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Design and Development of Green Pea Depoding Machine

Khilendra Kumar Sonboier[1], Kipoo Kiran Singh Mahilang[2*], Genitha Immanuel[1] and Pankaj Minj[1]

[1]*Department of Food Process Engineering, SHIATS, Allahabad, India*
[2]*Department of Farm Machinery and Power Engineering, SVCAET&RS, IGKV, Raipur, India*

**Corresponding author*

A B S T R A C T

Pea (*Pisum sativum L.*) is a multipurpose leguminous crop that can provide food and fodder for the small-scale farmer in subsistence agriculture. It is also known as 'Dry Pea' and it is called as 'Matar' in India. India is one of the largest producers of field pea in the world and stands at the 5th place in the list of major field pea producers. In India peas are mainly grown in Uttar Pradesh, Madhya Pradesh, Himachal Pradesh and Jharkhand. Pea is widely cultivated and processed in India predominantly done manually. India is also producer of pea but there is lack of machine for shelling of pea. Due to lack of this specialized technology and equipment for shelling of pea an effort have been made to develop a low cost green pea depoding machine which was designed and developed in the workshop at the department of Agricultural Process Engineering, SHIATS, Allahabad. The present study on designed and development of green pea depoding machine includes motor, frame, roller, sprocket, pulleys, belts, adjusting screw, tray vibrator shaft, plates and feeding tray. The machine was powered with a 0.5 hp motor with help of suitable mechanisms. The machine has overall length of 1015 mm, a height of 880 mm and a width of 400 mm. Three different types of pulleys were made attached on machine i.e. Transmission pulley which helps to rotate roller, smaller pulley lifts the tray in upward and downward motion and motor pulley for transmitting the power to the transmission pulley. An adjusting screw is provided in machine for adjustment of rollers to maintain clearance for shelling of green pea. A tray vibrator shaft is provided for passing peas towards roller. Two types of plates were also provided in machine for passage of pods and kernels. Results of the developed depoding machine showed mean values of depoding capacity, damage percentage and undepod percentage as 14.88 kg/h, 6.53 % and 7.52 %, respectively; while, the depoding efficiency was 93.53 %. The estimated cost of the machine was Rs. 20000 and the cost of operation was found 37.43 Rs/h. The overall weight of the whole machine was 45 kg which was easy to operate and individuals or user can easily handle it. Overall performance of the depoding machine was found quite

Keywords

Green pea, Shelling efficiency, Depoding capacity, Green pea pod Sheller, Depoding machine

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Introduction

Green vegetables are the essential items of our daily food. It is an important leguminous vegetable and occupy important place among the vegetables. Pea (*Pisum sativum* L.) a member of the family Fabaceae is one of the most important cool season vegetable crops grown throughout the world (Agropedia, 2015).

Peas are thought to have originated in Middle Asia and the central plateau of Ethiopia. In India, it is cultivated over an area of about 4, 34,000 ha with an annual production of 38, 69,000 tones (Al-Jalil, 1978).

Two types of peas are commonly grown in India. The garden pea (*Pisum sativum* var. hortense) is a green colored seeded and sweet in taste, used for canning purpose and other type is field (*Pisum sativum* var. arvense) whose seed are round or little angular, hard and whitish in color. The commercially grown varieties of peas are – Arkel, Pusa Pragati, Kashi Uday, Azad P-3 and Pant Uphar (IP 3) (Commodities control, 2015).

Pea is high yielding and relatively stable crop. It requires a cool, relatively humid climate and are grown at higher altitude in tropic with temperatures from 7-30°C. This provides protein, salt, mineral, calcium iron, carbohydrate and vitamins. Fresh Peas are rich source of protein, amino acid, carbohydrates, vitamin A and C, calcium, phosphorus and small quantity of iron (Davis *et al.*, 1985).

