RESEARCH ARTICLE

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Analysis of the Performance of Green Pea Depoding Machine using Treadle Mechanism

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ABSTRACT

In the food industry green pea is an important material for making different food products. It is cool season crop of India and also plays major role in Indian crops. It is a rabbi season crop and it's sowing begins from October to November mid in plains. To remove the peas from pedals, more labor and time is used to be consumed. To overcome the problem of labor and time, machine is designed for maximum removal of pea seeds from pea pods without using electricity. It is operated by treadle mechanism. This machine is fabricated by keeping in view for farmers, small scale industries and for that low cost material available in market was used. Treadle mechanism, roller gears, shaft, tray, hand pulley, are the major components of this machine. Principle of this Depoding of green peas is based on the friction generated between the two rollers and pea pods.

Keywords: Depoding machine, green peas, green pea pods.

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INTRODUCTION

In India, peas are cultivated in Maharashtra, Madhya Pradesh, Utter Pradesh, Jharkhand, Punjab, Haryana and Uttarakhand. Cultivation of Peas is over an area about 4,34,000 hectares with an annual production of 38,69,000 tons[1]. Importance of fresh peas is in terms of richness of protein, amino acid, vitamin C and A, calcium, carbohydrates, iron and phosphorous.

Pea is very important ingredient consumed as green, as well as dried in the spice form and used in the vegetarian, non-vegetarian dishes. Many food products like chutneys, curry powders and many other are prepared from pea. the vegetarian, non-vegetarian dishes and pickles.

Now a day, there is increase in mechanization in terms of agricultural machinery in performing the various farm operations in more efficiently with higher speed. Scope of vegetable processing.

Green pods are shelled manually which are laborious, energy and time consuming. There is necessity to design and develop small green pea pod shelling machine.

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LITERATURE REVIEW

Khilendra Kumar Sonboier et al.[1] fabricated motor operated machine in which pea pods passes between two adjustable rollers to maintain the clearance between them for that authors have used adjusting screw. In this machine, for the Vibration of feeding tray, a tray vibrator shaft is used.

Parminder Kamboj et al. [2] designed and fabricated small scale pea depoding machine by using CAD software. This machine was based on principle of friction generated by rubbing action of blades with

the pods on sieves which helps in the opening the pods of peas and cutting action of conveying blades 30kg/ hour.

Manjeet Prem et al. [3] have carried out study to know the different pod shelling machines available in the market with different type of materials of machines as well as the different techniques of shelling used in these machines.

Sharma S. K. et al. [4] developed hand operated pea shelling machine. They tried three different surfaces (i) punched tin sheet, (ii) cycle tyre treads and (iii) gunny bag cutting.

Khilendra Kumar Sonboier et al. [5] determined physical properties of green pea to develop appropriate technologies in design and adjustment of machines used during harvesting, separating, cleaning, handling and storing of agricultural materials and to give final shape in form of food, feed and fodder style, then select the appropriate name on the style menu.

H. M. Khobragade et al. [6] have developed mini green pea pod shelling machine which has 61.01per cent shelling efficiency with 2 mm roller clearance and roller speed of 1650 rpm.

From above studies, analysis of these pea depoding machines are carried and shown in table-1.

Table-1: Performance analysis of pea depoding machines

Pea Depoding machine (Author)	Power supply	Capacity	Efficiency (%)
Mr. Khilendra Kumar Sonboier[1]	Electric motor	14.8kg/ hour	93.53
Mr. Parminder Kamboj[2]	Electric motor	30kg/ hour	--
Mr.S.K. Sharma[4]	Hand operation	18 kg/ hour	---
Mr. H. M. Khobragade [6]	Electric motor	--	61.01

PROBLEM STATEMENT

Manual removal of kernels from green peas is laborious and time consuming. On an average one person in one hour, can depode about 3 to 3.5 kg of green peas from pods. [4] Due to it's natural tendency, it is difficult to store green pea pods. To overcome these issues it is necessary to design and fabricate the machine to obtain the green pea seeds

METHODOLOGY AND MATERIALS

The machines available for depoding the green peas present in the market are operated by electricity. To overcome this problem, green pea depoding machine is designed so that it can be operated manually with the help of treadle. It will meet the requirements of Indian farmers. It not only helps to reduce the time for depoding of pea pods, but they will able to get more income on investment. As it is operated by treadle, there is no electricity requirement to operate the machine.

