THE HULL CONTENT OF NORTH DAKOTA BARLEY VARIETIES

By

R. H. Harris, Cereal Technologist

A low hull content is desirable in feed barley since the hull is lacking in nutritive value. In the malting industry, however, a moderate proportion of hull is acceptable, but it should not be easily removed from the kernel. It constitutes 10% or more by weight of the kernel and forms, therefore, an important portion of barley, and is thus deserving of attention from the viewpoint of the plant breeder. Skinning and similar forms of damage to the kernel have an unfavorable effect on malting quality, and varieties which are easily harmed by threshing and handling are not as desirable for malting purposes as those which are not as readily damaged.

To develop barley varieties of specified hull content it is necessary for the barley breeder to possess information on this point, but knowledge of hull content has been difficult to obtain because of the labor and time required to determine this property by manual methods. In 1944, C. R. Fraser, working at the University of Saskatchewan, Saskatoon, Canada, developed an air jet technique for dehulling seeds which yielded reliable results by a fairly rapid, simple method. This method for barley consisted, in brief, of throwing the tempered grain violently against a wire screen lining the interior of a metal cup 2¼ inches in length and diameter. An air jet operating under a pressure of 20 pounds per square inch supplied the bombarding energy. A three-gram charge of barley was used for each determination.

Harris and Scott (1947) and Harris (1948) described a slight modification of Fraser's air jet method in ascertaining the hull content of some varieties of barley produced in North Dakota. It was found that tempering or wetting the grain before dehulling was not required, and therefore drying of the dehulled kernels before weighing was not necessary. The barley was first passed several times through a dockage tester to remove foreign material, then scoured to separate long awns, before using for dehulling. Various lengths of time were examined, and it was decided that 5 and 15 minute periods in the dehuller were the most informative. The 5 minute period yielded knowledge of the ease or rate of hull removal, while 15 minutes of treatment revealed the total quantity of hull present.

Fig. 1 shows the dehulling equipment disassembled on the left, with the dehuller in operating position to the right. The air hose, which operated at 17½ pounds per square inch, is in the central foreground. At lower right is a timing device employed for regulating the length of dehulling. Fig. 2 illustrates typical hulling results; many hulls are still in evidence after 5 minutes' treatment, but there is little or no trace of hull remaining after 15 minutes. Longer dehulling times tend to erode the kernel itself, and yield high results for hull content.

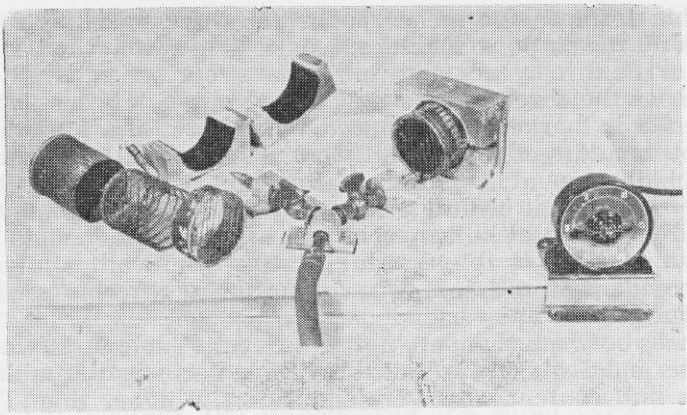

Figure 1. Dehulling equipment, showing container, wire cage, cover and opened holder at left while the huller assembled for use is shown on the right. At lower right is the timing device.

The results reported in this paper were obtained from two series of samples. One series embraces three crop years, 1946, 1947 and 1948, in which three varieties of barley were grown at each of six North Dakota stations, making possible a comparison among variety, location of growth, and seasonal influence on hull content. The other series consists of five varieties grown at seven stations in 1948 only, but affords a wider comparison of varieties than is presented in the first series. The data comprises values secured from both 5 and 15 minute treatments in each series.

