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OILSEED PROCESSING TECHNOLOGY IN PAKISTAN
Part X. Small-Scale Dehulling and Processing of Sunflower

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A technology system for the processing of sunflower seeds at the village (small scale) level has been studied. The system studied combined the use of an imported dehuller and the previously modified oil expeller. Details of the expelling characteristics of the undecorticated and partially decorticated sunflower seeds and their effect on oil yield are discussed.

Key words: Sunflower, Oil expeller, Seed.

Introduction

Sunflower as an oilseed crop was introduced in Pakistan during 1960s and commercial production started in 1970. Since then, the area under cultivation has been increasing steadily (from 0.7 thousand hectare in 1970 to 29.5 thousand hectare in 1988-89) and consequently the sunflower seed production has increased. The production for 1988-89 was recorded as 34.4 thousand tons with 1167 Kg. per hectare yield'. This production is likely to increase in future because of the ever increasing shortage of edible oil in the country.

At present, all the sunflower seed production is processed by the large solvent extraction plants located mainly in urban areas. These plants are equipped with (high costing) commercial decorticating machines being used both for sunflower and cotton seeds for maximum possible oil yields. There exists no low cost, village-level technology, in Pakistan, to decorticate and process these seeds effectively. It was, therefore, considered necessary to develop a low cost, small-scale dehulling and processing system for adoption at the village level in the country. The present report describes such a system for sunflower seeds while another for the small scale decortication and processing of cotton seeds will be dealt with separately.

Dehulling of sunflower seeds is essential for obtaining comparatively high yield and better quality edible oil in addition to increasing the feed value of the pressed cake. In sunflower seeds the approximate percentage of hulls and kernel are 25% and 75% respectively and about 99% oil is stored in kernels while hulls contain not more than 1% oil. If the hulls are not removed before processing they reduce the total yield of oil by absorbing or retaining oil in the press cake. The wax and the colouring matters of the seed hulls also get mixed with the expressed oil. This necessitates the refining process, which increases the production cost of the edible oil. The other disadvantage of processing the whole seeds is relatively more repair and maintenance cost of the processing equipment due to the abrasive action of fibrous materials of the hulls.

A number of practical units for dehulling sunflower seeds in world market are available, which are either manufactured on the concept of centrifugal threshing, rubber roller shelling or the rubber lined disc threshing [2-6]. It is a common observation that not all seeds are dehulled during single pass through a huller, therefore, unhulled seeds have to be recycled for removing maximum hulls. For the present study a small size dehuller of low cost was imported and evaluated for adoption.

The studies were thus undertaken to determine the small scale expelling characteristics of whole and partially dehulled sunflower seeds and their effect on oil yield. The objectives of the studies remained to develop and familiarize a new system for dehulling and processing of sunflower seed at the village level.

Materials and Methods

(a) The sun-dried and cleaned sunflower seeds, composed of kernels (72.2%) and hulls (27.8%) were partially decorticated to different degree on a small decorticating machine (Fig. 1) imported from Cecoco Co., Japan. The partially decorticated seeds were then processed to examine the effect on oil yield.

(b) *Decorticating machine.* The machine design is simple and works on gravity principle. The machine has a double walled, hollow disc, which is fitted with three blades inside it. The design of the disc is like a rotor being used in tubewells for sucking water from the wells. The rotor, inside the machine rotates at high speed (3200 rpm.) and sucks seeds through a small-hole from one side around the axil on which the rotor is fitted. The seed is then thrown with great force against the rubber lined, slanting walls of the outer cylinder. The mixture

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of kernel and hull was separated by means of the winnowing machine (Fig.2).

A batch of seed (20 kg.) was dehulled in three successive cycles. After each cycle the separated hulls were removed by means of winnowing/blowing machine, which is both hand and power driven (0.5 h.p. single phase motor). The weights of the hulls removed and the mixture of unbroken seeds and kernels in each cycle weighed and recorded. The dehulling efficiency was calculated by the separated hulls divided by the total hulls on seed and multiplied by 100. The capacity and dehulling efficiency in the three successive cycles were recorded and are produced in Table 1.

(c) *Modified expeller model-3.* The earlier modified expeller model-3 (Fig. 3), operated by 10 h.p. 3-Phase 440 volts, 950 rpm., was used for the processing of whole and partially decorticated seeds [7]. The experimental data for the processing of whole and decorticated seeds (such as 57.6%, 72% and 82%) is presented in Tables 2-5 respectively and compared in Table 6).

Results and Discussion

Dehulling of sunflower seeds. The sub-dried and cleaned sunflower seeds were laboratory analyzed for percentages of kernels and hulls present in seeds before subjecting to dehulling process. For this purpose a sample of 10 g was taken from the seed lot and hand cracked, which showed 14.44 kg. (72.2%) kernels and 5.56 kg. (27.8%) hulls in seeds (20 kg).

