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Performance Evaluation of De-seeding Machine for Custard Apple Pulp

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Abstract

Custard apple is a dryland fruit crop and grows well with less water requirement and adverse climatic conditions. The production of custard apple is increasing in India. The main constraint in custard apple processing is deseeding of pulp. Hence, there is demand for small size machine which can separate pulp and seed from custard apple.

Therefore, deseeding machine for custard apple pup was developed which was consist of a brush roller, cylindrical sieve, discharge chutes, cover with feed hopper, a rigid base supporting the frame and transmission unit. In order to evaluate the performance of the machine, experiment was conducted at roller speed (215, 227 and 257 RPM), feeding rate (0.2, 0.3, 0.42 and 0.6) and three cylindrical sieve (1,2 and 3). Cylinder 2 with inlet diameter of 213 mm and outlet diameter of 177mm shows better results with machine efficiency 82.50 % and minimum pulp loss of 2.09 % among three cylinders. It was observed that machine capacity and machine efficiency increased with increase in roller speed and feeding rate.

Keywords : Custard Apple, Pulp, Seeds, Deseeding, Pulp Separation

Introduction

Custard apple (*Annona squamosa* L.) belongs to family Annonaceae is one of the finest fruits gifted to India by tropical America. Custard apple is one of the most delicious and highly perishable fruit. It has its delightful taste, flavour and a high nutritional status. It is exported in large quantity from India to UAE, Saudi Arabia, Bangladesh and Kuwait (Chadha 1995).

The production of the custard apple was 1,35,640 MT from an area of 19,550 ha (Anonymous, 2012).

The main season of custard apple fruits is October and November which is very short which leads to wastage and distress. Being climacteric and highly perishable fruit, it cannot be stored for long period. Cold storage of fruits is not promising. Pulp can be stored for more period than the fruits. Instead of selling fruits directly to the market if they are processed by removing pulp and then selling pulp to the market will benefit the growers.

The manual separation of pulp from seeds is not commercially possible due to shortage of labour and it is very tedious and time consuming. Hence there is demand for small size machine for de-seeding which can separate custard apple pulp from seeds. There is no review available on the deseeding machine for custard apple pulp. Therefore, present study was undertaken with objectives: to develop deseeding machine for custard apple pulp and to evaluate the performance of developed machine.

Material and Methods

Machine Description

Deseeding machine for custard apple pulp was consist of a brush roller, cylindrical sieve, discharge chutes, cover with feed hopper, a rigid base supporting the frame and transmission unit as shown in Plate -1.

Brush Roller

It was consists of a polypropylene roller of 300 mm diameter and 440 mm length, which has a 25 mm diameter shaft attached concentrically on both ends.

Cylindrical Sieve

For testing purpose, three stainless steel cylinders (SS 304) with same sieve opening size of 20 x 4 mm and different diameters at inlet and outlet ends were fabricated as shown in Fig 1. As average

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thickness of seeds is 5.48 mm (Bakane et al.2014), sieve size kept 20x4 mm so that no seed come into pulp.

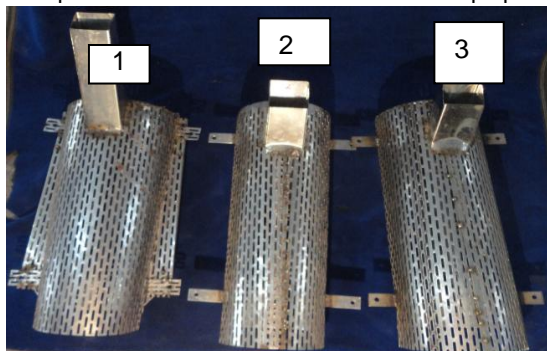


Fig -1 Cylindrical Sieves Used in Custard Apple Deseeding Machine

Main Frame

The cylindrical sieve along with roller was bolted to a frame. The frame was fabricated using stainless steel square pipe of size 20 x 20 mm. Slope of 19° is provided to the machine to facilitate the easy discharge of seeds from the lower end.

Pulley

Three driven pulleys of different diameters were used to test the performance of machine at different speeds.

Transmission Unit

Transmission unit consists of single phase, 0.25 hp and 1425 RPM electrical motor, driving and driven pulleys and a rubber V-belt.

