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TESTING MISSOURI SOFT WHEAT FLOURS  
FOR QUALITY:  
METHODS, AND VARIETY COMPARISONS

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# TESTING MISSOURI SOFT WHEAT FLOURS FOR QUALITY: METHODS, AND VARIETY COMPARISONS

FERNE BOWMAN, LETA MAHARG, and J. M. POEHLMAN\*

## INTRODUCTION

A project for testing soft wheat flours for quality was initiated at the Missouri Agricultural Experiment Station in 1941. The primary objectives of this project were: (a) to find simple tests and procedures useful in evaluating soft wheat flour for the making of cakes and cookies, (b) to learn the quality characteristics of the varieties of soft wheat grown in Missouri, and (c) to study environmental conditions for growth that may affect flour quality. For these studies commercial varieties and promising new strains of wheat were obtained from experimental plots conducted by the Department of Field Crops at various locations in Missouri. Experimental milling has been contributed (since 1945) by the Experimental Laboratory of the Scott County Milling Company, Sikeston, Missouri. Baking studies on the flour have been conducted by the Department of Home Economics. The milling and baking properties of these wheats have been measured by studies on the wheat grain, chemical analyses of the wheat and flour, determinations of flour yield, measurements of dough properties, baking studies with cakes and cookies, and finally, by scoring the baked products. In this bulletin are presented the methods and the variety comparisons for the eight-year period, 1941 to 1948.

## THE MEANING OF "QUALITY" IN WHEAT AND FLOUR

Quality, as used here, refers not only to the suitability of the wheat for milling into flour for some specific purpose, but also to the suitability of that flour for its intended use. Some of the products made from wheat flours are bread, cakes, cookies, pastries, biscuits, crackers, and macaroni. A specific lot of wheat may be adapted excellently for making one of these products but unsuited for making others. For example, soft wheats are excellent in quality for making cakes or cookies, but inferior in quality for making bread; hard wheats are superior for bread making but inferior for cakes or

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macaroni; or, the durumms are excellent in quality for making macaroni but undesirable for bread or cakes.

The properties of wheat or flour that determine their suitability for a specific purpose are many and complex. A large number of these properties are inherent in the wheat itself and they change with the variety. A few fluctuate greatly, but many others only slightly, with the environment in which the wheat is grown. Procedures in milling may also affect the character of the flour and alter its usefulness for a specific purpose. Thus, kind or variety of wheat, the environment where grown, and the skill of the miller are all interrelated and all contribute to the final measure of quality in flour.

Quality measurements cannot end there, for the flour must still be baked into bread, or cakes, or cookies. Here again, the knowledge and skill of the baker or housewife are involved. Selection of formula, alteration of baking procedures, addition of chemicals, kind of leavening agent, and manipulation all have an effect on the quality of the finished product.

These many properties of wheat and flour often are divided into *milling qualities* and *baking qualities*. The first apply to those properties of the wheat grain affecting the ease with which the milling procedures may be carried out, the completeness of the separation of the endosperm from the remainder of the kernel, and the amount and character of the flour obtained. The latter apply to those properties of the flour which affect the actual baking procedures and final quality of the baked product. Examples of characteristics determining or relating to milling quality are bushel weight and granularity of the endosperm, while water absorption and viscosity of the flour, and volume of the baked product are examples of properties determining or relating to baking quality.

The term "quality," as used here, makes no reference to the nutritive value of the wheat or flour. Tests designed to measure the suitability of a variety or kind of wheat for bread or for cakes do not necessarily measure or compare the nutritive properties of the two wheats or flours, or of the baked products. Flours compared in this report have been milled, in most cases, from varieties grown under similar environmental conditions, and it is assumed that differences in nutritive value of the flours under comparison were very slight, if indeed they did exist at all.

#### QUALITY DIFFERENCES IN HARD AND SOFT WHEATS

The two commercial classes of wheat grown in Missouri are hard red winter and soft red winter. The soft class has always been the more important, comprising in past years upwards of 90 per cent of the Missouri crop, although the amount of the hard wheat has increased sharply in the past two or three years. These classes of wheat differ in their quality characteristics, a consideration which is

inherent in the general recommendation of wheat varieties in Missouri as well as in the purpose for which the wheat may be used. It appears pertinent at this point to review some of the generally accepted facts about the differences in quality of these two kinds of wheat and the flour milled from them.

