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Development and Evaluation of Centrifugal Sheller for Muskmelon Seed

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Abstract

A refined design of centrifugal Sheller for muskmelon seed decortications was developed and evaluated. The developed machine has a capacity of 5 kg/h which operates on 1400 r.p.m emery roll speed and seed moisture content of 25 % (w.b), with this optimum condition, the shelling efficiency, seed damage and capacity was 51.0 %, 32 % and 5.0 kg/h, respectively. The decortication cost of muskmelon seed using developed machine was Rs. 1.20 per kg as compared with manual methods of Rs. 100.00.

Keywords: Centrifugal Sheller, shelling efficiency, seed damage.

Introduction

The seeds of musk melon, also commonly known as melon (Cucumis melo), are rich in protein and fat. The kernels are used in baking and dressing bread, cake, confectionery; sweets and snack foods[1]. A refreshing drink is prepared for ground melon seeds. The seeds are also a source of an enzyme and have medicinal uses. Large quantities of melon seeds are available in the country. They are normally collected by vendors and after manually dehulling is sold to the retailers are wholesalers. Manual dehulling is tedious and time-consuming. Muskmelon seed is held in a fibrous network that needs to be removed. Number of researchers worked on performance, optimization of centrifugal shelling, dehulling, physicochemical evaluation of muskmelon seeds. Some studies were effects of impeller vane configurations and seed size on dehulling efficiency of sunflower seeds using a centrifugal sheller[2], performance of centrifugal dehulling system for sunflower seeds[3], optimization of operation of operating parameters of a centrifugal sheller for dehusking `Jaya' variety paddy[4], studies on the chemical composition of cucurbit kernels and their seed coats[5], densities of Melon Seeds, Kernels and Hulls[6]. From the above discussion it was established that centrifugal shelling will be a suitable option for muskmelon seed decortication. Presently the seed is decorticated manually, which is very time consuming and non-scientific operation. Hence it was proposed for the design refinement of the centrifugal Sheller as per the suitability of muskmelon seed.

Material and Methods

Conditioning of the muskmelon seeds: The local variety of muskmelon seeds was procured from local market for testing and evaluation of the developed decorticator. The seeds were soaked in water to condition for optimized time to attain desirable moisture content for experimentation. The observation for time of soaking and attained moisture content (%, wb) was calculated and recorded.

Evaluation of centrifugal Sheller with muskmelon seed: Two Shellers viz. Satake rice polisher and centrifugal sheller based on centrifugal action and a rubber roller shaller was evaluated for suitability to decorticate muskmelon seed for *Magaj.* The experiments were carried out with pretreatment including condition to obtain suitable moisture content and maximum shelling efficiency.

Centrifugal force: The centrifugal force was calculated by using the standard formula as below:

$C_f = m. v^2. /r$

Where, C_f = centrifugal force, N; m = unit mass of seed, kg; v = velocity, m/s and r = radius, m

Design and development of Muskmelon decorticator: The main components of the decorticator consist of mainframe, hopper, emery roll, perforated concave, collection box, stopper plate and power transmission unit etc.

Design consideration: In general for the design of machines, the factors that affect its values are considered. The design and component detail was shown in figure. 1. The parameter consideration for development of Muskmelon seed decorticator was given in table 1.

Table-1
Parameter consideration for development of Muskmelon seed decorticator

S No.	Variables	Design value
1	Feed rate, kg/h	3-7
2	Cylinder concave clearance, mm	4-5
3	Cylinder speed, rpm	1400
4	Power, HP	1
5	Moisture content, (% wb)	20-25

