Decorticating Linseed and Other Oilseeds

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Abstract

A unique model huller capable of effectively decorticating linseed and other small oilseeds was developed.

On linseed, a yield of 25 to 30% of apparently clean hulls was obtainable, but the hulls had an inherently high oil content ranging from 16 to 25%. Altho the oil in hulls has approximately the same iodine number and drying time as the kernel oil, it appears to be characteristic of the hull structure rather than absorbed from the kernel.

Decorticating hempseed with this same huller noticeably improved the oil color, and materially improved the protein content and appearance of the cake.

Good decorticating results were also obtained with this huller on cantaloupe seed, rapeseed, and some varieties of mustard seed. Tests on perilla were inconclusive.

AMONG the well known advantages of decorticating oil seeds before pressing are the following:

1. Increased oil yield — Separation of the non-oil-bearing portion of the seed, or a large part of it, prevents it from absorbing oil up to the amount normally left in cake after pressing. Altho in general practice the percent oil left in cake from decorticated seed is frequently slightly higher than in cake from whole-pressed seed, the actual amount of oil lost in cake per ton of seed is considerably less. Taking cottonseed as an example, a ton of seed gives around 1450 lbs. of cake if whole-pressed, but only around 900 lbs. if decorticated. If the whole pressed cake contains 4.5% oil, and the decorticated seed cake 5%, the corresponding amounts of oil lost in cake are 65¼ lbs. and 45 lbs. Thus decortication results in increasing the oil yield about 1% in this case. Separation losses affect this figure slightly, but not enough to materiallv reduce the advantage of decorticating.

2. Decreased working cost and overhead — The most expensive department of an oil mill is the press room, both as to cost of equipment and labor and other costs. If non-oil-bearing hulls or shells in the amount of say 25% of the seed are separated before the press room, the capacity of the latter will be increased 33⅓% with the same equipment, labor, and other costs; that is, the press room handling 100 tons daily of whole-pressed seed will handle 133.3 tons of decorticated seed. The press room costs, and to some extent the overhead of the whole mill, are reduced in direct proportion, less the cost of decorticating and separating, making a substantial net saving.

3. Increased value and marketability of products — For some oil seeds, the quality of oil is better when the seeds are decorticated. For all of them the value and marketability of the cake is increased, due to the higher protein content and improved appearance. The decreased bulk and weight per unit of protein for cake from decorticated seed give it a wider market because of lower shipping costs.

With these definite advantages for decorticating oilseeds, it was desired to determine whether this process could be economically extended to seeds other than those now commonly decorticated, the most important of which are cottonseed, peanuts, sunflower, cocoa beans and tung nuts. A cursory search of the literature revealed no reports of any efforts in this direction; in fact, there is not even any mention of the relative proportion of hull or shell to kernel for such seeds as linseed, hempseed, rapeseed, etc.

LINSEED — Some tests were made on Bombay linseed averaging 7.5% moisture and 43.0% oil content. When cracked by pinching on the edges with forceps the seed could be opened and separated into the hull and a yellowish white kernel, the former being 42.9%, the latter 57.1% of the seed. The inside of the hull was grayish white, and appeared oily under a glass.

Moistening some linseed resulted in softening the hard gum which covers the seed like a varnish, until it swelled up into a slippery, jelly like mass, this being a familiar property of all linseed. As the absorption of water progressed, it became increasingly easy to rub off the hull from the kernel by mild pressure between the fingers in a cloth. This corresponds to the manner in which sesame seed are decorticated for use in the bakery and confectionery industries, and of course other common applications of this principle are well known, such as the blanching of almonds and peanuts.

It was noted that the soft, wet hull tended to separate into two separate "skins," the outer one being quite thin, brownish, and semi-transparent; while the inner one was brownish on the outer side (next to the inner side of the outer skin) and whitish on the inner side, being thicker and more opaque. This separation of the hull into two parts took place more freely as the seed became wetter.

Some humidified seed were passed between a pair of wooden discs 2″ wide x 12″ dia. running at differential speeds and spaced apart just enough so as to scrape the seed as they passed thru. This "skinned" the seed fairly effectively, and the resulting mass of skins and kernels was separated partly by flotation in salt solution, and partly by handpicking. The hulls and kernels thus separated were dried and analyzed for oil content, showing 1.94% and 69.7% respectively.