Analysis of PEA Pods and PEA Seeds

The size and shape of green pea pods and seeds are measured so as to decide the dimension of slots of tray and for the gap between two rollers and are shown in Figure 1 and 2. The diameter of pea seed is calculated by measuring different seeds diameters and taking their average. The values of diameter of pea seeds we measured are 7.94mm, 9.31mm, 8.2mm, 10.61mm, 5.4mm, 10.33mm, 4.07mm, 7.22mm, etc. Similar method is used for the calculation of width of pea pods. The values we measured are 14.04mm, 12mm, 13.08mm, 14.12mm, 13.6mm, 13.0mm, etc.

Diameter of pea seed =
7.94+9.31+8.2+10.61+5.4+10.33+4.07+7.22/8
= 7.88 mm = 0.788 cm

Diameter of pea pods=
14.04+12+13.08+14.12+13.6+13.0/6
= 13.3 mm =1.33 cm

Figure 1: Actual measurement of green pea seeds using vernier caliper

Figure 2: Actual measurement of green pea pods using vernier caliper

Working Principle and Mechanism used in Machine

A rough design of the machine is done for proper visualization of machine. Design of machine is not an easy task. To reduce time required for designing most of the designing work is done by using CAD (Computer Aided Design), Creo, PRO-E, Solid Edge, Solid Works etc tools. Creo software helps in future expansion of model by providing facilities to modify the designed work later. As there is wide scope of Creo in agricultural field, therefore an attempt to design the pea depoding machine was made by using Creo software.

CREO Modeling of Green Pea Depoding Machine is shown in Fig 3 and its side view is shown in Figure 4.

Figure 3: CREO Modeling of Green Pea Depoding Machine

Figure 4: Side View

Calculations

Tension Calculation of Pulley : Pulley and rope system (shown in Figure 5) is used to transmit power from treadle mechanism to roller of the machine.

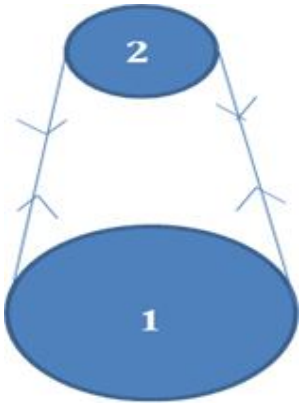

Figure 5: Pulley and Rope System

P1=driver pulley

P2=driven pulley

R= Radius of pulley

R1=21.5cm

R2=4cm

N1=593rpm

Distance between two pulleys (X) =50cm

By doing further calculation, we get tension in the rope,

T1=13.972 N

T2=7.607 N

T=T1+T2

T=21.579 N

Force Analysis in Spur Gear : Force analysis is carried out and is shown in Figure 6

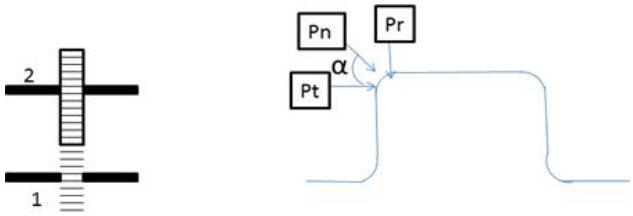

Figure 6: Forces on Spur Gear

Gear 1 (lower gear)

D= Diameter of gear

D1=51.94mm

D2=57.14mm

Power =85Watt=0.085kW

Mt= Mt= 60*0.085/2π*407

Mt=1994.33N.mm

Mt=199.433N.cm

Pt=76.794 N

Pr=27.95N
Pn=81.722N
Gear 2 (upper gear)
N2=367 rpm
Power =0.085 kW
Mt=221.169 N.cm
Pt=72.384N
Pr=26.346 N
Pn=77.029 N

The fabrication of the machine detailed literature survey has done with the help of research papers and videos. A market survey is required regarding need and scope of machine. Following methodology is planned for the fabrication of the machine.

CONSTRUCTION

During designing the pea depoding machine power supply, ergonomics, space and cost are considered. This machine is simple in construction with elements like rollers, shafts, gears, hand pulley, treadle, tray, etc.

Rollers are of made up of SAE 1030 and are hollow which help to reduce the weight of machine. The length of the rollers are 34.29cm (length is same for both) and diameter of lower roller i.e. threaded roller 5.5cm and upper roller diameter i.e. plain roller is 6cm. Threaded roller generate more friction with pea pods and the weight of both the rollers are 1100 gm.

The material of shafts is stainless steel (SAE1030). The rollers, gears, and pulley are mounted on a shaft. The length of the shaft is 48.26 cm and the gap between two shafts is 6 cm. This distance is taken by measuring number of green pea pods. Shafts are mounted on SAE 1030 plates.