In Uttar Pradesh, Jalaun district contributes highest in terms of area and production by 21 % and 29 %, respectively to the State total area and in production of field pea. Again, Lalitpur stands at the second position in the area (18 %) and production (19 %) share to the state total, followed by Jhansi (area 14 % and production 14 %), Mahoba (area 8 % and production 5 %), Hamirpur (area 3 % and production 3 %) and Azamgarh (area 2 % and production 2 %). Rest 33 % and 28 % of acreage and output respectively are come from other states (Husle, 1994).

Mechanization of pea crop shelling is considered of great importance as it reduces time, labour and also cost of operation that is required in case of hand shelling. Manual removal of kernels from green pea is very tiring job. One person can depod about 3-3.5 kg of green peas from pods in one hour. Hand shelling is done in almost all parts of world but it is time consuming and requires labourers due to which in many countries like Egypt they are using different threshing and cleaning machines for green pea. From this point of view, many small workshops produce depoding machine without any scientific guidance which creates problems for users (Sonboier, 2016).

So, keeping in view all the above facts and points, an effort is made to design and develop a suitable low cost mechanical green pea depoding machine at SHIATS, Allahabad which will meet the requirement of the Indian pea growers. The depoding machine not only helps to reduce the time for depoding of pea pods, but can also provides a good opportunity for small farmer to use such kind of machines. By using such kind of depoding machines for pea, they are able to get more income on investment. And in short, green pea depoding machine will help in developing a technology for processing of green pea as small scale industry in India.

Materials and Methods

A Green Pea depoding machine was designed and developed in the workshop of SHIATS, Allahabad. It comprises of Frame, Roller, Sprocket, Pulleys, Belts, Adjusting Screw, Tray Vibrator Shaft, Plates and Feeding Tray.

The components of a pea depoding machines are as follow:

Motor

For better depoding of Pea a motor of power segment 0.5-1.0 hp was identified from which a motor of 0.5 hp was selected from local market.

Frame

The frame was fabricated by welding 25 x 25 x 5 mm mild steel angle iron pieces together keeping in view the orientation and attachment of different components.

Length of a frame - 1015 mm,
Width of a frame - 400 mm,
Height of a frame - 880 mm and
Overall weight of a frame - 20 kg

Roller

A Roller is made of two components:

Shaft and rubber bush.

The shaft is made of Mild steel rod of 28 mm diameter and length of 490 mm.

A rubber bush of outer diameter of 51 mm and length of 300 mm is provided on the periphery of the MS rod for better depoding of pea. Therefore, the overall length of roller is 510 mm and 490 mm.

Four bushes are welded on the upper surface of the frame. On these bushes, the two rollers are made fixed which are rotating in opposite direction by the help of gear which is made fixed on one of the sides of the rollers and due to these rotating motion of rollers a pea is depoded between the two rollers.

Sprocket

The sprocket is made up of Mild steel. It is fixed on side of the rollers. It is designed in such a way that it move together without slipping and ensures perfect velocity ratio with less friction.

Specifications of sprockets used in Pea Depoding Machine

No. of teeth = 18
Diameter of sprocket = 63 mm
Pitch of the chain = 12.7 mm

Pulleys

Pulleys are made of cast iron and are easily available from local markets. Three pulleys of different diameters and functions are provided on the machine.

Transmission pulley

Transmission pulley of outer diameter 350 mm was selected. It is made fixed on the lower roller with the help of nuts and bolts. The pulley gets power from motor with the help of belt. The Pulley is made fixed on the roller due to which roller rotates on its axis.

Smaller pulley

Two numbers of Smaller Pulley of outer diameter 55 mm and inner diameter of 28 mm was provided. One of pulley (i.e. Pulley-A) is made fixed on the lower portion of the roller apposite to the transmission pulley.

Another smaller pulley (i.e. Pulley- B) of same size is provided at a distance of 478 mm from the Pulley – A. Pulley – B is made fixed on the shaft and these shaft have one small attachment provided which lifts the tray in upward downward motion.

