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Development of pomegranate arils separator

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■ **ABSTRACT :** Pomegranate is high demanding fruit due to its unique properties. It is an important fruit crop of arid and semiarid regions of the world and India is the leading producer of pomegranate in the world. As per the data available on national horticultural board the annual area and production of pomegranate fruit for Maharashtra state in year 2015-16 is 128.40 ('000 Ha) and 1486.11 ('000 MT), respectively. As pomegranate having leathery pericarp, it requires more time for manual separation approximately 8-10 minutes for one fruit. The various materials required for the development of pomegranate arils separator are cylinder, shaft, nylon rods, stationary rods, motor, sieve, cutting mechanism, speed regulator, cylinder supporting frame, arils collection tray, etc. The performance evaluation was carried out on the product basis. In these parameters like aril removal efficiency (%), aril unremoved (%), mechanical waste (%) and capacity (kg/hr) of machine were calculated. The results of aril removal efficiency (%), aril unremoved (%), mechanical waste (%) and feeding capacity (kg/hr) were 76.18, 23.80, 14.10 and 38.34 kg/hr capacity at 250 RPM. The results performance was checked by using four different RPM like 150, 200, 250 and 300. In this 250 RPM was selected because it is observed that, as speed of motor increased at certain level it produced better results like high aril removal efficiency, high capacity and low mechanical waste than lower speed.

■ **KEY WORDS :** Pomegranate, Arils, Pericarp, Sphericity, Probes, Compression, Texture profile analysis

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Pomegranate fruit plays an important role in our daily life. Botanical name of pomegranate fruit is *Punica granatum*, which belongs to family Lythraceae. It is a small tree around 6-8 meters in height. Pomegranate fruit is native to Caucasus, the Himalayas in North Pakistan and Northern India. The physical shape of pomegranate fruit is spherical and size varies from 2.5-5 inch. Inside fruit there are numbers of arils present which are fleshy and darkish red in colour. The seeds are present inside the arils. The peel is well known for its astringent property. Pomegranate tree has lance shaped leathery leaf which is green in colour. Flower of pomegranate consists of 5-8 petals which is yellowish red in colour (Shah *et al.*, 2011).

Pomegranate is the largest demanding fruit in India. There are various processed products prepared from pomegranate but among these aril separation is somewhat difficult process (Singh and Sethi, 2007). Determination of physical and mechanical properties of pomegranate fruit plays important role for machine design and also for handling and storage. Some properties include geometric mean diameter, sphericity, surface area, volume, bulk density, etc. (Dhineshkumar *et al*., 2015). In the structure of pomegranate fruit, arils are fleshy in nature and which are tightly packed into rind. As pomegranate having leathery pericarp or outer skin. Due

to its rough surface it requires more time for manual separation approximately 8-10 minutes for one fruit (Gomathi *et al.*, 2015). Also due to manual method there is chances of arils became unhygienic due to its direct contact with hand. Now a day's arils separation is done by using large scale automatic machines or by manually. The pomegranate fruit has various therapeutic applications. The fruit is used in several systems of medicine for variety of ailments. The pomegranate is called as super fruit due to its unique properties. (Bhowmik *et al.*,2013).

Need for developing pomegranate arils separator:

This research study undergone with the development of pomegranate arils separator because there are some lacunas in existing pomegranate arils separator in the market as follows: This machine is applicable for small scale pomegranate processing industry. It is simple in construction and easily assembles and dismantles all parts easily than large automatic machines. Due to its simple in construction and easy to operate it does not require some prior knowledge to handle it. It requires less time for arils separation than manual method. The labour requirement is less; it requires only one labour for continuous operation. The cost of machine is low as it is economically feasible for small scale industry person. It can be operated on low power consumption. We can move machine from one place to other means easy to transport.

METHODOLOGY

Separation of arils from pomegranate is somewhat critical process due to its fleshy nature. The materials required for development of the arils separator were collected from Aurangabad local market. The fabrication was completed at Aurangabad and whole assembly was done at Farm Machinery and Power Engineering Lab, Department of Agricultural Engineering, MIT, Aurangabad. The various points considered for this study are mainly,

Development of pomegranate arils separator :

In order to develop pomegranate arils separator having medium capacity, it was decided to use electric motor for the separation. The materials required for the development were collected from market Aurangabad.