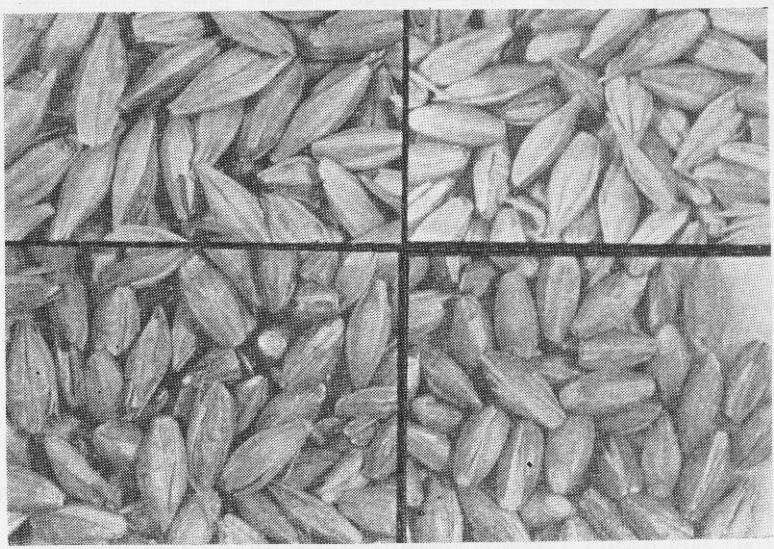

Figure 2. Typical appearance of barley before and after dehulling. Upper left before dehulling; upper right, after five minutes treatment; lower left after ten minutes treatment; lower right, after fifteen minutes treatment.

Table 1 shows the mean results for these varieties for three years at all the stations, for the six stations at which the barley was grown in the three years, and finally data representing hull content for each of the three years. As pointed out by Harris and Scott, kernel size is markedly influenced by variety, and hull thickness may not vary directly with hull content as found by this method. Rate of hull removal is expressed as percent of the total hull found, because the amount of hull removed after five minutes may be influenced by the total hull present and in this manner yield a fictitious value. It is possible that high rate of removal may indicate a greater tendency for "skinning" to occur during threshing and handling of the grain. The varietal averages are very similar and indeed differences between them are not significant (Table 2). It was found by Harris and Scott (1947) that these three varieties resembled each other in hull content, and were significantly higher than Trebi or Plush. In rate of hull removal, however, there are important differences between Manchuria and the other varieties.

For stations, there are significant differences in both hull content and rate of hull removal. Fargo, Minot and Dickinson are lowest in hull content, as reported by Harris and Scott; Edgeley, Williston and Langdon are very similar, also, as before. There are thus real differences in rate of hull removal between the six stations.

For years, the differences in hull content are significant, but for rate of removal they are not.

Table 1. Mean Values of Hull Content and Rate of Hull Removal

Varietal Means

Tregal		Manchuria		Kindred	
Total %	Rate %	Total %	Rate %	Total %	Rate %
12.1	70.8	12.0	62.8	11.7	69.1

Station Means

Edgeley		Williston		Langdon		Fargo		Minot		Dickinson	
Total %	Rate %	Total %	Rate %	Total %	Rate %	Total %	Rate %	Total %	Rate %	Total %	Rate %
12.9	70.4	12.7	73.6	12.0	58.4	11.7	71.7	11.2	66.4	11.1	64.8

Yearly Means

1948		1947		1946	
Total %	Rate %	Total %	Rate %	Total %	Rate %
12.3	66.1	12.0	68.1	11.5	68.5

Table 2 is an analysis of variance of the data, and offers mathematical proof of the significance or true importance of differences caused by varieties, locations of growth, or seasonal factors. There are three principal sources of variation corresponding to these, and the analysis brings to light the importance of each. The importance or significance of the differences which are represented by the variance values may be estimated by comparing the corresponding F values with the 5% and 1% point estimates. Thus, the F values for hull content between varieties is lower than either the 5% or 1% points, while the F estimate for between stations is higher than either point, and we accordingly state that the first F is not significant, while the second is significant at both points. If the F value is intermediate in size between the 5% and 1% points we say that it is significant at the 5% but not at the 1% point.