Motor pulley

A Motor pulley of same size as smaller pulley is provided. It is made fixed on the motor shaft with the help of nuts and bolts. This pulley gets the power from the motor which then with the help of belt system transmits the power to the transmission pulley.

Belts

Belts (B-Type) are selected from locally available market. It is made up of Standard Rubber polyester cord. Two belts are provided in between the pulleys for better transmission of powers.

Size of belt provided in between motor and transmission pulley = 1900 mm

Size of belt provided in between smaller pulley = 1140 mm.

Adjusting screw

It was attached with the upper covering of the depoding machine so that the two horizontal rollers can be adjusted to maintain the clearance between them. This would help us in depoding of the pea upto its maximum capacity or say upto the level when reaches its rupture point. These adjusting screws serve the main function of maintaining clearance between the rollers. Maximum clearance between the rollers can be increased upto 10 mm.

Tray vibrator shaft

A Tray Vibrator shaft is made up of M.S. Rod of diameter 28 mm and length was 460 mm. Bushes are welded on the frame and the vibrating shaft is made fixed on these bushes in which it rotates.

On a vibrating shaft, one attachment is provided in the middle of the shaft which is elliptical in shape.

When the shaft rotates this attachment also rotates and this attachment on each revolution touches the lower side of the feeding tray which causes the feeding tray to move up and down and due to this upward and downward motion the pea passes towards the roller.

Development of plates

Two different kinds of plates are used on Pea Depoding Machine

Pods discharge plate

It is made up of SS sheet of length 260 mm and width of 253 mm is provided. The shape of plate is rectangular. It is attached to frame by nuts and bolts just below the roller. The purpose of providing the plate just below the roller is to pass the pods to some distance after depoding of the pea.

Kernel discharge plate

It is made up of SS sheet of length 330 mm, upper width of 320 mm and lower width of 190 mm is provided.

The shape of plate is similar to triangle and is tapered downwards so that more no. of kernel falls on the ground. It is provided just opposite to the kernel discharge plate.

Feeding tray

It is made of two components.

Feeding frame

It is made of MS angle iron. Its length is 605 mm and width is 240 mm. One side (roller side) is welded on main frame with suitable attachments. It is welded in such a way that the tray gets a linear motion when the vibrating shaft rotates and another side of the feeding frame is free it is just supported on the upper surface of the frame.

Feeding plate

It is made of SS Sheet of length 600 mm and width of 238 mm. It is provided on the feeding frame with the help of nuts and bolts.

