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Optimisation of the parameters related to sunflower seed shelling

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Abstract : In this study shelling of sunflower seed (Co 2 variety) was carried out in a centrifugal dehusker and the various crop and machine parameters were optimized by evaluating the performance of the centrifugal dehusker. The parameters studied were moisture content of the seed at 4 levels *viz.* 6.5, 9, 12 and 15 per cent (w.b.), peripheral speed of the impeller at 4 levels *viz.* 1700, 2000, 2300 and 2600 m/min., radius of curvature of the vanes at 4 levels *viz* 6, 8, 10 and 12 cm and the number of vanes in the impeller at 3 levels *viz.* 3, 4 and 5 number of vanes. The feed rate was maintained throughout the study as 60 kg hr^{-1}. All the parameters chosen for the study were found to be significant and their interactions were also significant statistically. The maximum shelling efficiency was obtained as 87.72 per cent at a moisture content of 6.5 per cent (w.b.) of the seeds with 4 number of vanes in the impeller, 8 cm radius of curvature of the vanes in the impeller and at a peripheral speed of 2600 m/min. The shelling efficiency was almost same (87.64 per cent) with 5 number of vanes and 12 cm radius of curvature of the vanes for the above said mositure content of the seed and peripheral speed of the impeller. *(Key words : Shelling, Sun flower seed, Peripheral speed, Impeller)*

The removal of outer seed coat hull by shelling is an important process in the sunflower processing. Sunflower seed contains about 30 per cent hulls, which contain about 50 per cent crude fiber. Hull contains very less quantity of oil (1.8 per cent) when compared with the oil present in kernel (50.3 per cent). Also hull makes more wear in the machinery and its presence during processing reduces in plant capacity apart from producing a low quality meal.

Various crop and machine parameters influence the hull separation process in a centrifugal dehusker. The important crop parameters are crop variety and moisture content of the seed, the important machine parameters are feed rate, peripheral speed of the impeller, radius of curvature of the vanes in the impeller and number of vanes in the impeller.

Materials and Methods

The sunflower seed variety Co2 was used for this study. The moisture content of the seed was taken in 4 levels *viz.* 6.5, 9, 12 and 15 per cent (w.b.) To obtain the moisture content of the seed at various levels, calculated quantity of water was sprinkled over the seeds and agitated well for 30 minutes. Then they were packed in 300 guage low-density polyethylene bags, sealed and kept for a week. Before starting the experiment the seeds were allowed to equilibrate in ambient conditions for 6 hours. The moisture content was tested before the start of the experiment using hot air oven method.

A centrifugal type sheller used for shelling paddy was used for this study. It consists of a feed hopper, rotating impeller with vanes, rubber lined striking surface and outlets for husk, unshelled seeds and shelled seeds. It is operated by a 2 hp motor. The shelling operation in the centrifugal sheller is done by the action of impact. When the material fed through the feed hopper is made to strike the rubber surface by the rotation of the impeller it gets shelled and they are separated. The components of the sheller were modified for shelling the sunflower seeds and the parameters influencing the shelling were optimized.

By keeping the feed rate in the sheller as 60 kg hr^{-1}. (by adjusting the slide gate in the feed hopper) the other machine parameters were varied in different levels as peripheral speed of the impeller at 4 levels *viz.* 1700, 2000, 2300 and 2600 m/min., radius of curvature of the vanes in the impeller at 4 levels *viz.* 6, 8, 10 and 12 cm and number of vanes in the impeller at 3 levels *viz.* 3, 4 and 5 number of vanes.