A batch of 20 kg. seeds was dehulled by the small decorticating machine in 3 cycles/passes. During each cycle the separated hulls were blown out by the winnowing/air blowing machine. It was observed that 3.2 kg. (57.6%); 4.0 kg (72%) and 4.56 kg. (82%) hulls on the total hulls bases, were removed in Ist, 2nd and 3rd cycles respectively and the energy consumption was 1.6 Wh. per kg. seeds dehulled (Table 1). When the number of passes were increased from three, it was seen that the separated kernels were broken into fine particles, which again adhered to the hulls and therefore, not separated for further processing for oil yield.

Processing of sunflower seeds. Experiments were carried out on whole (undecorticated) and decorticated seeds by removing hulls such as 57.6, 72 and 82% as were obtained during different cycles/passes by the decorticating machine. The expeller Model-3 was used for the processing of the seeds. The processing data with regard to capacity, number of cycles and energy consumption Wh. per kg. oil recovered is presented in Table 6. The processing data on whole (undecorticated) and different degree of decorticated seeds is discussed as follow:

(i) *Undecorticated sunflower seeds.* 20 Kg. seeds yielded 7.1 kg. oil (extraction efficiency 88.8% with a capacity of 100

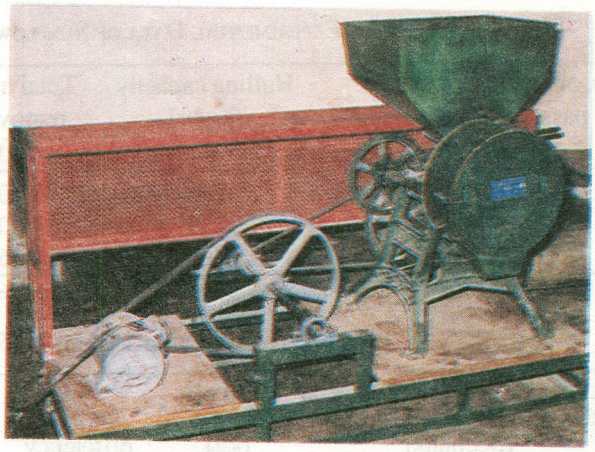

Fig. 1. Sunflower decorticating machine imported from Japan.

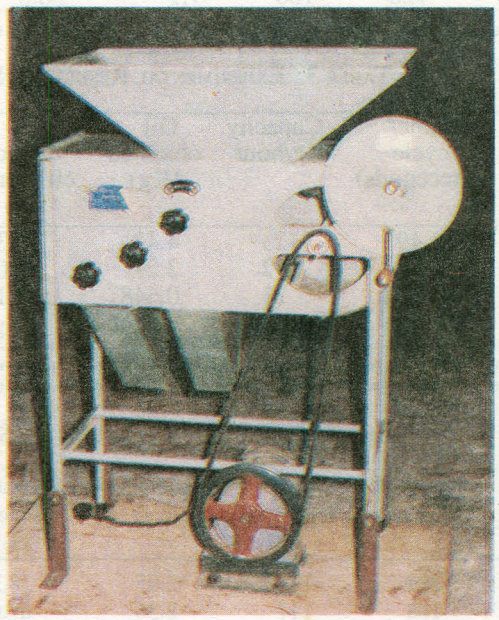

Fig. 2. Winnowing machine imported from Japan.

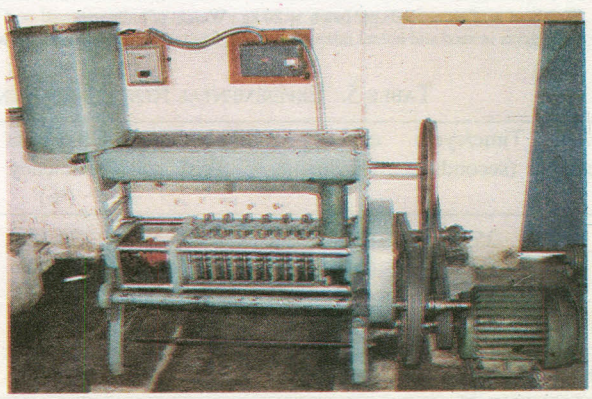

Fig. 3. Modified oil expeller model No. 3.

TABLE 1. DEHULLING EXPERIMENTAL DATA OF SUNFLOWER SEEDS ON SMALL-SIZE DEHULLING (DECORTICATING) MACHINE.

