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SUNFLOWER SEEDS: SMALL SCALE DEHULLING AND OIL EXTRACTION

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Developing countries are becoming increasingly aware of the need to develop small scale methods of processing oilseeds, and the Tropical Products Institute has received a number of requests for small capacity sunflower seed dehullers.

The TPI has designed and manufactured two different models. These are both hand operated and it is intended that they can be constructed in developing countries using materials which are mainly available locally.

One of the dehullers is a disc or plate mill (Slide 1) which is suitable for removing the hulls from lower oil bearing varieties of sunflower seed. A high percentage of whole kernels is produced which is an advantage when they are required for human consumption or confectionery purposes.

The mill consists of two cast iron discs (Slide 2) 190 mm (7.5 inches) in diameter and 9.5 mm (0.375 inches) thick, one of which is static and the other rotary. On the surface of each disc are 36 equally spaced radial grooves so designed that the seed drops into the grooves and is cut by shearing when one disc is rotated at 150 to 200 rpm. Seed is fed from a hopper through a hole in the centre of the static disc and the distance between the discs can be adjusted to accept different sizes of seed.

The capacity of the mill is up to 10 kg per hour with a whole kernel recovery of 90% on average. When dehulling for long periods, it is desirable to use two operators, one taking over when the other becomes tired.

The second hand operated dehuller, which is more suitable for dehulling high oil bearing varieties of seed, is a bar mill (Slide 3)

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consisting of a rotating cylinder made of metal or wood 100 mm (4 inches) diameter by 100 mm (4 inches) long, to which are fixed strips, or bars, of metal (Slide 4). A concave stator one quarter the circumference of the cylinder, also with metal sheet strips, has an adjustable gap between the rotor and the stator. Seed is fed from a hopper and passes between the rotating cylinder and the stator and is dehulled by the shearing effect of the metal strips.

The operating speed of this machine is 450 rpm and is achieved by belt driven step up pulleys. A wooden flywheel is incorporated to assist in maintaining a constant speed.

A bar mill was given field trials in a developing country. The locally grown black seed was processed at throughputs of up to 25 kg per hour. When the hull was winnowed off, 83% of the heavy fraction which remained was kernel and 17% hull; 93% of the available kernel was recovered by this method.

During our experimental work it was found that the dehulling efficiency decreased when the moisture content of the seed exceeded 9%. Accordingly all seed used in the trials reported in this paper had moisture contents of less than 9%.

Kernel is recovered from the dehulled seed in two stages. First by screening on two sieves with apertures of approximately 3 mm and 1mm respectively. Three fractions are produced: material which remains on the 3mm and 1mm screens and material passing through the 1mm screen.

Kernel is separated from the material remaining on the two screens by air separation or winnowing. A simple hand operated winnower was developed at the Tropical Products Institute for this purpose (Slide 5).

The total recoverable kernel is made up of the two kernel fractions obtained by winnowing and the material which has passed through the 1mm secreen. This latter is not winnowed to avoid loss of fine kernel.

As an alternative to air separation, the use of water was investigated to separate kernel from dehulled seed. Experimentally, 1 kg quantities of seed were coarsely ground in an electric coffee grinder then put into a vessel containing water. The majority of hulls floated whilst the kernel sank allowing ready separation into two fractions. The obvious disadvantage here is that the recovered kernel would require drying (Slide 6).

A small engine powered machine was also developed which dehulls the seed by means of a bar mill 200mm (8 inches) long by

200mm (8 inches) in diameter. Kernel is separated from husk by a system of sieves and air separators (Slide 7).

The capacity of the machine during field trials was in the order of 60 kg per hour with a kernel content in the recovered kernel fraction of about 90% when feeding locally grown seed and over 99% from imported seed. Total kernel recovery was in the order of 96%.

Rural Technology Guides which describe how to construct the two hand operated dehullers and the winnower will be published by the Tropical Products Institute.

In the development of a seed decorticator it is important to monitor the seed coat/kernel content of the various fractions in order to minimise kernel loss in the seed coat fraction and seed coat contamination of the kernel fraction.

The normal way of doing this is to take samples from the decorticator, physically separate the kernel and hull in each fraction and weight them.

Whilst this is tedious for the major hull and kernel fractions it is impossible to do with the "fines" fractions.

The procedure which we have adopted to overcome these problems is as follows. A sample of the whole seed is separated by hand into pure kernel and pure seed coat. The oil contents are measured using a Newport Quality Analyser. The oil contents of the seed fractions after decortication may then be measured and the percentage of kernel in the fractions obtained from the following relationship:

$$\frac{(a - c)}{(b - c)} \times 100 = \% \text{ kernel}$$

where a= oil content of fraction from decorticator
b= oil content of pure kernel %; moisture free
c= oil content of pure seed coat

Alternatively the % kernel/seed coat can be read from a nomogram as shown in Slide 8.

The procedure is rapid and simple and a single worker can determine the kernel/seed coat ratio of up to 50 samples from the decorticator in a day.

In investigations into oil extraction yields a small screw press expeller was used with a rated throughput of 25 kg-50 kg of seed per hour. The expeller was pre-heated with sunflower seed cake until the barrel temperature was about 90°C. The results of these investigations are presented in Slides 9 and 10.

The five sunflower varieties selected differed widely in their appearance and their oil contents (47.9% to 29.4% oil). Each type ofseed was into the expeller whole and at ambient temperature with no pre-conditioning of seed by grinding or heating. The choke in the expeller was adjusted to produce cake of 1mm thickness.

In a separate experiment black seed having an oil content of 47.9% was used to investigate the effects of dehulling and grinding on oil yield. Simple grinding of the seed prior to expelling had an adverse effect on oil yield and the residual oil content was 18.28%. This may be due to the unusual configuration of the expeller worm and its high operating speeds of 120 rpm. When feeding pure kernel a high residual oil content of 19.6% was produced. However, the crude oil produced per hour was higher than that from feeding whole seed because the oil content of the kernel was 63.8% compared to 47.9% for whole seed.

For further work on small scale oil extraction a small hand-operated hydraulic press was designed and built (Slide 11). It is stressed however that this work was experimental only as the high cost of producing the press and the relative low capacity does not make the press economically viable.

The press cage has a capacity of about 750 gm of whole funflower seed, or 1 kg of decorticated and ground seed. A maximum pressure of 8200 kPa (1200 lb/in^2) can be exerted on the material in the cage.

The results clearly indicate the benefits of decortication as an aid to oil extraction. The tests were arranged to determine yields of oil at different pressures and the following pressing regime was used.

Pressing time (minutes)	Approximate cage pressure (kPa)	(lb/in^2)
0-10	2000	300
10-20	4100	600
20-30	6100	900
30-60	8200	1200

With whole seed, oil was not obtained until the pressure reached 4100 kPa. The total yield averaged 150 gm of oil per kg of whole seed. This was equivalent to extracting 33% of the oil in the seed, based on a seed oil content of 45%.

With decorticated and ground seed, oil yield began at below 2000 kPa pressure, and the total yield for 1 kg of whole seed (ie before decortication) was 218 gm of oil, equivalent to extracting 48% of the oil present. Cooking the seed prior to pressing had no significant effect on the yield.

Another test in which pressure was inmediately applied at 8200 kPa, and maintained for one hour, showed that some 85% of the oil extracted was obtained in the first 20 minutes. This suggests that for maximum throughput a pressing time of about 20 minutes should be adopted despite the slight drop in efficiency.