Factorial completely randomized design (FRCD) was adopted to conduct the experiments on shelling in the centrifugal dehusker. The performance of the machine was tested in terms of per cent shelling (shelling efficiency) and per cent seed damage using the following formulae (Nag *et al.* 1983)

$$\text{Shelling efficiency (per cent)} = \frac{\text{Weight of shelled seeds}}{\text{Weight of the seed fed in to the machine}} \times 100$$

$$\text{Per cent seed damage} = \frac{\text{Weight of damaged shelled seeds}}{\text{Weight of total shelled seed}} \times 100$$

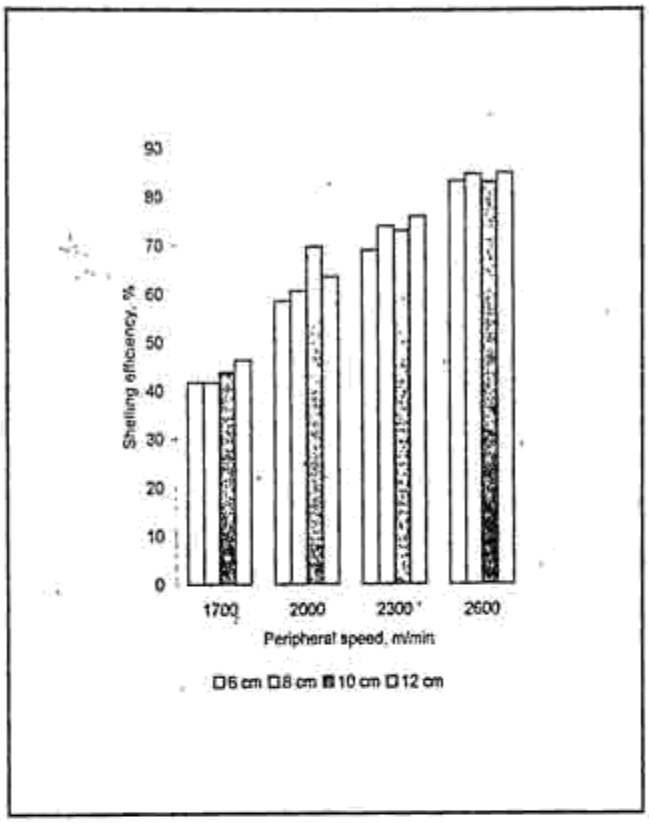

Fig.1 Shelling efficiencies of the centrifugal shellerfor various radius curvatures of the vanes at 6.5% (w.b) moisture content

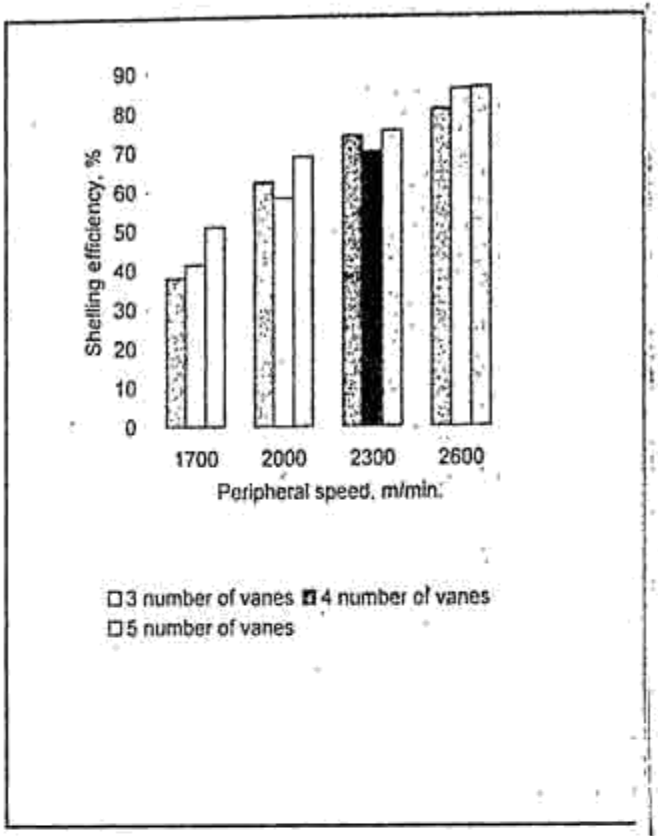

Fig.2 Shelling efficiencies of the centrifugal sheller for various number of vanes at 6.5% (w.b.) moisture content