When subsequent dry decortication tests (described hereinafter) gave hulls averaging 20% oil, and kernels 58%, the accuracy of the analyses on these wet-decorticated hulls and kernels was questioned. The apparatus for wet decortication had already been dismantled, and the test was not repeated; likewise there was no retained sample of the wet-separated hulls on which to check the analysis, altho the calculations of the original analysis were found to be correct. There was a retained sample of the original wet-separated kernels, however, and a check analysis 14 months after the first one showed 68.4% oil. This is a fairly good check, as some oil was probably oxidized in the interval. Thus it seems probable that this method of wet decortication did separate hulls of low oil content.

It is improbable that wet decortication would be a practicable or economical process for ordinary oil mill purposes, as the difficulty of separation of hulls and kernels and subsequent cost of drying them would make it impractical. Likewise the humidification might well harm the oil quality by increasing FFA or otherwise. The diffusion of the linseed mucilage or gum thruout the mass would be a serious obstacle.

The action of acids and alkalies on linseed was next tried, and it was found possible to char off the hull by concentrated sulfuric acid, or to disintegrate it by strong caustic. The cost of either of these processes, however, would doubtless be prohibitive.

Finally the real object of the tests was achieved by developing a dry decortication process. A model huller was built along unique principles, and this was found to be capable of decorticating the seed fairly effectively, especially after certain preliminary treatment. A rudimentary shaker screen and aspirator were also rigged up to aid in separating the kernels and hulls.

The average results of many tests with this equipment are given in the table of data. It was readily possible to separate 25 to 30% of clean hulls, but their high oil content, ranging from 16 to 25%, was disappointing. This was accompanied by a correspondingly lower oil in kernels, the whole balancing out fairly well with the seed. Thus, assuming 22% av. oil in hulls and 58% in kernels by mechanical separation, and on the basis of 42.9% hulls and 57.1% kernels in seed as shown by hand-cracking and separating, the oil in seed would be 42.5%, as against 43% found by analysis.

Evidently linseed hulls separated by dry decortication, either by hand or by mechanical hulling, are high in oil content. The wide variation in amount of oil found in hulls in various tests with this huller is due to several factors, among them: — The amount of oil absorbed by the hulls varied due to varied length of time the cracked seed mixture stood before the hulls were separated — The varying heat treatment to which the hulls and kernels were subjected in some cases before analysis probably affected the amount of oil extractible, as various investigators have shown. — The samples were imperfectly and variably ground, the hulls usually not being ground at all.

Dr. G. S. Jamieson of the Bureau of Chemistry & Soils, U. S. Dept. of Agriculture, found the iodine numbers and drying times of the oils extracted from the hulls and from the kernels to be practically identical, indicating that the oil content of the hulls may have been absorbed from the kernels. On the other hand, he first washed a batch of the hulls with petroleum ether to determine roughly the amount of "absorbed" oil, finding only 3.1%; subsequent grinding and prolonged extraction of the washed hulls gave 21.8% additional oil, indicating that the major portion of the oil in the hulls is inherent in their structure.

Mr. G. L. Keenan of the Food and Drug Administration, U. S. Dept. of Agriculture, made some microscopical examinations of linseed hulls and kernels supplied by the author, including samples separated by the model huller and others by wet decortication. He found that the hulls from dry decortication appeared to have a layer of the oil-bearing kernel substance adhering to the inner surface; likewise the "inner" skin of the wet decorticated hulls. The "outer skin" of wet decorticated seed showed no such oily material, nor even any absorbed oil. He concluded that the oil in the hulls is due to a part of the oily endosperm of the kernel remaining attached to the hulls. Since one analysis of dry decorticated hulls showed 21.9% protein with 18.8% oil, this conclusion appears to be supported.

It seems probable therefore, that when linseed are decorticated, a certain amount, probably variable, of the endosperm or kernel remains attached to the hull, increasing its weight and oil content. In wet decortication most of the actual woody hull structure separates as an "outer skin" containing no oil; while an "inner skin" consisting mostly of oily endosperm bears a part of the woody hull too. In dry decortication, an integral hull separates with a variable amount of oily endosperm sticking to it. This would help to account for the wide variations observed in oil content of hulls from dry decorticated seed, and would also explain why the quality of the oil in the hulls is the same as that of the kernels, altho it is inherent in the hull structure rather than absorbed from the kernel.