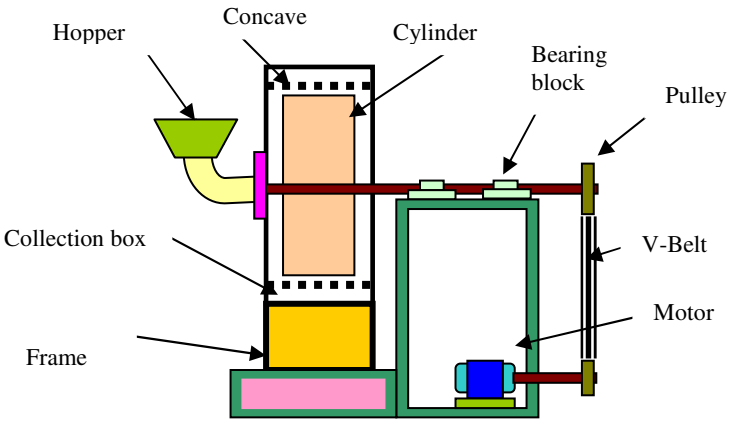

Figure-1
Design of muskmelon decorticator

Testing of Muskmelon decorticator: The developed Muskmelon decorticator of 5-kg/h capacity was tested. An electric motor of 1 HP; single phase was used as power source. The drive system was designed so that the emery rolls are near about 1440 RPM. At this speed the linear velocity was about 12 m/s, which was than the required velocity for efficient separation of the husk and other lighter impurities. The developed decorticator was tested for its performance.

The following test with described standard procedures was carried out:

Moisture content: The amount of moisture in Muskmelon seed is designated on the basis of the weight of the water and usually expressed in percent. For this test, the moisture content on wet basis is desirable. The moisture content on wet basis is obtained by dividing the weight of the water present in the material by the total weight of the material. Standard oven method is recommended to determine the moisture content of the muskmelon seed.

Broken kernels: It is determined by dividing total weight of shelled kernels to the weight of the broken kernels, multiplied by 100.

Capacity: The capacity of the decorticator is defined as kg of muskmelon seeds decorticated/shelled in one hour. For the determination of the capacity sample (5 kg) is taken and shelled in the decorticator. The stopwatch recorded the time required to decorticate the sample. The weight of the sample in kg divided by time in hours gives the capacity in kg/h.

Shelling efficiency: A decorticating machine generally terns out three products these are decorticated kernels, Unshelled kernels, hull and powder of full or fine broken kernels. The overall performance of the process is dependent upon decorticating/de-hulling efficiency, non-recoverable fraction of kernels and energy consumed to do the useful work. However, the decortication efficiency (D_c) as is expressed in percent and defined as ration of the decorticated material to that of the feed. Thus,

$$Dc = [(Ws + Wb + Wh) / Wt] \times 100$$

Where, Dc = Decortications efficiency, %; Wt = Weight of sample, g; Wh = Weight of husk, g; Wb = Weight of broken, g; Ws = Weight of decorticated sample, g

Techno-economic feasibility analysis of the centrifugal Sheller: The overall cost-economics was calculated considering cost, capacity and time of operation for developed centrifugal Sheller for its economic feasibility.

Results and discussion

Conditioning of the muskmelon seeds: Experiment on conditioning of the seed for decortications was carried as per the method discussed under § 13.2.2. The findings showed that as the soaking time increases from 10 min to 60 min, final moisture content, (% w b) increases rapidly. The maximum final moisture content of 28.35 % (wb) was attained in 60 minutes. After that the conditioned seeds achieved equilibrium moisture content (figure 2).

