the machine improves efficiency and can be useful for small-scale food processing applications.

IX. CONCLUSION

The vegetable slicing machine was successfully designed, fabricated, and tested. The machine reduces manual labor and increases the efficiency of vegetable cutting operations. The use of a motor-driven slicing mechanism allows faster and more uniform slicing compared to manual methods.

The shaft design was verified through engineering calculations to ensure safe operation. The stainless steel body improves hygiene and durability, making the machine suitable for food processing environments.

Overall, the developed machine is simple in construction, economical, and suitable for small-scale kitchens, restaurants, and food processing units.

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