Design and Analysis of Portable Pedal Operated Pepper Thresher

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Abstract

Pepper is one of the cash crops in India. Separation of pepper berries from spikes requires lot of time as well as labour cost is also high. To solve these issues, pepper thresher is designed. At present, agricultural projects have gained more scope due to its needs. Many problems are detected in the current pepper thresher such as high cost, requires electric current, high weight, size and damage of berries due to the usage of metallic parts. The aim of the research is to design and fabricate an effective pedal operated portable pepper thresher with no power consumption, light weight and reduction of damage in the berries with the use of plastic materials in the roller. The pepper is threshed between the fixed drum and roller to separate berries and spikes. This machine helps the mankind in the field of pepper cultivation.

Keywords: *Pepper thresher, Components, Power, Design and Analysis*

1. Introduction

Agriculture plays a major role in Indian Economy. Harvesting of crops followed by threshing is an important process in the field of agriculture. At the beginning, threshing is done manually with the help of labour. But now some of the technologies are used even now many industries and farmer use manual mode of threshing.

1.1 Pepper and other cash crops

Some of the cash crops are pepper, cardamom and cotton. Pepper which popularly known as "King of all spices" is widely produced in the world. There are many methods for the separation of pepper berries from the spikes but it requires lot of time as well as effort. In the recent years, many threshers for various crops are developed with the use of rotating metallic drum. The usage of metallic parts leads to the damage of berries. To overcome this pepper thresher with plastic roller is developed.

1.2 Traditional method

Many labours are required in the traditional threshing as well as it is tedious and unhygienic. It requires lot of time as well as more human power is required. Because of this process in industries, it involves loss of time and money. In order to reduce this loss, technologies are implemented in the form of pepper threshing machine. There is chance of mixture of many contaminants when pepper is threshed in the ground due to this problems, the quality of pepper is affected.

1.3 Pepper Thresher

Pepper thresher is a new technology for separating the pepper berries from the spikes. In this process, the machine is operated with motor. The available model of thresher components are rotary drum, hopper and cam operated arrangement. The pepper berries are more hygienic but it might have some damage due to the use of metallic parts in the roller. The existing pepper thresher requires either electric current or fuel for the operation.

Karthik Madhyastha tried to reduce the damage of berries in the pepper separator machine and cost is also reduced. V belt drive is used for the effective power transmission. In this machine, on supplying 2kg of pepper spikes, an output of 470 grams was obtained. The berries were not damaged during threshing which was the major objective of the project.

Paulsen and WR Nave concluded that by increasing the drum speed and reducing feed rate the efficiency of the thresher can be increased.

In the analysis work, Suranjith Kumar K and others have designed and made up the pepper thresher to avoid the wastage of berries. The components within the machine are rotating drum, hopper and cam operated receptacle arrangement. The aim was to interchange labour separation method which is not efficient and to automate the method.

Risfaheri and Hidayat worked on hand powered thresher style. The experiment consisted of 3 steps coming up with constructing and testing. The separation mechanism was supported impact and friction, whereas the separation of the berries from the stalks was supported the distinction in form and dimension.

Zakaria M. I and Emara have altered the drum of a local thresher for the effective separation of flax seeds. An automatic device for determining the separating times and giving signal after separating the seeds has been designed and fabricated minimizing the stalks damage.

1.3.1 Problem Definition

- The existing pepper thresher requires either electric current or fuel for the operation.
- The use of metallic parts in filtering of berries may damage the pepper berries.
- The cost of the thresher is high.

1.3.2 Objective

The main objective of this machine is to design a portable pepper thresher with the reduction in weight, electricity and the cost.Materials are changed to reduce the weight, pedal operation is carried out to reduce the usage of electricity and plastic material is used in the roller to lessen the damage of berries

1.4 Advantages

- It reduces time.
- Labour cost and effort can be reduced.
- Large quantity of pepper can be threshed.
- More hygienic.

1.5 Existing Pepper Thresher

Fig 1: Existing pepper thresher

The cost of existing pepper thresher used in industry is Rs.42,500 and the estimated weight is nearly 175 kg and the materials used in this thresher are

S.No	Parts	Material
1	Body	Iron
2	Roller	Iron
3	Motor	Extruded Aluminium
4	Belt drive	Balata
5	Pepper filter	Iron
6	Pepper collector	Iron

Table 1

2. Experimental Details

2.1 Software used

2D design is generated with the help of 2D Drawing option in SOLIDWORKS. 3D Modeling is done with the help of SOLIDWORKS software. All the views can be projected in the model with use of this software. The complete analysis of pedal and sprocket is carried by using Solidworks Simulation.

