The Control of Meal Grinding Through Cake Analysis

By J. L. Mayfield

It is my belief that the control of meal protein through cake analysis depends upon the organization and correlation of a large number of details rather than on any very involved or impossible chemical feat. Therefore, in this discussion, I wish to give a general resume of the subject rather than any ideal procedure or panacea. It is not my thought that all of the faults nor all of the suggested changes in this paper apply to every mill or to any one mill; but that through a discussion of the whole field the average mill might find some points applicable to itself and thus be able to more accurately and efficiently handle the problem.

The value to the mill of accurate control of protein content of the meal is obvious. Probably during the present prevailing low prices the importance of this accurate control has been minimized. However, with rising prices the unit value is increasing to a point where much money may be gained or lost in this operation. Another equally valuable factor is the greater flexibility in milling which can be enjoyed. For instance, a mill crushing one hundred tons of seed per day can increase its crush by about seven tons by raising the cake protein from forty to forty-five per cent. This saving in larger daily crush can be materially enhanced if accurate product control is practiced so that money is not given away in high protein deliveries.

In an examination of the causes of difference in cake and meal analysis several factors which exert important influences are found. Probably the most obvious, and, under ideal conditions, the only one with which it would be necessary to contend, is the difference in moisture content of the cake and the meal ground from it. This spread is surprisingly constant and is indispensable in calculations for meal control.

Another factor of great importance, which, to my mind, is probably the most frequently neglected, is the handling of the cake itself. Cake is usually so sampled that each sample represents a complete watch. This cake is then often run into two or more tanks for storage. This would not be quite so bad if each run was homogeneous. However, a series of tests conducted at this mill showed that a run of cake, sampled at the stripper at regular intervals, varied as much as two hundred points in protein content, due, of course, to ammonia variation in seed crushed. Moreover, this fluctuation is not rapid but one extreme may hold for three or four hours at a time. Thus, if the run is divided, the value of the cake sample to the chemist is entirely lost, since, while it represents the entire watch, it may not be at all true of a portion of it. It is absolutely essential that the cake from each watch should either all go in to one tank or series of tanks, or that the cake should be sampled by tank only.

Again, a great many apparent discrepancies are caused by the necessity of adding hull bran to the cake on grinding. This, of course, can not be avoided, but, unless some provision is made in the mill report to show it, meal results that will appear erratic and low in protein content as compared to the theoretical values are bound to follow.

Doubtless, the most difficult problem to solve in connection with meal control is the sampling of the material. A great many methods have been tried, none wholly successful. In my opinion, in any comparison between cake and meal, meal analysis should be considered as the basis since it is both easier to sample and is the final marketed product. This sample is probably best taken by a continuous automatic sampler. The most logical spot would seem to be at the point the meal enters the scale and is free falling, thus eliminating the chance of sifting and segregation. Such a sample should be as nearly representative as it is possible to get. It is also absolutely essential that the meal be sampled by tanks instead of watches. If not, the same difficulties will be encountered that occur when the cake is mixed in the storage tanks. In grinding meal, a tank of cake may be finished at any time, yet in some cases the sample is continued until the end of the watch. Thus the sample is not representative and represents another of the important sources of error in this problem.

In the sampling and analysis of the cake, the chief difficulty lies in the nature and physical condition of the material itself. It is well established that the ammonia, oil content, and compactness of any cake slab varies quite considerably with the part of the cake under observation. In this regard it is enough to say that the center is harder and of higher ammonia, while the ends and sides tend to be softer, oilier, and with correspondingly less ammonia. Because of these facts, as the cake goes through the breaker, the ends and sides are broken up more finely. Such a condition prohibits the use of any type of automatic sampler since any such sample will invariably have too large a proportion of the soft, low ammonia portions of the cake present. The old method of sawing various slabs gives a fairly representative sample, but the time involved, as well as the human element entering too largely, precludes the best results. As this study progressed, it became more and more apparent that, only if some way could be found to use the whole slab would any representative, sure sample be obtained. As a result of this feeling the following scheme was worked out at this mill with very good results.

One cake slab from each charge is removed by the stripper and put aside. The slabs which are taken are immediately put into a tightly covered box so constructed that the cake stays warm and moist and thus passes the breaker easier. At the end of the watch they are removed and run through the breaker in the usual way. By a by-pass and a few feet of conveyor the broken cake goes to a small tank especially built to hold it. Here it remains until the sample is prepared for the laboratory. From this small storage tank the broken cake goes to the meal mill where it is ground. In short, exactly the same procedure is followed with the sample as is used with the cake run itself. The weight of sample taken averages about three hundred pounds as compared to about seventy-five pounds by the automatic sampler. Of this amount about the first fifty pounds is allowed to pass through the mill as a wash and is discarded. The remainder is caught, well mixed and a portion brought to the laboratory. While it may seem that this method is long and needlessly elaborate, the time required of the man in charge of the preparation of the samples has been reduced from fifteen to twenty minutes a sample to less than ten.