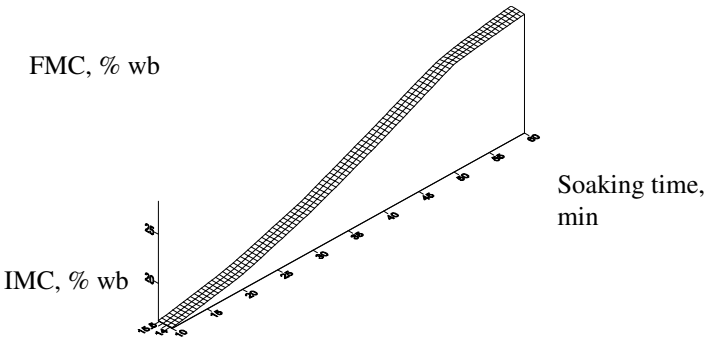

Figure-2
Solid surface graph (SSG) for conditioning of muskmelon seeds

Evaluation of centrifugal Sheller with muskmelon seed: The evaluation of centrifugal Sheller with muskmelon seed based on the experimentation on *Satake* rice polisher, centrifugal Sheller and a rubber roller Sheller, was done. The experimentation result showed that, centrifugal Sheller was not found suitable for decortications of conditioned seeds up to 60 minutes of soaking. The Sheller yield only un-husked and broken seeds. In addition with this rubber roller Sheller yielded only broken un-husked seed during entire levels of conditioning. However, the *Satake* rice polisher based on the principle of centrifugal as well as abrasion was found suitable after yielding 46 % of shelling efficiency in single pass at 20.24 % moisture content (w. b) in 40 minutes of soaking time. Hence, three moisture levels ie 20 %, 25% and 30 % were considered for further experiments with developed decorticator for muskmelon.

Design refinements: The existing *Satake* dal polisher design was refined to decorticate successfully muskmelon seed. The main refinements were done in emery grit size and concave perforation size. In refined design, the emery grit size was suitably reduced to 0.3 mm from 0.5mm. Changing the grit size increases the decortication efficiency from 46 % in old design to 51 % in refined design. The concave perforation size was also reduced from 5 mm to 3 mm. The modification in concave perforation size reduced the broken seeds up-to 32 % in refined design of muskmelon seed decorticator and further improved the efficiency. The chute height was also increased to 150 mm keeping in view the ergonomics. A feed control plate was provided at the inlet to control the feed rate as desired which was missing in old design. The details of refinements are given in table 2.

Table-2
Refinement details of muskmelon seed decorticator

S No	Parameters	Old design	Designed refined muskmelon decorticator
1	Grit size, mm	0.5	0.3
2	Concave perforation (oblong), mm	20 x 5	20 x 3
3	Chute height	100	150
4	Feed control plate	Nil	Provided

Testing of Centrifugal Sheller: The developed centrifugal Sheller/decorticator was tested and evaluated.

Effect of moisture content on shelling/decorticating efficiency and kernel damage: In this experiment, at different moisture content of 20, 25 and 30 %, (wb) the muskmelon seed was fed in the decorticator keeping the drum speed constant at 1400 rpm and feed rate at 5 kg/h to study the effect of moisture content on shelling efficiency and the seed damage (figure 3).

The decorticating efficiency was observed maximum at 25 % (wb) moisture content and then decreasing at 20 % (wb) moisture content and 30 % (wb) moisture content. Similarly the moisture content does affect the seed damage. On increasing the moisture content up to 25 % the seed damage was 32.0 %, and then it also started increasing beyond 25 % moisture content.

Effect of feed rate on shelling/decorticating efficiency, capacity and seed damage: The feed rate controls the capacity, breakage, decortications efficiency and overall performance of the developed decorticator. In an experiment, the effect of feed rate on shelling/decorticating efficiency, capacity and seed damage was studied and the results were summarized in table 3.

It appears from the above table 3, that the increasing the feed from 3 to 7 kg/h the maximum decorticating efficiency of 51.2 % is obtained. Beyond 6 kg/h the efficiency decreases. However, the seed damage appears to be directly proportional to the feed rate as it increases from 22 to 35 %. The capacity of the decorticator increases with increasing the feed rate to a maximum level of 5.2 % at feed rate of 6 kg/h.