Operation of Machine

Custard apple pulp can be deseeded by rubbing, squeezing or combination of both. As the custard apple seeds are toxic in nature precaution was taken that seeds should not break during operation of machine. Hence in this machine deseeding was mainly carried out by rubbing action of brush.

The completely ripe fruit was split into two halves. Then seeded pulp was removed by using table spoon. This seeded pulp was fed to the machine for deseeding. The roller rotates inside the cylindrical sieve. The seeded pulp when comes in contact with the rotating roller get separated into pulp and seeds due to the force of friction. The flakes (Thin layer present on the seed) are removed by the shearing action in between roller brush and the cylinder surface. The pulp along with flakes comes out through sieve opening and collected at the pulp outlet. The seeds moves down with the inclination and discharged through the outlet at the lower end as shown in plate 1 .

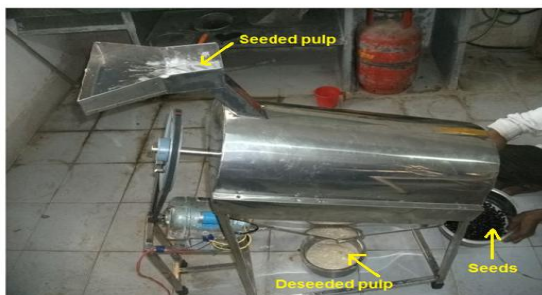


Plate 1 De-Seeding Machine for Custard Apple Pulp Performance Testing

After considering the relative importance of machine, crop factors that are directly related to the performance of machine and the available material at hand, machine was tested with following three independent variables

Independent Variable	Level	Responses
Roller speed	3	Machine efficiency,%
Cylinder diameters	3	Pulp loss, %
Feeding rate	4	Machine capacity, Kg/min

Results and Discussion

Performance of the Machine

Effect of Different Variables on Machine Capacity of Custard Apple Deseeding Machine

The effect of roller speed and feeding rate on machine capacity of custard apple deseeding machine for three cylinders of different sizes is shown in Fig 2a through 2c. In case of cylinder 1, the highest machine capacity of 36.08 kg/h was observed at 257 RPM roller speed whereas the lowest machine capacity of 11.09 kg/h was observed at 215 RPM roller speed. The machine capacity was found to be increased with increase in roller speed. This may be due to at higher roller speed the pulp must have moved forward faster along with rotation of roller brush. For cylinder 2 and 3 the machine capacity remains nearly constant for all three roller speeds. It was observed that machine capacity increased with increase in feeding rate for all three cylinders.

The maximum machine capacity for cylinder 1, 2 and 3 was found to be 36.08 kg/h, 34.92 kg/h and 33.96 kg/h, respectively. Though the higher machine capacity was observed for cylinder 1 as compared to other two cylinders, less pulp was separated from the seeds and more pulp loss was observed at seed outlet which was not desirable. This may be due to large clearance between roller and cylinder surface.

Fig. 2 (A) Effect of Roller Speed and Feeding Rate on Machine Capacity for Cylinder 1.

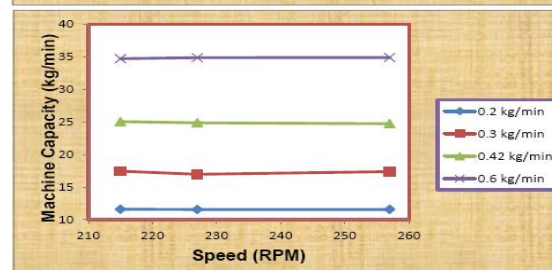
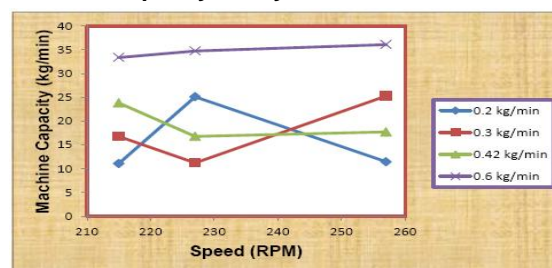


Fig. 2 (B) Effect of Roller Speed and Feeding Rate on Machine Capacity for Cylinder 2.