3. Material Selection

The material is selected based on their properties. Some of the materials used in our project are listed below

S.No	Parts	Material
1	Frame	Low carbon steel
2	Chain	Alloy steel
3	Sprocket	C49 high carbon steel
4	Roller	Coated with plastic material
5	Pedal	Carbon reinforced plastics
6	Crank arm	Iron
7	Motor	Extruded Aluminium
8	Belt drive	Balata
9	Pepper filter	Sheet metal
10	Pepper collector	Sheet metal

Table 2

4. Components

Frame

Frame is a fixed link which can be manufacture by low carbon steel material. All the components are mounted with this frame. Hopper is on the top while chain, sprocket, pedal is mounted at the side. Below the frame, a hollow part is fixed to attach the grinder.

Fig 2 : Frame

Hopper

Hopper acts as an input for the insertion of pepper. This limits the inflow of pepper.

Chain

Chain is connected between the two sprockets for the power transmission from the pedal to the shaft. Chain and sprocket drives are used to transfer power from one component to another.

Fig 3: Chain

Sprocket

A sprocket is of C49 high carbon steel and it is used to transfer the rotary motion. Two sprockets are connected with chain to transfer the motion from one sprocket to the other.

Fig 4: Pinion Sprocket

Fig 5: Wheel Sprocket

Roller

The pepper is separated from the spikes and the spikes moves along the thread. The berries are collected by the use of pepper collector. The waste is obtained near the shaft.

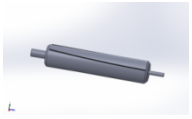

Fig 6: Roller

Pedal

Pedal is used to drive the chain and sprocket. Minimum of 100N force is required for pedaling.

Crank arm

The part which is supporting the pedal is crank arm.

Motor

Single phase induction motor of 0.5hp is used in this machine. It is capable of converting electrical energy into mechanical energy.This motor is low cost as well as easy to handle. This is used to run the belt drive in this machine. When the belt drive rotates, the roller starts functioning.

Fig 7: Single phase induction motor

Belt drive

Belt drive is used for the effective power transmission. In this machine, V belt drive is used. The purpose of belt in this machine to operate the roller which is used to separate the pepper berries from the spikes. The belt drive is operated with the help of motor.

Pepper filter

The main purpose of the pepper filter is to separate berries from spikes with the help of net like structure.

Pepper collector

The obtained pepper berries are collected by the user of pepper collector and it can further used for many purposes. Sac or vessel can be placed at the bottom of the collector.

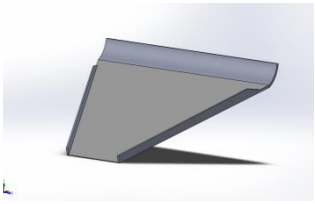

Fig 8: Pepper collector

5. Design procedure

Chain drive calculation:

Speed of pinion sprocket(N_1) = 200rpm

Speed of wheel sprocket(N_2) = 90rpm

Number of on pinion sprocket(Z_1) = 20

$Z_2/Z_1 = N_1/N_2$

$Z_2 = (200/90) \times Z_1$

$Z_2 = 2.22 \times 20$

$Z_2 = 44$

Pitch radius(r) of wheel sprocket = 74mm

Torque on wheel sprocket = F x r

= 150 x 0.7074

= 11 Nm

Power Calculation:

Force on pedals = 150N

Torque on wheel sprocket = 11 Nm

Power = $2\pi NT/60$

= 2x3.14x90x11/60

= 104 W

5.1 2D Drawing

In this pedal operation is done. This gives the general view of the design and helps to detemine the proper 3D model and design for the thresher. Motor is attached with belt drive for the hybrid operation of the equipment. Spring is planned at the beginning but the vibration cannot be produced effectively from the pedal operation. In this project, we are optimizing the existing industrial machinery.