Under the circumstances, decortication of linseed for oil mill purposes would hardly be economical. Even if the woody hull alone could be separated without any adhering oily endosperm, probably the amount of it would hardly justify the operation. By observation alone, the inner skin represents considerably more than half the weight of the total hull; in other words, if the woody hull alone could be separated, it would probably be less than 20% of the seed, possibly only 10 to 15%.

MEDICINAL VALUE OF LINSEED HULLS — Boiled linseed (flaxseed tea) is a recognized mild laxative and intestinal demulcent. Since the boiled whole seed pass thru the digestive tract unchanged, their action is obviously due to the soothing, lubricating action of the gum that covers the outside of the seed and becomes very slippery and mucilaginous when wet, rather than to the acknowledged slightly purgative action of linseed oil.

Linseed hulls obtained in the above decorticating tests, when freed from oil, were found to have a mild laxative effect when taken in amounts of 1 tablespoonful a day or less. They appear to have the effect of an inert bulk laxative such as wheat bran, plus the lubricative effect of their natural gum. If most of the oil is extracted, and the hulls are subjected to a heat treatment, a not unpleasant flavor is developed.

The same cyanogenetic glucoside which has been found in linseed is present in the hulls, since they emit a faint odor of peach kernels when moistened and allowed to stand. The enzyme on which this reaction depends, however, can be easily destroyed, so that the hulls could be made entirely safe, just as linseed tea is safe due to boiling the seed. The amount of hulls ingested daily by a human for laxative purposes would not be dangerous in any case, even if they were not treated, as many times this amount would be required for harm to result.

HEMPSEED — It is believed that hempseed have not been decorticated in this country, altho there are reports of this having been done on a small scale in other countries.

The seed consists of a hard, rather thick shell, and a soft white kernel. The hull is covered by a light brown, flaky, paper-like skin, which is said to be poisonous to canaries when the seed are used as birdseed; and it is lined by a thin, waxy, greenish skin, part or all of which may adhere to the kernel rather than to the hull. Mature kernels are usually pure white, altho a small percentage are found which are greenish, these possibly being immature or damaged. A few brownish damaged kernels also occur.

The ordinary hempseed oil of commerce, pressed from the ground whole seed, usually has a more or less intense green color. This can be refined out, but is objectionable when very dark, or when the oil is to be used as a paint vehicle without refining. Presuming that this green color comes from the inner green skin principally, it was desired to see whether a superior oil could be obtained by decorticating.

A supply of seed, source unknown, was obtained from a seed store, and found to contain 7.7% moisture, 30.9% oil, 22.2% protein. Cracked and separated by hand, the proportions of hulls and kernels were 38.0 and 62.0% respectively. Oil extracted from some of the pure white kernels picked out by hand without any green skin adhering was found to be almost colorless; while that from kernels with the hard shell removed, but still enveloped in the green skin was decidedly greenish.

Some of the seed was decorticated, using the same unique model huller and rudimentary separating equipment developed for linseed, good results being rather easily obtained after establishing the proper conditions by various tests. Results are given in the table of data. 25% or more of clean hulls could be separated with only 2-3% oil when hulls and kernels were separated quickly. In a test on a larger amount of seed where the hulls and kernels remained in contact several hours after decortication, the oil in hulls was 6.7%. Another factor influencing the oil content of the hulls would probably be the amount of green skin included. Since these skins appear to be quite oily, the more of them removed from the kernels and included with the hulls, the higher the oil in hulls would be. It might be profitable to separate the green skins apart from the hulls, and press them for their oil, which would undoubtedly be dark green and require refining.

In one test, 33 lbs. of seed were divided, one part being pressed whole and unground in an Anderson Midget Expeller; the other part being decorticated and the kernel mixture pressed. The small amounts involved did not permit of accurate determinations of oil and cake yields, nor of efficiency of pressing on the two materials, the object being primarily to obtain samples of the oil for quality. Even this object was not wholly achieved, because the inefficient pressing of the unground whole seed probably did not extract all the color that would be normally obtained in a regular hot pressing of whole hempseed, and the oil, while dark green, was still not nearly so dark as some commercial oils; while the kernels were more efficiently pressed due to their softness and ground up condition, so that probably the color of the oil in their case more nearly resembled what would be obtained under plant scale conditions. The kernel oil was quite noticeably lighter in color than the whole seed oil, tho not sufficiently so to make any appreciable difference in the color of panels painted with paints made of the same pigment with the two crude oils as vehicles.