Machine description and working :

The first step is to cut raw pomegranate into four parts by cutter which helps to loosen the arils from rind as it is the thinnest part around the arils. The motor is assembled at top of the cylinder, and the rotational speed of motor is monitored by using non contact type digital tachometer. Shaft attached to the motor is hollow, holes are drilled and nylon rods are inserted horizontally. The sliced pomegranate fruits are transferred into the cylinder from hopper, within the peripheries surface, stationary rods are fixed

Table A : Materials required for development of pomegranate arils separator

Sr. No.	Part	Material	Size/specification	Feature/function of material
1.	Cylinder	Stainless steel	Height-380 mm, Inner Dia.-300 mm Thickness-1.5 mm	To hold the product during operation
2.	Shaft	Stainless steel	Height -465 mm Inner Dia -16 mm Thickness -20 mm	To fix the nylon rod and gives rotation for separation
3.	Nylon rods	Nylon	Length-290 mm Thick -12.5 mm (1/2")	Helps to separate arils from pomegranate fruit
4.	Stationary rods	Stainless steel	Length-100 mm (4") Thickness-8 mm	SS bolts acts as a stationary rod during rotation of shaft
5.	D.C. electric motor	-	Power- 180V 0.24 hp (178 watt)	To drive the shaft
6.	Cutting mechanism	Stainless steel	-	To cut the pomegranate into four equal parts
7.	Cylinder supporting frame	Mild steel	-	To provide rigid support to arils separator machine
8.	Peel/waste collection Tray	Stainless steel	300mm*300 mm	To collect peel

Fig. A : Pictorial view of developed model

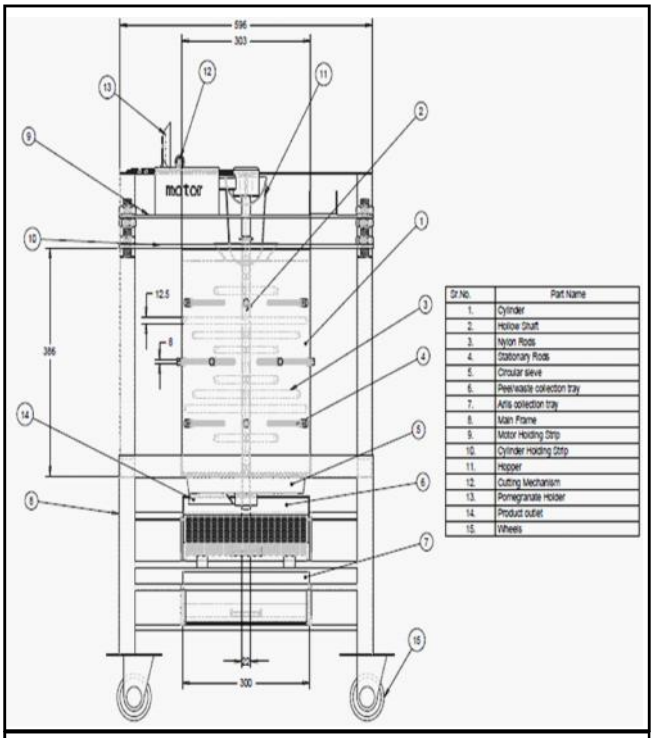

Fig. B : Two dimensional view of developed model

parallel in direction of moving nylon rods, they act as source of zig-zag pattern for pomegranate slices; which helps critically to separate the peel from arils during operation. Finally arils are collected into stainless steel tray below. The design considerations of developing lab scale arils separator is for high efficiency, less damage, low cost and for easy handling. The pictorial view and performance and two dimensional views of developed pomegranate arils separator is shown in Fig. A and B, respectively.

Performance evaluation of developed model :

After development of efficient lab scale arils separator with required specifications and sizes, it is needed to evaluate its performance. The performance evaluation was carried out on the product basis. In these parameters like aril removal efficiency (%), aril un-removed (%), mechanical waste (%) and capacity of machine were calculated. Performance parameters were evaluated at four different RPM's of 150, 200, 250 and 300. All trials were taken three times and the average of four was taken for final result. Time for each operation was recorded to calculate the capacity of machine.

Aril removal efficiency (%) :

$$A_{re} = \frac{W_{ar}}{W_{ar} + W_{au}} \times 100$$

Arils unremoved (%) :

$$A_u = \frac{W_{au}}{W_{ar} + W_{au}} \times 100$$

Mechanical waste (%) :

$$M_w = \frac{W_f - (W_{au} + W_p)}{W_f}$$

Feeding capacity (kg/hr) :

$$C_p = \frac{W_f}{T_m}$$

(Aviara *et al.*, 2013)

where,

A_{re} = Aril removal efficiency, A_u = Wt. of arils undamaged, A_d = Wt. of arils damaged, A_u = Arils unremoved, W_{ar} = Wt. of arils removed, M_w = Mechanical waste, W_f = Wt. of feed sample, W_{au} = Wt. of arils unremoved, W_p = Wt of waste peel, C_p = Capacity, T_m = Time

