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PERFORMANCE EVALUATION OF MANUALLY OPERATED SUNFLOWER SEED DECORTICATOR

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Abstract: Sunflower is one of the principle oil-seed crops which has a nice fitting in existing cropping pattern and adapted well to major agro-climatic conditions of the country. De-husking of sunflower seed is an important process prior to its oil extraction. Manual de-husking of sunflower seeds is a time consuming and tedious operation. Therefore, the effectiveness of a shear and impaction type decorticator for sunflower seeds was studied and evaluated for its performance parameters. The performance test for maximum seed yield was evaluated on the basis of various performance indicators, which includes percentage of whole seed, broken seed, un-husked seeds, machine capacity and decortication efficiency. These performance indicators of the decorticator were evaluated at three different seed storage moisture contents (9%, 12% and 14% d.b.) expand and at constant cylinder speed (56 rpm). The clearance between rotating cylinder and concave was fixed at 5 mm for optimum force. The best results of 52.73% recovery of whole seeds and machine capacity of 6.08 kg/h were recorded at seed moisture content of 9% (d.b.) and less broken seed percentage 0.76% was notified by decorticating seeds used at 14% moisture content the highest dehusking efficiency of 98.43% was observed with the decortication of 12% moisture content sunflower seeds.
Keywords: Decordicator, seeds, Manually operared, performance, treatments.

Introduction

Sunflower is one of the principle oilseed crops of india and gravity in an area of 1.48 m.ha, with a total annual production of 0.90 million tonnes and productivity of 607 kg per ha. Karnataka has the largest share in sunflower area (8.08 lakh ha.) and production (3.16 lakh t) in India, and is recognized as “Sunflower State” seed of the country. Sunflower seed is an achene, therefore, a dehiscent fruit. The coats of sunflower are produced by the ovule. The percentage of kernels and hull in sunflower is depands on cultivar, the seed size oil content. Their structure gives more rigidity to the hulls which are more likely to break under the impact of the dehuller. Processing of sunflower seeds include cleaning, washing, drying, shelling and oil extraction. Traditional method of shelling sunflower seeds is slow, time consuming, tedious, inefficient and is a drudgery. There has been more demand in the commercial side for oil extraction from sunflower seeds. This is because seed is having very

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good quality and quantity of edible oil which is good for health and also very economical, but the drudgery associated with sunflower seed processing before its end use influences to a greater extent its cultivation and cost. This has given concern to scientist and researchers in the recent past, particularly since women are the major processors of the sunflower especially at shelling stage (Olayiwole, 1987)

In view of facts presented above, proper dehusking method or machine needs to be developed to remove the outer husk of the sunflower seeds which helps in higher percentage of oil yield. Therefore, a research study was conducted to access the performance of the manual sunflower decorticator developed in the Department of Agricultural Engineering, University of the Agricultural Sciences, GKVK, Bangalore using the sunflower seeds of varying moisture contents and the decortication parameters were analysed statistically with a focus to suggest better processing method for farmers and commercial entrepreneurs.

Material and methods

The fully matured good quality sunflower seeds of variety *KBSH-44* were procured from AICRP on sunflower, UAS, GKVK Bangalore for conducting experiments. Cleaned and well dried raw sunflower seeds were stored in plastic bags to avoid the possible moisture imbibitias into the seed and also to prevent insect attack. Then the initial moisture contents of the seeds were determined by oven drying at 105±1 ^{o}C for 24 h (Ozarslan, 2002). The initial moisture content of the seeds was 8% on dry basis. The samples of the desired moisture contents were prepared by adding required the amount of distilled water as calculated from the following relation (Sacilik et al., 2003).

$$\text{Moisture Content (\%)} = \frac{\left(\begin{matrix}\text{Initial weight}\\ \text{of seed /kernel}\end{matrix}\right) - \left(\begin{matrix}\text{Final weight}\\ \text{of seed/kernel}\end{matrix}\right)}{\text{Initial weight of seed/kernel}} \times 100$$

All the dehusking operations of the seeds were determined at three moisture contents in the range of 9 to 12% d.b. with three replications at each moisture contents. The following methods were used to determine some dehusking parameters of sunflower decorticator.