No. of. cycles/ passes	Time (seconds)	Hulling capacity (kg/hr)	Total hulls removed (kg)	Total unbroken seeds & kernels (kg)	Dehulling efficiency (%)	Energy consumed (Wh)	Wh/kg seed dehulled
1	290	248	3.20	16.80	57.6	13	0.6
2	230	139	4.00	16.00	72.0	22	1.1
3	224	97	4.56	15.44	82.0	32	1.6

Weight of Sunflower Seeds per batch dehulled = 20 kg.; Weight of total kernels present in seeds= 14.44 kg.; Weight of total hulls present in seeds = 5.56 kg..

TABLE 2. EXPERIMENTAL RESULTS ON SUNFLOWER SEED (UNDECORTICATED) PROCESSING.

No. of cycles	Time/ cycle (Seconds)	Capacity kg/hr	Oil obtained (kg)	Oil extract efficiency (%)	Residual oil contents in cake (%)	Foots obtained (Kg)	Energy consumed (Wh)	Ampere reading	Wh/kg oil expressed
1	420	171	5.5	68.8	17.24	-	910	13	166
2	300	100	1.6	88.8	6.98	-	700	16	227
Total:	720	100	7.1	88.8	6.98	-	1610	13-16	227

Weight of Sunflower seeds per batch processing = 20 kg.; Total oil contents in seed and kernel mixture = 40.0%; Seed treatment (addition of water) = 800 ml.

TABLE 3. EXPERIMENTAL RESULTS OF SUNFLOWER SEEDS (57.6% HULLS REMOVED) PROCESSING.

No. of cycles	Time/ cycle (secconds)	Capacity Kg/hour	Oil obtained (Kg)	Oil extract efficiency (%)	Residual oil contents in cakes (%)	Foots obtained (Kg)	Energy consumed (Wh)	Ampere reading expressed	Wh/kg oil
1	491	123	4.43	55.38	28.86	1.0	386	9	87
2	164	92	2.29	84.00	12.70	0.7	454	14	125
3	202	71	0.648	92.1	6.7	–	672	20	205
Total	857	71	7.368	92.1	6.7	1.7	1512	9-20	205

Weight of sunflower seeds per batch dehulled = 20 kg.; Weight of hulls removed = 3.2 kg.; Weight of partially dehulled seeds and kernels used for obtained processing data = 16.8 kg.; Total oil contents in seed and kernel mixture = 47.26%; Seed treatment (addition of water) = 800 ml.

TABLE 4. EXPERIMENTAL RESULTS OF SUNFLOWER SEEDS (71.94% HULLS REMOVED) PROCESSING.

No. of cycles	Time/cycle (seconds)	capacity Kg/hour	Oil obtained (Kg)	Oil extract efficiency (%)	Residual oil contents in cake(%)	Foots obtained (Kg)	Energy consumed (wh)	Ampere reading	Wh/kg oil expressed
1	324	178	3.05	38.2	38.12	0.8	280	8	92
2	168	117	2.36	67.6	24.46	0.5	328	12	112
3	156	89	1.50	86.37	11.99	0.4	424	17	149
4	168	71	0.605	93.93	5.71	-	448	18	197
Total	816	71	7.515	93.93	5.71	1.7	1480	8-18	197

Weight of sunflower seeds per batch = 20 kg.; Weight of hulls removed = 4 kg.; Weight of partially dehulled seeds and kernels used for obtaining processing data = 16.0 kg.; Total oil contents in seed and kernel mixture = 50%; Seed treatment (addition of water) = 800 ml.

TABLE 5. EXPERIMENTAL RESULTS OF SUNFLOWER SEEDS (82% HULLS REMOVED) PROCESSING.

No. of cycles	Time/cycle (seconds)	capacity kg/hr	Oil obtained (kg)	Oil extract efficiency (%)	Residual oil contents in cake(%)	Foots obtained (kg)	Energy consumed (wh)	Ampere reading	Wh/kg oil expressed
1	255	218	2.73	34.12	41.5	1.0	232	7	85
2	232	114	2.87	70.00	24.4	0.7	270	8	90
3	150	87	0.98	82.25	16.02	0.5	255	11	115
4	150	71	0.60	89.75	9.93	-	285	11	145
5	139	60	0.38	94.5	5.58	-	309	13	179
Total:	926	60	7.56	94.5	5.58	2.2	1351	7-13	179

Weight of Sunflower seeds per batch dehulled = 20 kg.; Weight of hulls removed = 4.56 kg.; Weight of partially dehulled seeds and kernels used for obtaining processing data = 15.44 kg.; Total oil contents in seed and kernel mixture = 51.81%; Seed treatment (addition of water) = 800 ml

TABLE 6. EXPERIMENTAL DATA ON SUNFLOWER SEEDS (WHOLE SEEDS, 57.6, 72 AND 82% HULLS REMOVED SEEDS).