Table 1 : Performance results of four different rpm

Sr. No.	Shaft speed	Wt. of feed sample (W_f)	Wt. of arils removed (W_{ar})	Wt. of arils unremoved (W_{au})	Wt. of waste peel (W_p)	Time (T_m)	Aril removal efficiency (A_{re})	Aril unremoved (A_u)	Mechanical waste (M_w)	Feeding capacity (Cp)	Arils capacity
Unit	RPM	kg	kg	kg	kg	min	%	%	%	kg/hr	kg/hr
1.	150	2.015	0.685	0.394	0.935	3.62	62.89	36.51	19.56	33.39	11.35
2.	200	2.014	0.782	0.350	0.881	3.34	69.05	30.93	16.72	34.46	13.38
3.	250	2.013	0.908	0.284	0.821	3.15	76.18	23.80	14.10	38.34	17.29
4.	300	2.002	0.700	0.350	0.950	3.25	66.66	33.32	18.05	36.96	12.92

*Each value is an average of three determinations

Table 2 : Analysis of variance (ANOVA) for Table 1

Source of variation	*SS*	*Df*	*MS*	*F*	*P- value*
RPM	94336.92	3	31445.64	200.9306	7.204E-08* (< 0.05)
Wt. of arils removed	1252	8			
Total	95588.92	11	156.5		

Where, SS- Sum of squares, Df- Degree of freedom, MS- Mean of sum of squares, F value- Variance ratio and * Significant value

Statistical analysis :

The data were statistically analyzed for analysis of variance (ANOVA), Mean sum of squares, F value and P value.

■ RESULTS AND DISCUSSION

As developed model separates arils from fruit it is necessary to evaluate its efficiency, mechanical damage, capacity and operational time with different RPM. The rotational speed of shaft is checked by using digital non-contact tachometer. Fresh pomegranates of Bhagva variety were taken for performance evaluation. Firstly take the weight of pomegranate on weighing balance. Then cut the pomegranate into four parts by using sharp knife. After that start the machine and set the required RPM then observations were recorded. The following Table 1 shows the average results of four different rpm, respectively.

The data illustrated in Table 1 shows the performance results of four different rpm and calculated different parameters like aril removal efficiency, aril unremoved, mechanical waste, feeding capacity and arils capacity. It is clearly indicate that at 150, 200 and 250 RPM aril removal efficiency, feeding capacity and arils capacity goes on increasing and at 300 RPM all these results goes on decreasing. However, 250 RPM gives best results among four different RPMs.

The statistical analysis of results presented in that the variation in score between different RPM groups the arils removal rate is significant and p value is less

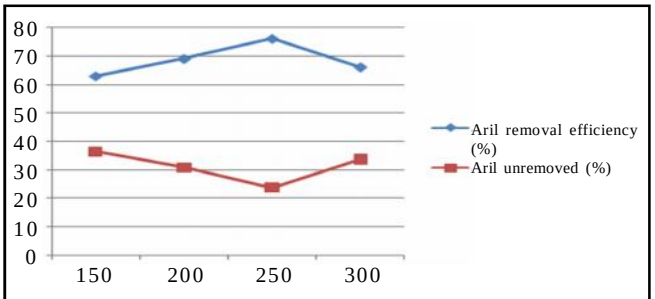

Fig. 1 : Average graph of four different RPM

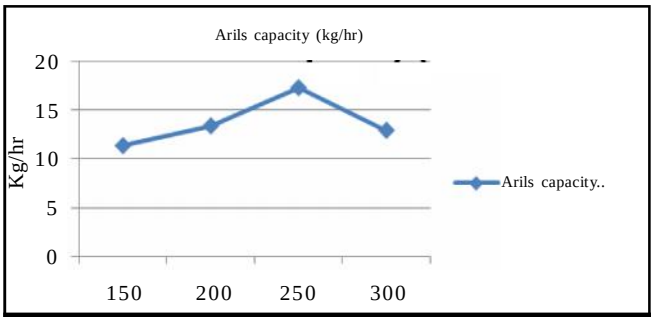

Fig. 2 : Capacity of arils removing per hour at four different RPM

Plate 1 : Pictorial view of final collection of peel and arils in tray

than 0.05.

Conclusion :

– The all parts of arils separator can be easily assembled and disassembled due to its simple construction.

– The machine is capable of separating arils of any size of fruit and any variety.

– The feeding capacity of developed machine is 38.34 kg/hr and aril removing capacity is 17.29 kg/hr feasible with respect to other pomegranate deseeder.

– In the performance evaluation it is observed that, as speed of motor increased at certain level it produced better results at 250 RPM like high aril removal efficiency, high capacity and low mechanical damage than lower speed.

– The efficiency of machine was 76.18 per cent and final cost of developed model was INR 10420.

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