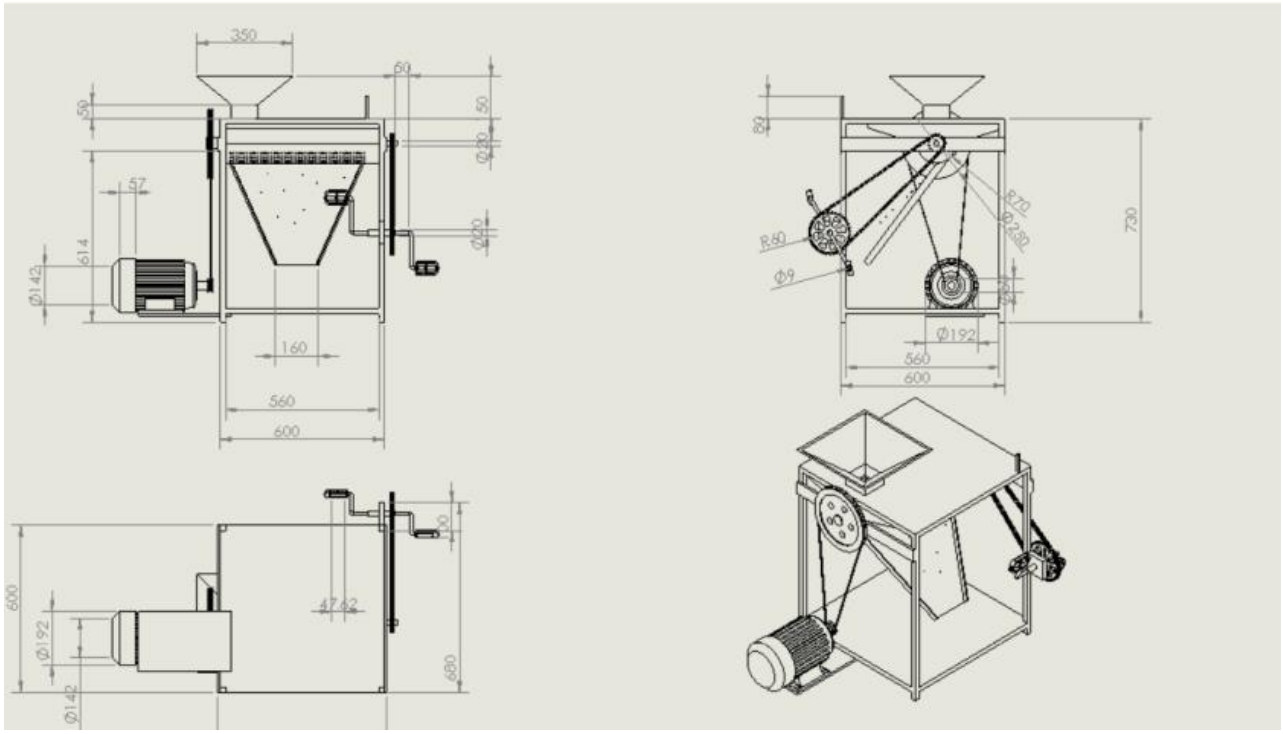

Fig 9: 2D Drawing

5.2 3D Model

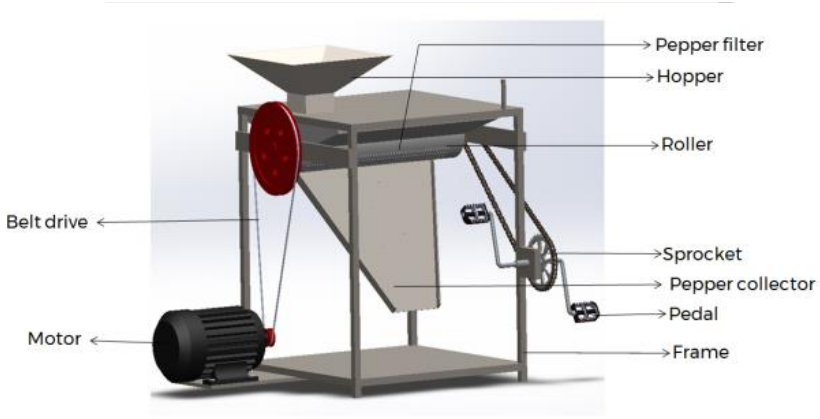

Fig 10: Pepper thresher (Machine Operation)

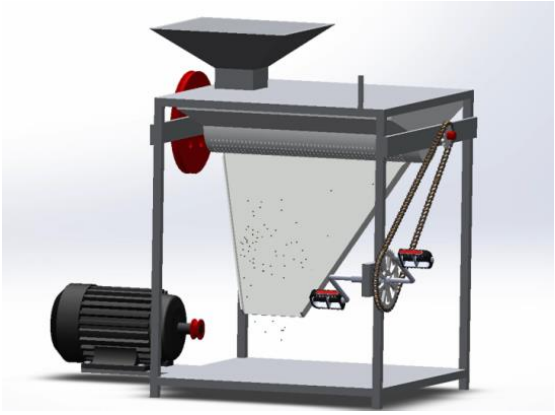

Fig 11: Pepper thresher **(**Manual operation)

6. Analysis of thresher parts

It is analyzed with the help of Solidworks Simulation. In this, it shows where the stress is acted maximum and minimum in the pedal and sprocket which is used in this pepper thresher. This analysis helped us to reduce the stress. In case of sprocket, the stress is concentrated more on the center.