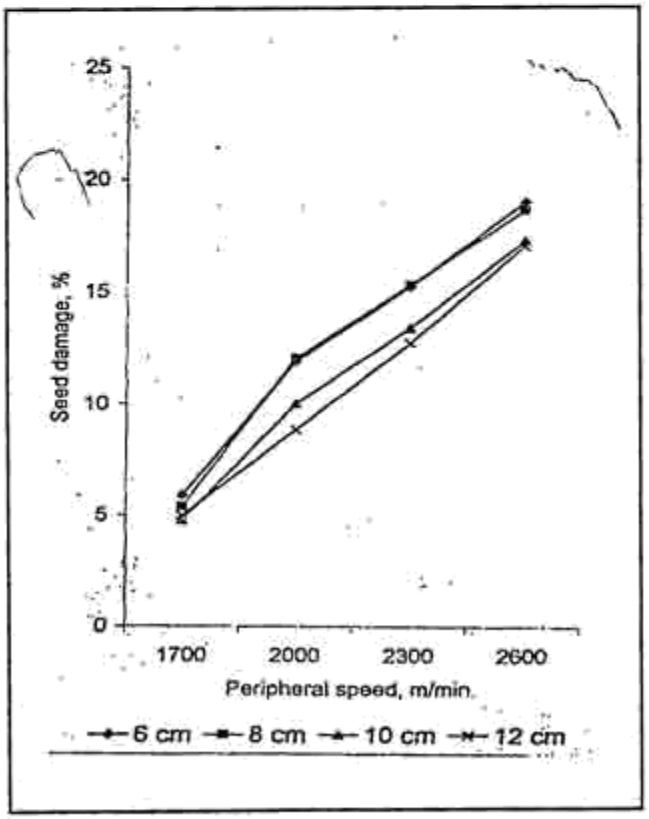

Fig.3 Seed damage (%) in the centrifugal sheller for various radius curvatures of the vanes at 6.5% (w.b) moisture content

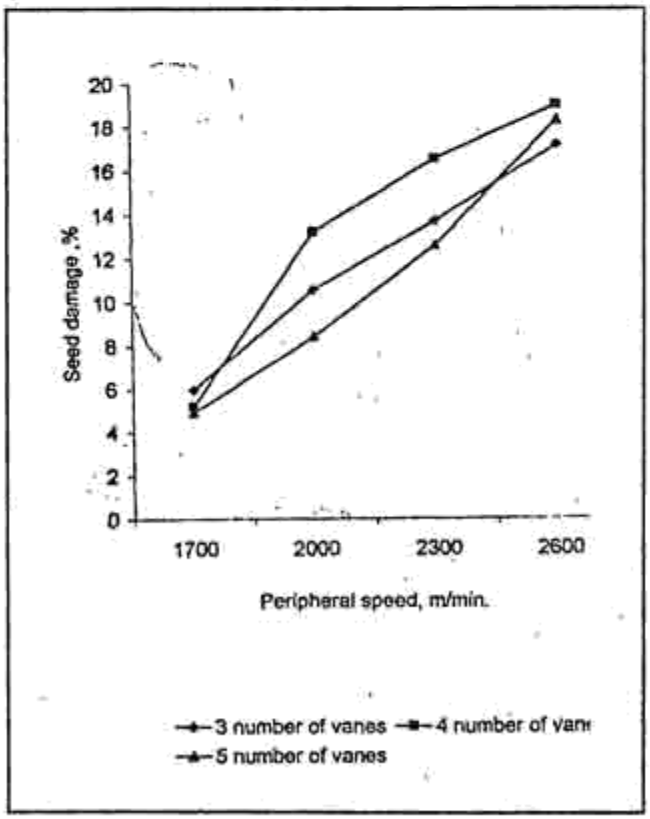

Fig. 4 Seed damage (%) in the centrifugal sheller with various number of vanes at 6.5% (w.b.) moisture content

The desired radius of curvature was obtained by cutting the M.S. plate to required radius by cutting and the different number of vanes were obtained by changing with 3, 4 and 5 number of vanes in the impeller. The thickness of the vane in the impeller was chosen as 1.6 cm so as to enable the seeds to move freely in the clearance between the discs of the impeller and the width of the vane in the impeller was 1.5 cm. The peripheral speed of the impeller was varied using a variable speed motor.