			10% Moist. Basis	
Cake, whole seed	60.8% yield	— 6.4% moist.	— 6.2% oil	— 30.3% protein
Cake, decorticated	26.9% yield	— 3.3% moist.	— 5.5% oil	— 51.0% protein
Clean hulls	29.7% yield	— 1.4% moist	— 6.7% oil	

On a plant scale, 25 to 30% hulls could probably be easily separated with an oil content considerably lower than that of the cake, altho it might be necessary to produce two grades of oil, one from the green skins, and the other from the pure kernel mixture.

The cake from the decorticated seed was of much better appearance, lighter color, etc., than that from whole seed, as well as much higher protein. It should be correspondingly more valuable and saleable.

These tests indicate that large scale decortication of hempseed for oil mill purposes would probably be practicable, altho they do not definitely prove that this would be advantageous. Finding a market for the hulls might not be easy, altho if the cake were sold on a unit protein basis, there would be but little loss if the hulls were discarded altogether.

CANTALOUPE SEED — The seed, obtained from the Port Huron Storage & Bean Co., Port Huron, Mich., were probably about a year old when tests were made. They cracked easily by hand when squeezed on the edges with forceps, and the kernels fell out readily. These hulls showed only 0.09% oil and 4.4% protein; while the kernels showed 48.3% oil and 32.9% protein. The seed contained 7.5% moisture, 29.1% oil; 39.9% hulls and 60.1% kernels.

Good results were obtained in the model huller (See table). On the basis of these tests, calculations can be made as follows:

	Whole Seed	Decorticated Seed
Cake yield (10% moist., 5% oil)	74.5%	52.1%
Oil yield	25.4	26.2
Protein in cake (10% moist., 5% oil)	28.8	38.6
Hull yield (1% oil in hulls)		30.0

Decortication of this seed would undoubtedly pay, if it existed in large enough quantities to be used for oil mill purposes.

RAPESEED — Some rapeseed obtained from a seed store, source unknown, analyzed 6.4% moist., 42.2% oil. Cracked by forceps they separated fairly well, the bright orange yellow kernels falling freely out of the black hulls. Proportions by hand separation, 17.8% hulls to 82.2% kernels. They worked well in the model huller (See table).

Due to the small relative proportion of hull to kernel in this seed, it is doubtful whether decortication would pay, unless the value of the cake were greatly increased by elimination of the black hulls.

PERILLA — A small sample of Perilla Nankinensis was furnished by Mr. Frank Rabak of the Bureau of Plant Industry, U. S. Dept. of Agric. It analyzed 6.6% moist., 33.8% oil; by hand cutting and picking 32.4% hulls, 67.6% kernels. These seed do not crack well in forceps, nor did the model huller open them very successfully, altho this may be partly due to the hulling elements having been unsuitable. Changing these elements to ones designed especially for Perilla might make considerable difference. Nevertheless, a considerable amount of hulls was separated by repassing the seed several times. The hulls aspirated out contained some immature seed which may have contributed to the 8.1% oil found in them. The softness of the kernels would tend to make oil absorption by the hulls larger than usual for this seed anyhow. Perilla seed is especially difficult to press, and the cake often contains 8% or more oil, so that separation of hulls with 8% oil would not necessarily prohibit decortication.