When two gears are in contact with each other they move in opposite directions. Here, two gears are used so that the rollers will move in opposite directions for holding pea pods and generate required friction.

Different numbers teeth's of gears are used to maintain the required gap between two rollers so that pea pod will easily get passed between them. Speed of the gears is calculated using tachometer. Speed of gear G1 (N1) = 407 rpm

Speed of gear G2 (N2) = 367 rpm

The material of hand pulley is Cast Iron (SAE 30 I.S. Grade 20) and diameter of the pulley is 8 cm. It is mounted on the lower shaft and gives power to Gear (G1). The hand pulley (Figure 7) is also used to give initial starting torque to the machine. It gets power from the treadle mechanism.

Figure 7: Hand Pulley

Treadle is a lever device pressed by the foot to drive a machine. It is mechanism (Treadle), operated with a pedal for converting reciprocating motion into rotating motion. It allows human power to operate the machine in the absence of electricity. The treadle works by pressing the pedal with one or both feet, causing rocking motion. This movement rocks a large crankshaft driving a flywheel. Treadle Mechanism is shown in Figure 8

Figure 8: Treadle Mechanism

The length of treadle is 51 cm, height is 71 cm, width is 40 cm and the flywheel diameter is 43 cm and its speed is 593 rpm.

Slotted tray is used to provide proper input of pea pods between the rollers. The width of slot is decided by the width of pea pods. The average width of pea pod is 1.33 cm and average diameter of pea seed is 0.788cm. Slotted Tray is shown in Figure 9.

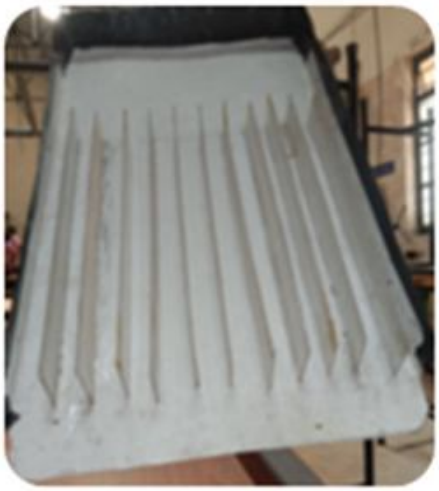

Figure 9: Slotted Tray

WORKING

To operate the machine, initially manual power is provided to rotate the hand pulley which is mounted on the lower shaft. This makes the flywheel of the treadle rotate and the whole treadle mechanism starts. It gives power to the gear and then start rotating in the opposite direction. If lower gear moves in clockwise direction, then upper will move in counter clockwise direction or vice versa. The gears move the rollers in such a way that it allows pea pods to pass between the rollers and this will result in the removal of pea seeds from the pods.

On one side of the roller there would be feeding tray and from another side operator has to operate the machine. There is gap between tray and roller so as to collect pea seeds in the collecting chamber and the kernels would be collected in another side of roller machine.

For vibration we used cam mechanism. Here the cam shaft is unbalanced i.e. the shaft on which cam shaft was mounted passes above the center of the circular cam. Due to the unbalanced center it creates vibrations and as a result tray gets vibrated.

All above parts were assembled and final construction of pea depoding machine was carried out. Developed Green Pea Depoding Machine is shown in Figure 10 and 11 as front and side view respectively.

Figure 10: Front view of Developed Green Pea Depoding Machine

Figure 11: Side View of Developed Green Pea Depoding Machine

RESULT

Performance of this pea depoding machine is measured in terms of efficiency as well as in mass of pea depoded per hour by the machine. Depoding efficiency is defined as the mass of the kernel actually depode to the total mass of kernels on the before Depoding. The total mass of pea pods is 418 gram/min and mass of depode pea pods is 357 gram/min. So, 21.420Kg/hour is achieved. Comparatively from previous pea depoding machines, this machine is more economical as it is run by human being.

Depoding efficiency= (Mass of Depoded Sample/ Total mass of sample)* 100

= (357/418)* 100

= 85.4%

The Depoding Efficiency is obtained as 85.40 %.

Total mass of pea pods in Kg per hour is 25.8kg/hour and mass of depoded pea is 21.45Kg/hour

CONCLUSION

Pea depoding machine is quite simple in construction as well as in working. It is capable to extracting large amount of peas in less time with minimum cost. This machine will be very helpful for small scale food industries and farmers also. This machine saves the electricity. It is operated by legs therefor both hands are free during working and both hands help to control the flow of pea pods to the roller of the machine.

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