Results and Discussion

The performance of the centrifugal dehuskar was evaluated in terms of per cent shelling and percent seed damage (Figs. 1-4). The results obtained in the study were analysed statistically and they were found that the parameters selected and their interactions were statistically significant.

As the shelled kernel is being used for oil milling purpose, the per cent shelling was considered more important. Secondly the still excessive seed damage (more than 20 per cent) cause chocking in the oil expeller. Hence, the seed damage per cent was also taken into account while evaluating the performance.

Effect of moisture content of the seed on performance

The shelling efficiency and percent seed damage decreased with increase in moisture content of the seed. The average values of shelling were 65.68, 31.24, 29.06 and 23.80 per cent for 6.5, 9, 12 and 15 per cent (w.b.) moisture content. The maximum shelling efficiency obtained was 87.72 per cent at a moisture content of 6.5 per cent (w.b.) 4 number of vanes, 8 cm radius of curvature of the vanes and at 2600 m/min. peripheral speed of the impeller. The increase in the percent shelling efficiency due to the reduction in the moisture from 15 per cent (w.b.) to 6.5, 9 and 12 were 41.88, 7.44 and 5.26 per cent respectively. This shows that the results obtained in the study are better when compared with the result obtained by Nag *et al* (1983) that an increase in shelling of 18 per cent was obtained for a reduction in moisture content from 12.2 to 6.7 per cent (w.b.). The increase in shelling efficiency and per cent seed damage due to the reduction in moisture content of the seed are that at reduced moisture levels the brittleness of the hull is more and hence it is easily split by the action of impact.

Effect of peripheral speed of the impeller on performance

The peripheral speed of the impeller also increased the shelling efficiency and percent seed damage at all moisture content of the sunflower seeds. The average shelling efficiency of 43.35, 62.89, 72.75 and 82.68 per cent was obtained respectively at 1700, 2000, 2300 and 2600 m/min peripheral speed. The increase in shelling efficiency was 19.54, 29.4 and 44.33 per cent for the change of peripheral speed from 1700 to 2000, 2300 and 2600 m/min respectively. The increase in speed after 2600 m/min. causes more breakage (more than 20 per cent) which would result in chocking in the oil expeller during oil milling, hence with the constraint taken into account, the maximum shelling efficiency obtained was 87.72 per cent at 6.5 per cent (w.b.) moisture content of the seeds with 4 number of vanes in the impeller, 8 cm radius of curvature of the vanes in the impeller and a peripheral speed of 2600 m/min.

Effect of radius of curvature of the vanes in the impeller on performance

The shelling efficiency increased with increase in radius of curvature of the vanes as the peripheral speed was increased. The average shelling efficiencies obtained at different radius of curvature of the vanes namely 6, 8, 10 and 12 cm were 62.95, 66.01, 66.72 and 67.40 per cent, respectively. In general, radius of curvature of the vanes increased shelling as they spread the seeds uniformly over the hard surface. But the percent seed damage decreased with increase in radius of curvature at 6.5 per cent (w.b.) moisture content and there was no significant level of per cent seed damage at other moisture contents.

Conclusions

The optimum combination for sunflower seed shelling in a centrifugal dehusker was found to be 6.5 per cent (w.b.) moisture content, 2600 m/min peripheral speed of the impeller, 8 cm (if 4 number of vanes) or 12 cm (if 5 number of vanes) radius of curvature of the vanes in the impeller. The maximum shelling efficiency was obtained as 87.72 per cent.

References

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