Brief description of then newly developed manual sunflower seed decorticator

The manual sunflower decorticator designed to operate by means of roller mechanism, consists of a feed hopper, shelling unit, and outlet (Fig. 1). The hopper, which is trapezoidal in shape, mounted on the shelling unit at an inclination of the seeds angle of repose. Shelling unit mainly consists of the cylinder and concave. The cylinder was manufactured using dimple sheet of size 32.4×0.5 cm. The sheet was welded on the cylinder using bearings and flat plates in such a way that it forms the shape of a cylinder. The concave was fabricated

using 20 mm size mild steel rods. The length of concave was 30 cm with perforations of 5 mm, 4.5 mm and 4 mm size used at different treatments. It was made up of 18 gauge thick M.S. sheet and was bent to semicircular shape of diameter 18.5 cm and was rigidly fixed to give protection to the cylinder and avoid seeds spilling out. The roller shaft was one of the key components of the machine; other parts flats of cylinders and bearings were mounted on the shaft. The outlet was provided at the opposite end of hopper and just below the concave.

Testing of decorticator

The developed decorticator was tested as per standard procedures for various treatments. Before starting the actual testing shaft bearings and handle were a properly lubricated and pre checking of all the components was done manually. The clearance between cylinder and the concave were recorded using venires caliper. The cylinder speed was also recorded using tachometer and the constant speed was maintained throughout the operation. After the preliminary set up, sunflower seeds were then fed manually through the hopper into the cylinder concave space. The rotating cylinder controlled though the handle produced two kinds of forces like impact and shearing which caused the outer layer of the seeds (husk) to decorticate. Due to the presence of the concave which was wide open and the size of the perforations in the concave was based on the kernel size of the seeds, the kernels and the husk starts to the fall down through the concave opening which was collected in a tray at the bottom. The husk and the broken seeds will also get mix up in the main outlet and needs to be separated later. Two labors were required for these operations one for feeding seeds at hopper and other for rotating the handle and collecting de-husked materials at outlet. Weight of kernels, broken kernels and husk were recorded (separately), and time of operation to calculate output and efficiencies.

The procedure was repeated for all the combinations of treatments and data such as

1) Speed of cylinder (rpm),
2) Mass of seeds fed through the hopper (kg),
3) Mass of kernels after decortications (kg),
4) Mass of broken kernels (kg),
5) Mass of un-decorticated seeds (kg),
6) Mass of husk (kg),
7) Time of operation (h),
8) Clearance between the cylinder and concave.
9) Moisture content of whole seeds

By using these preliminary data the following performance indicators were estimated by using the formula given against these

$$\text{Decorticator Capacity (kg/h)} = \frac{\text{weight of seeds decorticated (kg)}}{\text{Time taken(h)}}$$

$$\text{Unhusked seeds } (\%) = \frac{\text{weight of unhusked seeds (kg)}}{\text{weight of total seeds fed (kg)}} \times 100$$

$$\text{Decortications Efficiency } (\%) = \frac{\text{Mass of seeds decorticated (kg)}}{\text{Total mass of seeds fed (kg)}} \times 100$$

$$\text{Kernel damage by mass } (\%) = \frac{\text{Mass of broken kernals (kg)}}{\text{Mass of total dehusked seeds(h)}} \times 100$$

Statistical analysis

The results of the machine performance for different pre-treated seeds decortications were analyzed using Fisher's factorial completely randomized design to determine the significant differences among treatments. Significant differences were tested by using F-test at 0.05 percent probability level.

Results and discussion

The results on performance evaluation of the newly developed manually operated sunflower decorticator operated at constant cylinder speed using sunflower seeds of different moisture contents namely 9 %, 12 % and 14 % moisture contents were presented in Tables 4.1, 4.2 And 4.3, respectively. The sunflower seeds were dried to 9 per cent moisture content (wb) and subjected to de-cortication to assess its shelling parameters . The results showed that, decorticator capacity, dehusking efficiency and percentage of seed breakage were 6.08 %, 98.03 % and 1.55 %, respectively.

Similarly, the sunflower seeds were soaked in water and seeds were dried to 12 % moisture content (wb) and the seeds were subjected to de-cortication to assess its shelling parameters and the results showed that, the throughput capacity, dehusking efficiency and percentage of seed breakage were 5.95 %, 98.43 % and 1.09 %, respectively.