Fig.1 View of motor

Fig.2 Isometric view of frame

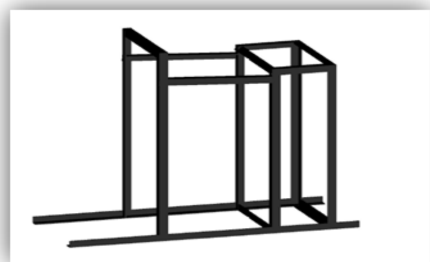

Fig.3 Isometric view of roller

Fig.4 View of sprocket

Fig.5 Isometric view of transmission pulley

Fig.6 Isometric view of tray vibrating shaft

Fig.7 View of discharge plates

Fig.8 Isometric view of feeding tray

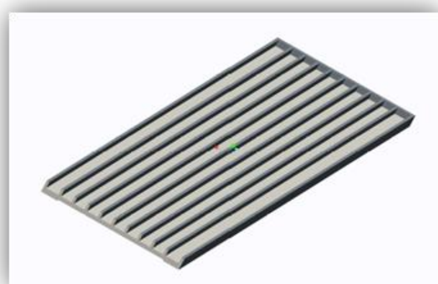

Fig.9 AutoCAD front view of green pea depoding machine

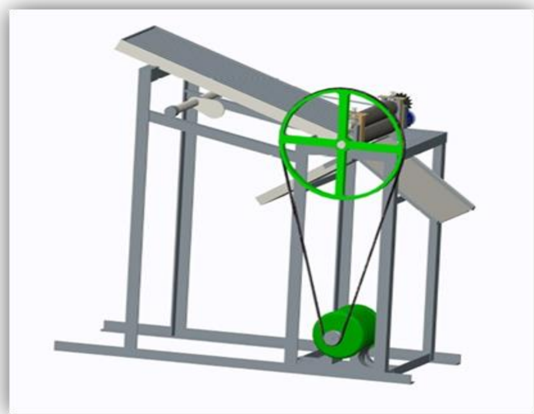

Fig.10 Fabrication of green pea depoding machine

Fig.11 Developed green pea depoding machine

Fig.12 Green pea depoding machine during depoding operation

Table.1 Performance evaluation of the green pea depoding machine

S. No.	Depoding capacity (kg/hr)	Depoding efficiency (%)	Damage percentage (%)	Undepod percentage (%)	Total depoding loss (%)
1	14.90	93.46	6.50	7.00	13.50
2	15.30	93.89	6.10	8.50	14.60
3	14.80	93.46	7.00	6.50	13.50
4	14.50	93.19	6.50	7.00	13.50
Mean	**14.88**	**93.50**	**6.53**	**7.25**	**13.78**

Nine channels are provided on a feeding tray of 600 mm and 26.4 mm width. On all these channels the pea is passed towards the roller for depoding (Fig. 1–12).

Methodology

The developed pea deporting machine was tested in SHIATS, Allahabad and the following performance features was noted:

Capacity,
Efficiency,
Total Depoding Loss

Capacity of green pea depoding machine

Any depoding device that will compete successfully with conventional sheller must have a high depoding capacity. Depoding capacity measurements were made to evaluate the capacity of the roller sheller in comparison with existing depoding machines.

For each sample depod by the machine, the depoding capacity was calculated as follows (Al-Jalil, 1978)

$$DC = \frac{W}{t}$$

Where,

DC = depoding capacity in kg/h

W = mass of kernel actually depod, kg

t = time of depoding, hours

Efficiency of green pea depoding machine

Efficiency of depoding is another important parameter for evaluating the performance of the depoding machine. Depoding efficiency is defined as the mass of the kernel actually depod to the total mass of kernels on the before depoding.

$$DE = \left(1 - \frac{L}{W + L}\right) \times 100\%$$

Where,

DE = depoding efficiency, %
L = depoding loss (wt. of undepod kernels),
W = mass of the depod kernels, kg

Total depoding losses

Total depoding losses are defined as the sum of the damage percentage and undepod peas. They were determined according to relations used by (Gore *et al.*, 1990).

$$\textbf{A. Damage percentage, \%} = \frac{Mass\ of\ damaged\ sample}{Total\ mass\ of\ sample} \times 100$$

$$\textbf{B. Undepod percentage, \%} = \frac{Mass\ of\ undepod\ sample}{Total\ mass\ of\ sample} \times 100$$

Results and Discussion

The average values of the depoding capacity, depoding efficiency, damage percentage and undepod percentage are shown in Table 1.

The mean value of depoding capacity obtained was 14.88 kg/h in range of 13.33 to 15.79 kg/h. The mean value of depoding efficiency obtained was 93.50 % in range of 93.19 to 93.89 %. The mean value of damage percentage obtained was 6.53 % in range of 6.10 to 7.00 %. The mean value of undepod percentage obtained was 7.25 % and in range of 6.50 to 8.50 %. The mean value was Total depoding loss obtained was 13.78 % and in range of 13.50 to 14.60 %.

The developed Pea depoding machine was tested in all conditions and it was observed that machine worked quite satisfactorily. The depoding efficiency was found to be 93.50 % with 6.53 % damage pea and 7.25 % undepod pea which is under acceptable limits of an industry. Overall capacity of machine was found to be 14.88 kg/h. The overall weight of the whole machine was measured 45 kg. The estimated cost of the machine was Rs. 20000 and the cost of operation was found 37.43 Rs/h.

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