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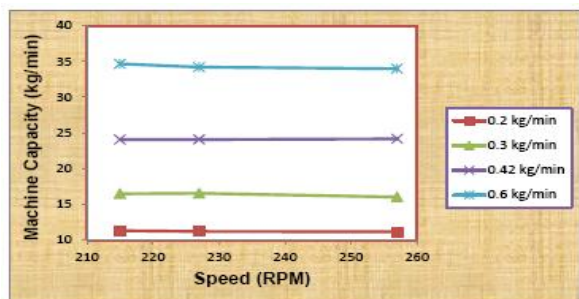


Fig. 2 (C) Effect of Roller Speed and Feeding Rate on Machine Capacity for Cylinder 3

Effect of Different Variables on Machine Efficiency of Custard Apple Deseeding Machine.

The effect of roller speed and feeding rate on machine efficiency of custard apple deseeding machine for three cylinders of different sizes is shown in Fig. 3a through 3c. The maximum machine efficiency of 59.90%, 82.50% and 66.57% was observed at cylinder 1, 2, and 3, respectively, at 257 RPM roller speed whereas the minimum machine efficiency of 50.77%, 70.33% and 57.00% was observed at cylinder 1, 2 and 3, respectively at 215 RPM roller speed. This indicates that the machine efficiency increased with increase in roller speed. The increase in machine efficiency with increase in roller speed could be expected due to more shearing action provided by the brush.

It was observed that machine efficiency was higher in case of cylinder 2 which was having clearance of 8.5 mm and 5.5 mm at inlet and outlet diameters respectively, which is less as compared to other two cylinders. Hence machine efficiency increased with decrease in clearance between cylinder surface and brush. In case of cylinder 1, 2 and 3 the maximum machine efficiency was found at 0.6 kg/min feeding rate and minimum machine efficiency was found at 0.2 kg/min feeding rate. It was observed that machine efficiency was increased with increase in feeding rate. This may be due to higher feeding rate, the quantity of seeded pulp feed to the machine was more which forms thick layer of pulp over the roller brush and fills the clearance between sieve and brush surface completely. Hence, more pulp must have separated from seeds because of more friction and shearing action which might have resulted into higher machine efficiency. At lower feeding rate less quantity of seeded pulp was fed to the machine which forms thin layer of pulp over the brush surface and does not fill the clearance between the sieve and roller brush completely. Hence, less pulp must have separated from seeds because of less friction and shearing action which might have resulted in low machine efficiency.

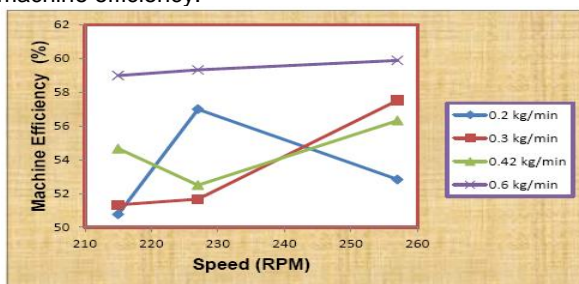


Fig. 3 (A) Effect of Roller Speed and Feeding Rate On Machine Efficiency for Cylinder 1.

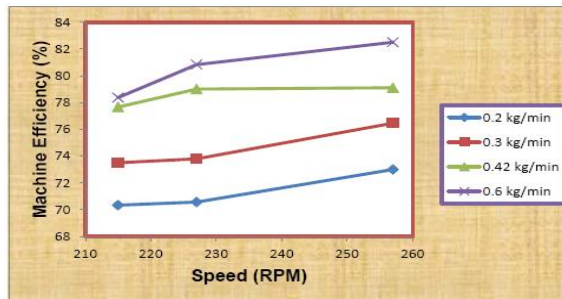


Fig. 3 (B) Effect of Roller Speed and Feeding Rate on Machine Efficiency for Cylinder 2.