Another treatment was drying of water soaked seeds to 14 % moisture content and the seeds were fed to manually operated sunflower decorticator and the performance evaluation results were revealed that, the shelling parameters namely, throughput capacity, de-husking efficiency and percentage of seed breakage were 5.95 %, 97.77 % and 0.76 %, respectively. This variation is might be due to presence of higher moisture content makes the product to experience less shear or impact force during the decortication which will reduce the breakage of seeds and the lower moisture content will make the seeds to detach the outer husk and to decorticate easily that will increase the capacity of the decorticating process. By analyzing all factors such as percentage of breakage, whole kernels, efficiency, unshelled seeds and

capacity, it was found that the on an average decortications of dried seeds (9%, d.b.) usage under constant cylinder speed and moisture content yielded the best results.

Conclusion

The study clearly revealed that, the use of manual sunflower decorticator in the farm field definitely has its own impact on reducing the time and labour required for dehusking sunflower seeds used for the extraction of the oil provided the sunflower seeds after the harvesting should be brought down to the safer moisture content. The study indicated that the manual hand beating tradition method used for the decortications of the sunflower seed used in the rural could be replaced by the use of manual sunflower decorticator evaluated in the present study thus helping the farmers to reduce the labor cost involved in dehusking process besides higher profit to the processor.

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Table 4.1 Performance Evaluation of Sunflower Decorticator with the sunflower seeds 9% moisture content (w.b)

Replications	Whole Seeds (g)	Dehusked Seeds (g)	Broken Seeds (g)	Undehusked Seeds (g)	Time duration		Husk (g)	Dehusking Efficiency (%)	Broken Grains (%)	Dehusking Through put Capacity (kg/h)	Whole Seed Recovery (%)
					Min	Sec					
R1	500	277	10.0	8.5	5.0	0.0	204.5	98.30	1.29	6.00	53.42
R2	500	274	12.5	10.5	4.0	56.0	203.0	97.90	1.61	6.08	52.39
R3	500	274.5	13.5	10.5	4.0	52.0	201.5	97.90	1.74	6.16	52.39
Mean	**500**	**275.17**	**12.00**	**9.83**			**203.00**	**98.03**	**1.55**	**6.08**	**52.73**

Table 4.2 Performance Evaluation of Sunflower Decorticator with the sunflower seeds 12 % moisture content (w.b)

Replications	Whole Seeds (g)	Dehusked Seeds (g)	Broken Seeds (g)	Undehusked Seeds (g)	Time duration		Husk (g)	Dehusking Efficiency (%)	Broken Grains (%)	Dehusking Through put Capacity (kg/h)	Whole Seed Recovery (%)
					Min	Sec					
R1	500	267	8.5	6.5	5.0	0.0	218.0	98.70	1.11	6.00	51.84
R2	500	269	6.5	8.5	5.0	3.0	216.0	98.30	0.85	5.94	52.23
R3	500	266	10.0	8.5	5.0	4.0	215.5	98.30	1.31	5.92	51.30
Mean	**500**	**267.33**	**8.33**	**7.83**			**216.50**	**98.43**	**1.09**	**5.95**	**51.79**

Table 4.3 Performance Evaluation of Sunflower Decorticator with the sunflower seeds 14 % moisture content (w.b)

Replications	Whole Seeds (g)	Dehusked Seeds (g)	Broken Seeds (g)	Undehusked Seeds (g)	Time duration		Husk (g)	Dehusking Efficiency (%)	Broken Grains (%)	Dehusking Through put Capacity (kg/h)	Whole Seed Recovery (%)
					Min	Sec					
R1	500	270	5.5	10.5	5.0	20.0	214.0	97.90	0.71	5.63	52.33
R2	500	272	6.5	12.5	5.0	15.0	209.0	97.50	0.84	5.71	52.41
R3	500	274	5.5	10.5	5.0	11.0	210.0	97.90	0.71	5.79	53.10
Mean	**500**	**272.00**	**5.83**	**11.17**			**211.00**	**97.77**	**0.76**	**5.71**	**52.61**