For hull content, the influence of the three varieties is not significant. The values are the same for the stations for the three year period. The environment under which the barleys were grown, however, exerted an important effect on hull content, particularly the environment related to the growth location, or station. The seasonal or yearly environment had somewhat less effect. Thus the hull content of barley is significantly influenced by the conditions of growth, as one would expect. It is also true that hull content is not affected in the same way at all stations in each year, as shown by the interaction of stations with years.

Table 2. Analysis of Variance of Hull Content and Rate of Hull Removal

Source of variation	Degrees of freedom	Variance		F value		5% point	1% point
		Hull content	Rate of removal	Hull content	Rate of removal		
Between varieties	2	0.5458	317.40	1.04	5.15*	3.49	5.85
Between stations	5	5.2994	277.13	10.11**	4.50**	2.71	4.10
Between years	2	2.6985	30.93	5.15*	0.50	3.49[1]	5.85[1]
Interactions:							
Varieties x stations	10	0.6255	120.72	1.19	1.96	2.35	3.37
Varieties x years	4	0.1213	18.47	0.23	0.30	5.80	14.02
Stations x years	10	2.4016	207.37	4.58**	3.36**	2.35	3.37
Varieties x stations x years (error)	20	0.5241	61.62				
Total	53						

*Denotes 5% level of significance was attained.
**Denotes 1% level of significance was attained.
[1] These values valid for hull content only.

The rate of hull removal differs with the variety as well as with the location where the grain is grown, but apparently the rate does not change from year to year of growth. The rate is not affected at all stations in the same manner by yearly influences.

The means secured from the second series of five varieties grown at seven places in 1948 are given in Table 3. The three varieties Manchuria, Tregal and Kindred are the same in hull content, but Montcalm and Moore are definitely lower. These last two are also lower in rate of hull removal. The stations differ more than the varieties in their effect on hull content, but not on rate of removal. For content the range is from 14.8% at Edgeley to 11.1% at

Table 3.—Mean Values of Hull Content and Rate of Removal for 5 Varieties Grown in 1948.

Varietal Means										
Manchuria		Kindred		Tregal		Montcalm		Moore		
Total %	Rate %	Total %	Rate %	Total %	Rate %	Total %	Rate %	Total %	Rate %	
12.2	65.0	12.1	68.1	12.1	67.3	11.2	60.3	11.2	53.8	

Station Means													
Edgeley		Fargo		Williston		Langdon		Minot		Dickinson		Williston (irrigated)	
Total %	Rate %	Total %	Rate %	Total %	Rate %	Total %	Rate %	Total %	Rate %	Total %	Rate %	Total %	Rate %
13.8	70.3	12.1	63.6	11.9	66.4	11.4	58.8	11.3	66.4	11.0	51.8	10.8	62.0

Table 4—Analysis of Variance of Dehulling Data from 1948 Crop

Source of variation	Degrees of freedom	Variance		F value		5% point	1% point
		Hull content	Rate of removal	Hull content	Rate of removal		
Between varieties	4	1.7707	237.79	3.41*	4.01*	2.78	4.22
Between stations	6	5.0516	195.12	9.73**	3.29*	2.51	3.67
Interaction: Varieties x stations (error)	24	0.5189	59.29				
Total	34						

*Denotes 5% level of significance was attained.
**Denotes 1% level of significance was attained.

Dickinson, a difference of about 25%. An analysis of variance of this data is provided in Table 4. The analysis shows that barley variety and station both influence hull content and the tightness with which the hull clings to the kernel. The principal effect is exerted on hull content by the station where the barley is grown.

The results discussed in this report show that barley hull properties are affected by a number of factors, and emphasize that variety improvement does not come about by chance, but through the application of recognized laws of inheritance. In barley improvement, cognizance is also taken of protein content, diastase and extract as important quality factors, in addition to hull content (Harris, 1948).

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Figs. 1 and 2 are reproduced from CEREAL CHEMISTRY **24**, No. 6, November, 1947, by permission of the editor.

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