Exp under Table Nos	Water added (ml)	Oil yield (kg); Extraction efficiency pressing cycle					Energy consumption; Wh/kg oil. pressing cycle				
		1	2	3	4	5	1	2	3	4	5
2.	800	5.5/68.8	1.6/88.8	-/-	-/-	-/-	166	227	-/-	-/-	-/-
3.	600	4.43/55.4	2.29/84	.648/92.1	-/-	-/-	87	125	205	-/-	-/-
4	600	3.05/38.2	2.36/67.6	1.50/86.37	0.605/93.93	-/-	92	112	149	197	-/-
5	600	2.73/34.1	2.87/70.0	0.98/82.25	.6/89.75	.38/94.5	85	90	115	145	179

Last cycle	Results after last pressing cycle			Capacity kg./hour	Total energy consumption Wh/kg oil	Experiment under Table nos.
	Residual oil contents	Total oil yield	Extract efficiency			
2.	6.98	7.1	88.8	100	227	2
3.	6.7	7.368	92.1	71	205	3
4.	5.71	7.515	93.93	71	197	4
5.	5.58	7.56	94.50	60	179	5

kg/hr. in two cycles. The energy consumption per kg. oil recovered was 227 Wh. (Table 2). Process was observed to be smooth because of the high presence of the fibrous materials (hulls).

(ii) *Hulls removed (57.6%).* Initially a batch (20 kg.) of sunflower seeds was dehulled by small size dehulling machine to remove some of the fraction of hulls from them. The process removed hulls (3.2 kg.) in first pass through the machine. The remaining mixture (16.8 kg.) of undehulled seeds and separated kernels was processed by expeller. The mixture yielded oil (7.368 kg.) during 3 successive cycles (extract efficiency 92.1%) with a tendency of decreasing capacity of 71 kg. per hour in 3 cycles due to removal of fibrous materials (Table 3). It means when 57.6% hulls were removed from the seeds, it resulted in the production of relatively low pressure, inside the expeller and consequently the number of cycles were increased. The energy consumption was lowered due to extra yield of oil for per Kg. oil yield i.e. 200 Wh/kg. oil instead of 227 Wh. as in the previous case (Table 2).

(iii) *Hulls removed (72%).* A batch of sunflower seeds (20 kg.) was dehulled in 2 cycles, which removed hulls (4 kg.) from them. The remaining mixture (16 kg.) was processed to express oil (7.515 kg.) with an extract efficiency of 93.93% and capacity of 71 kg/hr. in 4-pressing cycles. The energy consumption for the last cycle was 197 Wh/kg. oil recovered (Table 4).

(iv) *Hulls removed (82%).* The sunflower seeds (20 kg.) were dehulled by dehulling machine in 3-passes. This process removed hulls (4.56 kg.) from the seeds. The hulls free mixture, or meat (15.44 kg.) obtained by removing 82% hulls, was processed by the Expeller to yield oil (7.55 kg.) extract efficiency 94.7% in 5 cycles. Since the number of cycles were increased to 5, therefore, capacity dropped to 60 kg/hrs. The energy consumption Wh/kg. oil was recorded 179, which showed a trend of decreasing energy consumption in the case of oil recovery (Table 4). The capacity decrease was attributed to the presence of low fibrous materials (hulls) inside the 82% dehulled seeds).

Conclusion

The experimental data for the processing of whole (undecorticated) and decorticated seeds of different degrees such as 57.6, 72 and 82% hulls removed is compared in Table 6.

A batch of 20 kg. whole sunflower seeds on processing yielded 7.1 kg. oil. When the same quantity (20 kg.) was dehulled to the above mentioned degrees and processed with oil expeller, it expressed relatively more oil; 7.368; 7.515 and 7.55 kg. respectively. The oil extraction efficiency improved from 88.8 to 92.1, 93.93 and 94.5% and residual oil content in cake was reduced from 6.98 to 6.0%, 5.71 and 5.58% respectively. It means that dehulling of sunflower seeds to different degrees i.e. 57.6, 72 and 82% (hulls removed) on processing yielded extra oil to the extent of 1.34, 2.075 and 2.25% as compared to processing whole seeds.

The energy consumption Wh/kg. oil expressed was 227, 205, 197 and 179 for the processing of whole seeds, 57.6, 72 and 82% dehulled seeds respectively. The energy consumption Wh. for per kg. seed dehulled in Ist, 2nd and 3rd cycles was 0.6, 1.1 and 1.6 respectively. It was, therefore, concluded that overall energy consumption is lowered to 9.4%, 12.7% and 20.4% on processing decorticated seeds in above mentioned degree of decortication.

The studies show that the small scale dehulling and processing system of sunflower seeds resulted in the increased production of oil and with appreciable energy saving. This simple technology seems to be suitable for adoption in the rural areas not only of Pakistan, but also of the other countries as well. It would also help in the creation of new self-employment chances as well as increase in the supply of edible grade oil at the village level.

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