6.1 Conditions

Force = 150 N
Torque = 11 Nm
No of nodes in pedal = 1500
Material of pedal = Carbon reinforced plastics
Young's modulus= 150 GPa
Material of sprocket = C49 high carbon steel
Young's modulus= 200 GPa

6.2 Pedal Analysis:

During analysis, one end is fixed and a force of 150N is applied at the top of the pedal as pedaling force. The material used during analysis of a pedal is carbon reinforced plastics

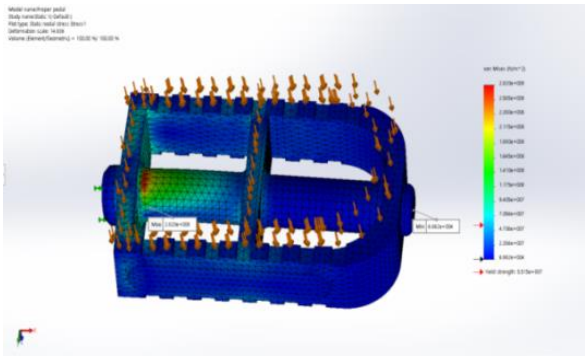

Fig 12: Pedal stress analysis

6.3 .1 Sprocket displacement analysis

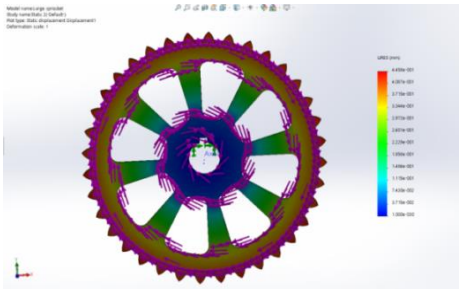

Fig 13: Sprocket displacement analysis

6.3.2 Sprocket stress analysis

During sprocket analysis, centre hole is fixed for the rotary motion and torque of 11 Nm is applied at its surface. A fine mesh is generated and this is analyzed using Solidworks Simulation.

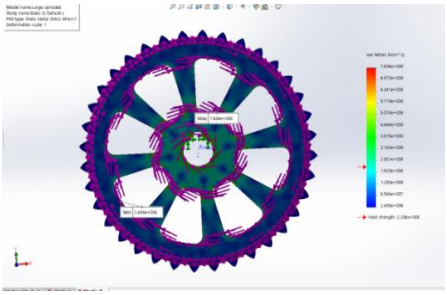

Fig 14: Sprocket stress analysis

7. Results

7.1 Stress in pedal

Max Stress = 2.82 X 10^8 N/M^2

Min Stress = 6.862 x 10^4 N/m^2

7.2 Stress in sprocket

Max Stress = 7.604 x 10^8 N/m^2

Min Stress = 2.499 x 10^6 N/m^2

8. Fabrication procedure

- The frame is build with cutting and drilling operation.
- The motor is attached at the bottom of the frame with the help of screws.
- The belt drive is attached to the motor and casing is also provided.
- The roller is connected to the pulley of the belt drive and to the smaller sprocket.
- The roller is placed at the centre of pepper filter. All the sides are covered with the help of multi-wood
- The pepper collector is generated by cutting and drilling operations
- The hopper is placed at the top to give the pepper with spikes.
- The assembly of chain and large sprocket is attached for manual operation.

Fig 15: Pepper Thresher

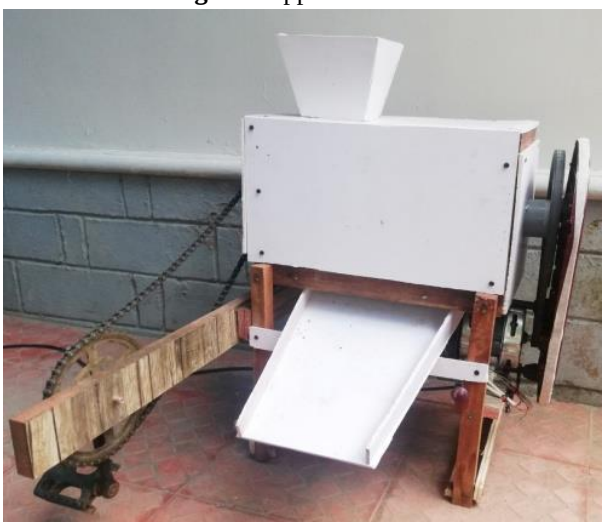

Fig 16: Pepper thresher Front View

9. Working and Cost

The mechanism in this machine is Chain and belt drive mechanism. In manual operation, when a pedal is operated the chain and sprocket tends to move which is connected to the shaft of the roller. The roller plays a major role in the separation of berries. The berries fall through net of the pepper filter and it is collected using the pepper collector. While in case of automation, belt drive is used instead of chain and sprocket.

The estimated price of this machine is Rs.7000 and the weight is 35 kg.

Capacity of the pepper thresher is 50 kg/hr

10. Conclusion

This pepper thresher will save the power as well as reduce the efforts in separating the pepper berries from the spikes. The hygienic pepper berries without damage are generated with the help of this machine. This is a portable thresher as well as user friendly. This machine will be a good invention in the field of pepper cultivation.

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