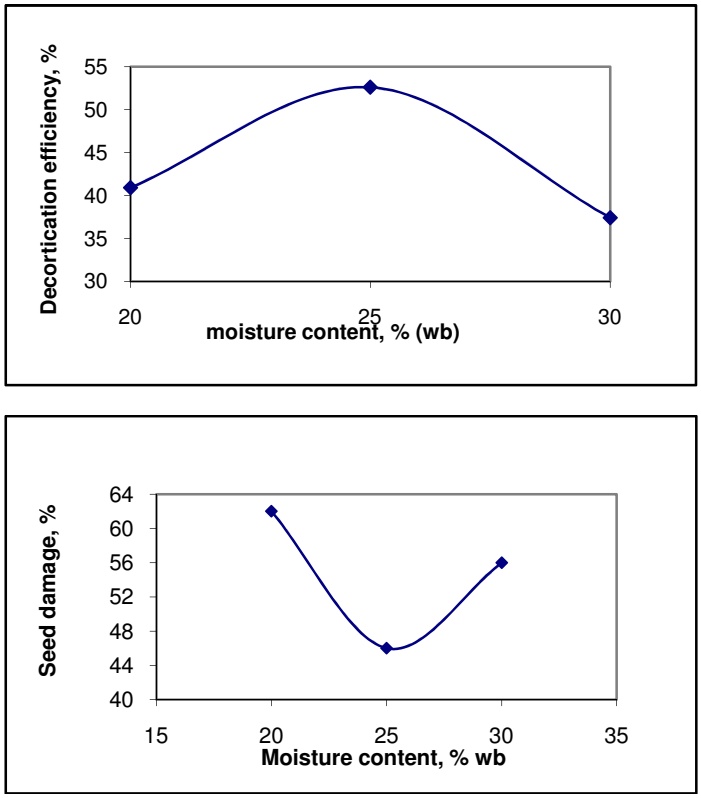

Figure-3
Decortications efficiency of muskmelon seeds at different moisture content and kernel damage (drum speed at 1400 rpm and feed rate at 5 kg/h)

Table-3
Effect of feed rate on shelling/decorticating efficiency, capacity and seed damage

Feed rate, kg/h	Decorticating efficiency, %	Capacity, kg/h	Seed damage, %
3	47.2	2.8	22
4	49.4	3.5	28
5	49.8	4.4	29
6	51.2	5.2	33
7	49.6	4.4	35

Techno-economic feasibility analysis of the muskmelon decorticator: Cost of decortications per kg of muskmelon seeds was calculated. Basic assumptions such as life of the machine, cost of equipment, cost of energy and other parameters are considered. The cost of decortications per kg of muskmelon seeds was calculated as Rs. 1.20. It was also calculated that 100 % value would be added by processing of muskmelon seed for *Magaj.*

Conclusion

A refined design of centrifugal Sheller for muskmelon seed decortications was developed and evaluated. The developed machine has a capacity of 5 kg/h which operates on 1400 r.p.m emery roll speed and seed moisture content of 25 % (w.b), with this optimum condition, the shelling efficiency, seed damage and capacity was 51.0 %, 32 % and 5.0 kg/h, respectively. The decortication cost per kg of muskmelon seed using developed machine was Rs. 1.20 as compared with manual methods of Rs. 100.00.

References

1. Gupta R.K., Technology for Commercialization: CFTRI, Technology Transfer and Business Development, CFTRI, Mysore, India **(2009)**

2. Das S.K. and Gupta R.K., Effects of impeller vane configurations and seed size on dehulling efficiency of sunflower seeds using a centrifugal sheller, *International J of Food Engg*., **1**, 1-7 **(2005)**

3. Gupta R.K. and Das S.K., Performance of centrifugal dehulling system for sunflower seeds**,** *J of Food Engg.,* **42**, 191-198 **(1999)**

4. Jain R.K. and Bhole N.G., Optimization of operation of operating parameters of a centrifugal sheller for dehusking `Jaya' variety paddy, *J of Food Sci Technol*., **23**, 252-256 **(1986)**

5. Madaan T.R. and Lal B.M., Some studies on the chemical composition of cucurbit kernels and their seed coats, *Plant Foods for Human Nutrition*, **34**, 81-86 **(1984)**

6. Teotia M.S. and Ramakrishna P., Densities of melon seeds, kernels and hulls, *Journal of Food Engg.,* **9(3)**, 23l-236 **(1989)**