As an assistance in the correlation of these details two reports have been introduced. One a small daily slip from the meal room foreman showing the tank in which the cake was stored and whether any hull bran was added on grinding or not. This is sent to the chemist. The other is a permanent monthly record showing all data pertinent to the cake and its corresponding meal.

	CAKE											MEAL						
Tank	No.	Date	Mois.	Pts. Off	Oil	Pts. Off	Amm.	Pts. Off	Prot.	Pts. Off	Std.	No.	Date	Mois.	Oil	Amm.	Prot.	Std.
6....	211	1-21	8.4	1.2	5.32	—.10	7.78	—.20	40.00	—1.00	68	211	1-24	7.2	5.42	7.98	41.00	68
2....	360	4-19	8.4	1.0	5.60	—.14	7.76	—.17	39.88	— .87	72	360	4-21	7.4	5.74	7.93	40.75	72

This report is of a two-fold worth. Its complete picture of meal and press room work is valuable as a permanent record; it furnishes the chemist with the figures necessary for guiding the meal protein.

Control of the meal by the use of this chart may be accomplished in two ways: First, by theoretical calculations based on the average difference in moisture content between the meal and cake. Second, by taking the average spread between all comparable cakes and their corresponding meals and using this average directly as the anticipated rise. Of course, under perfect conditions calculations based on the moisture spread would be ideal. However, in practice the chemist may obtain as good or even better results by use of the actual average, especially if this difference is fairly constant for a period of months.

All experimental work and changes incident to the use of this plan were completed at this mill by the first of the year. Since that time accurate records of the results obtained have been kept. The average monthly spread between cake and meal in moisture, oil and ammonia is shown by the following table. These averages are taken from comparable runs; that is, those cake runs in which no tank mixing occurred and to which no hull bran was added on grinding. They are based on the cake analysis and show the meal variation from that.

Month	Moisture	Oil	Ammonia
January	—1.2	.20	.18
February	—1.3	.15	.22
March	—1.0	.14	.17
April	—1.2	.18	.17

The encouraging feature of this table is the extremely consistent result obtained. The discouraging one, the fact that the spreads were in all cases larger than the theoretical values. However, the extreme regularity of the ammonia spread makes its direct use for control work entirely satisfactory. Using the average of the previous month instead of the theoretical value in calculating the ammonia rise from cake to meal the following results were obtained. In February all comparable meals analyzed within .10 per cent of their calculated ammonia values; in March all but three were within this range; and in April all but seven. It is thus apparent that while individual samples may vary considerably, by using the actual spread practical control within reasonable limits may be obtained.

As a further check on the accuracy of our method of cake sampling, the actual scale weights and analysis of all comparable cake runs for the past two months were obtained and from these, using calculations based on the moisture spread between each cake and its corresponding meal, the theoretical weights and analysis of the resulting meals were computed. These figures were then compared with the actual weights and analysis of the meals with the following results. An average of eighty per cent of the theoretical and actual weights agreed within one per cent, and eighty per cent of the actual and calculated ammonia results were within one-tenth per cent. Thus it seems possible by purely abstract calculation to direct the meal room with a fair degree of success.

However, even though the average protein of the meal of any run could be quite accurately controlled, that is not assurance that a car representing a part of that run would also have the same protein. This is, of course, due to the great variation that may occur in the cake analysis during the run. Probably the most practical and easiest way of eliminating most of this variation is by the use of divided tanks. In this method each tank is quartered by partitions from the top down to within a short distance of the bottom and the quarters are filled consecutively. Then when the cake is ground each quarter feeds simultaneously and at the same rate. The result is that the tank itself acts as a mixer and the meal has a relatively even constant protein content.

There is one last requirement which must be filled before the control of the meal room by the chemist can become practical and positive. That necessity is an installation which will deliver a weighed amount of hull bran to the mill or the cake stream immediately preceding it. Visual control or measuring devices are rarely accurate enough with the widely varying hull bran that is customarily used. Of course, in some instances where a very uniform hull bran is made measuring instruments carefully calibrated to the weight of the bran are satisfactory. The use of pointometer scales for both the cracked cake and the hulls would be the ideal arrangement for really accurate work. However, where this is not available a weighed bran will be found of material assistance in guiding the protein value of the meal.

With these mechanical aids and the degree of cooperation between the laboratory and the plant that their successful use assumes, I am confident that the mill will find its chemist has solved to a very large degree the problem of meal control and demonstrated again his value in modern scientific oil milling.

The Seed Analysis Committee of the A. O. C. S. in arranging its program of activities for the year anticipates a revision of the present Free Fatty Acid Methods for Cottonseed and would be glad to receive suggested improvements and criticisms. J. L. Mayfield, Pine Bluff Cotton Oil Company, Pine Bluff, Arkansas, is chairman of the committee.

Mr. A. G. Thompson, Jr., who has been stationed at the Savannah, Ga., laboratory of the Southern Cotton Oil Company, has been transferred to Columbia, South Carolina, as District Chemist, taking the place of Mr. James B. Pratt who died recently.

Mr. Thompson is a graduate of Clemson A. & M. College in the class of 1930, and has been in the employ of the Southern Cotton Oil Company since that date.