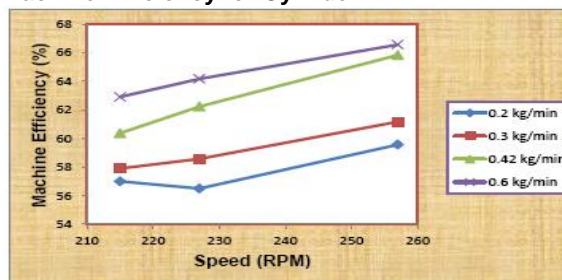


Fig. 3(C) Effect of Roller Speed and Feeding Rate on Machine Efficiency for Cylinder 3.

Effect of different variables on pulp loss.

The effect of roller speed, feeding rate on pulp loss for three cylinders of different sizes is shown in Fig 4a through 4c. The maximum pulp loss observed at cylinders 1 (24.42%), and minimum at cylinder 2 (2.09 %) was observed. The pulp loss was found to be decreased with increase in roller speed at all cylinders. This may be due to the reason that as roller rotates with higher speed more centrifugal force might have exerted on the pulp which forces it to come out of the sieve openings easily and reduces the quantity of pulp coming at seed outlet. This must have resulted in less pulp loss at higher roller speed.

In case of cylinder 1, 2 and 3 highest pulp loss was observed at 0.2 kg/min feeding rate and lowest pulp loss was observed at 0.6 kg/min feeding rate. This may be due to the reason that at higher feeding rate pulp must have filled the clearance between brush and cylinder surface completely. Hence due to more friction more pulp must have separated which resulted into decreased pulp loss. At lower feeding rate the clearance between brush and cylinder surface must not completely filled hence due to less friction less pulp might have separated which must have resulted into increased pulp loss.

Among three cylinders the minimum pulp loss was observed at cylinder 2 as compared to cylinder 1 and 3 this may be due to less clearance between brush and cylinder surface. Hence pulp loss was increased with increase clearance between brush and cylinder surface. (Kushawaha *et al.* 2005) reported that the seed loss increased with increase in concave clearance in case of okra seed extractor.

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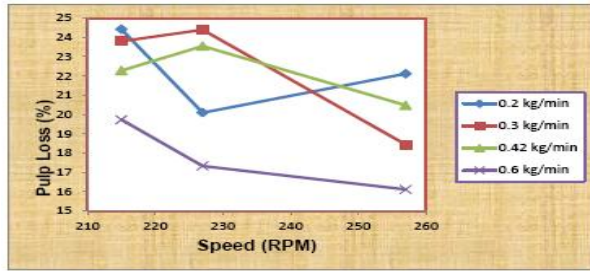


Fig 4 (A) Effect of Roller Speed and Feeding Rate on Pulp Loss for Cylinder 1.

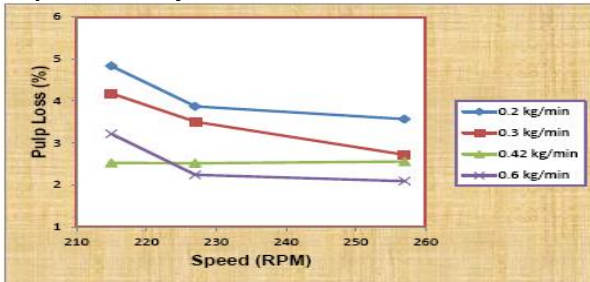
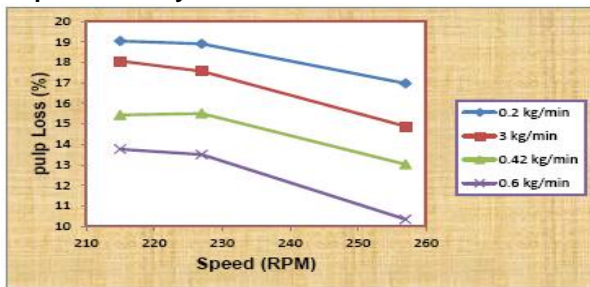


Fig 4 (B) Effect of Roller Speed and Feeding Rate on Pulp Loss for Cylinder 2.



Conclusion

The developed de-seeding machine for custard apple pulp gives better performance in terms of efficiency, capacity and pulp loss at roller speed of 257 RPM, feeding rate of 0.6 kg/min and cylinder no. 2 (inlet diameter of 213 mm and outlet diameter of 177mm with sieve opening of 20 x 4 mm).

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