It seems probable, however, that the difficulty of pressing this seed

DECORTICATING LINSEED AND OTHER SEEDS													
	Whole Seed		Seed Cut and Picked by Hand		Products from Seed Decorticated Mechanically, Using Special Model Huller								
					Percent Yields			% Oil, (10% Moist. Basis)				% Protein (10% Moist. Basis)	
Material	% Moist	% Oil	% Hulls	% Kernels	Clean Hulls	Hull Screenings	Kernel-Hull Mixture	Clean Hulls	Hull Screenings	Pure Kernels	Kernel-Hull Mixture	Clean Hulls	Pure Kernels
Bombay Linseed	7.5	43.0	42.9	57.1	25 to 30	1 to 4	70 to 75	16 to 25	27.9-28.3	57.0-59.4	48 to 54	18.8	21.9
Hempseed	7.7	30.9	38.0	62.0	26.7	2.2	71.1	2.2 to 6.7					35.8
Cantaloupe seed	7.5	29.1	39.9	60.1	27.7 to 36.8	0.5	64 to 72	0.5 to 2.7		48.3		4.4	32.9
Rape seed	6.4	42.2	17.8	82.2	10.8	1.6	87.6	6.2					
(Nankinensis) Perilla seed	6.6	33.8	32.4	67.6	18.6	1.0	80.4	8.1					
Large yellow Mustard seed			20.7	79.3	17.3	0.6	82.1	2.9					
Small yellow Mustard Seed			20.1	79.9	13.7	3.7	82.6	19.6 (?)					
Small Brown Mustard seed	5.6				4.3								
Small Purplish Brown Mustard seed	6.9	34.8			11.9	4.9	83.2						

would be increased by removing the hulls, as the resulting pure kernels would probably be too soft to handle.

The particular variety of Perilla used in this test was quite small. Doubtless better decorticating could be done on some of the larger varieties.

MUSTARD SEED — Tests were made on 4 different varieties of mustard seed, 2 white mustard, and 2 black mustard. Actually the white mustard seed are yellowish, while the black seed are brownish.

Good results were obtained on the larger yellow seed, and fair results on the smaller yellow seed, altho in the latter case the hulling elements in the model huller were not suitable, and better results could have been obtained by providing correctly designed elements.

The brown mustard was more difficult to handle, especially one variety the kernels of which stuck in the hulls even tho it was not very high in moisture.

While decortication of mustard seed may not be of much interest to oil millers, it is possible manufacturers of mustard flour condiments might find some advantage in taking off the hull before grinding the seed.

Lint on Cottonseed by Analysis and by Nature

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Abstract

The quantative analysis for lint on cottonseed is successful in the laboratory, in that reproducible results can be obtained. The percentage of lint found cannot be translated to reliable predictions of actual yield values because of the effect on delinting efficiency of variations in seed size and shape, and the proportionate distribution of long and short fibers. Analysis for residual lint on delinted seed does not indicate the cellulose content of second cut linters.

FOR many years the chemists of the cotton oil industry have worked on the development of a reliable laboratory method for determining the amount of lint on cottonseed. The degree of interest and activity on this problem has varied with the value of linters. During each period of high prices interest revives and a new method is usually presented. The recent development of the analysis of second cut linters for cellulose content as a basis for evaluation and sale to the chemical industry stimulated interest in some sections in the analysis for lint on seed. It was thought that by determining in the laboratory and controlling in the mill the residual lint on seed, second cut lint of a uniform cellulose value could be produced.

The presentation of each new modification of a lint on seed analytical method is accompanied by data showing the precision of the method, and often some evidence of agreement with actual plant yields. Laboratory procedures for removing the lint from the seed have varied from the traditional use of sulphuric acid to the radical attempt to nitrate the fiber and explode it off. With the development by Malowan about 1921 of the use of hydrochloric acid to hydrolize the lint in order to grind whole seed for analysis, the use of this acid has been generally preferred. With the standardization of the acid fuming procedure of the official seed analysis method, most chemists concerned with the problem have developed their own lint on seed tests. Usually 50 grams of seed are fumed, the brittle lint is rubbed off, and the loss of weight calculated as percent lint on seed. The individual variations apply to the way in which moisture is calculated and results converted to predicted yield figures. Apparently the most accurate method is to determine the moisture on a separate portion of the original sample, and to dry completely the denuded seed. The difference between the total loss of weight, and the calculated loss due to moisture only, gives dry lint on dry seed. This figure can then be calculated to the desired basis, which is usually 8% moisture basis lint on original moisture basis seed.

The method of McKinney and Jamieson published in OIL & SOAP, Vol. XIII, No. 6, even with an assumed constant moisture in the fumed lint which was rubbed off, gave results which could be reproduced with some accuracy. With a well established routine, control of all moisture variables, and the use of 50 gram samples in duplicate, a uniform lot of clean seed can be analysed repeatedly with results agreeing within .5% of lint on seed. Therefore, as far as reproducible laboratory results are concerned, the analysis of clean cottonseed for percentage of lint is successful. That its use has not been applied more generally must be due to some reason in addition to the relatively high cost of analysis.