Among the many properties of wheat and flour that are related to quality, the quantity of the protein and the nature of the gluten are of first importance. Certain specific endosperm proteins hydrate and form gluten when water is added. Through manipulation the gluten is developed into a fibrous network which retains the gas produced by the leavening agent. During the baking process the gas expands, the gluten structure stretches and coagulates, and a light, porous baked product is obtained. This specific property of forming gluten is characteristic of wheat flour.

The characteristics of the gluten are inherent in the variety, although these may be altered with changes in protein content when wheat varieties are grown in different environments. The hard wheat varieties are ideal for bread flours. The gluten from these flours is tenacious and elastic; it absorbs large quantities of water, and thus produces an excellent loaf of bread. Since the amount of gluten is roughly proportional to the amount of protein, a high percentage of protein, by increasing the total amount of gluten in the flour, adds to its total strength. Hard wheat flours are in general "strong" flours. Their strength is derived both from the inherent nature of the gluten in the hard wheat varieties and their high protein content; the latter resulting from the environment in which the hard wheat varieties are generally grown.

Soft wheat flours are in general "weak" flours. These flours are weak because (1) soft wheat varieties are grown in environments that tend to produce a lower percentage of protein, and (2) the nature of the protein is inherently different. Soft wheat flours absorb less moisture than hard wheat flours and they form doughs that have a relatively weak and non-elastic gluten meshwork. As a result, soft wheat doughs are less extensible and resilient, and thus retain less of the leavening gas as it is produced by the action of the yeast. Therefore, yeast breads made from soft flours are somewhat smaller in loaf volume. On account of the low protein and mellow characteristics of their gluten, soft wheat doughs are too weak to undergo the machine-mixing procedures that are necessary during modern bread-making processes. But both low protein and the delicate nature of their gluten render soft wheats far better suited than hard wheats for the production of chemically-leavened baked products such as cakes, cookies, crackers, and pastries.

Hard and soft wheat types are each grown in the United States in fairly distinct geographic areas where each produces flours with characteristic properties. For this reason, the terms "hard" and

"soft" have come to have various meanings and are often used synonymously with several different properties of these two classes of wheat. For example, in the wheat trade these terms may connote (a) texture of the grain, (b) color of the grain (hard textured wheats are usually darker and more vitreous in appearance than soft wheats), (c) size and shape of the grain (in commercial grading size and shape of kernel is a distinguishing feature of the variety and the class), (d) protein content (hard wheats are mostly grown in environments that result in high protein and soft wheats in environments that result in low protein), and (e) "strength" of gluten (most hard wheat varieties have inherently "strong" and soft wheats inherently "weak" gluten characteristics). Strictly, the term "hard" applies to those specific wheat varieties which on the market will grade as "hard red winter" or "hard red spring,\*" and "soft" to those varieties that will classify as "soft red winter" or "soft white." Under present systems of grading wheat, shape and appearance of the wheat kernel and a knowledge of kernel shape characteristics of a given variety are largely depended upon to identify and separate commercial lots into the above classes.

In addition to the gross quality differences between wheat classes, individual varieties of hard or soft wheat will vary in their quality characteristics. Some varieties of hard wheat may be excellent for making bread, while others are less desirable for bread but can be used for family flours. Certain varieties of soft wheat may be well suited for making cake flour. Others, for example, may be better suited for cracker dough or cracker sponge flours, or even family flour. Herein lies the need for specific testing of individual varieties to evaluate accurately their quality characteristics. It is especially desirable to characterize new varieties and experimental strains which have not previously been grown and used on a commercial basis, thereby preventing release and distribution of a variety with poor milling and baking qualities. Since Missouri soft wheats traditionally have been excellently adapted to the production of high quality cake flours, emphasis in variety evaluation at the Missouri Agricultural Experiment Station has been placed on testing the suitability of flours for cakes.

#### NEED FOR WHEAT QUALITY STUDIES IN MISSOURI

The present wheat quality studies were initiated as the direct result of an alarming increase in the acreage of Kawvale wheat in Missouri. The Kawvale variety, first introduced into Missouri about 1936, was high in yield and quickly became popular with the farmer. While Kawvale originally was graded as a soft wheat, the quality characteristics more nearly approach those of the hard wheats, thus making it totally unsuited for the production of cake or other flours

\*The durum wheats are also referred to as "hard" wheats.

requiring a weak type of gluten. As soon as Kawvale reached the market in large quantities, the inferior quality of this wheat for cake flour was evident. The stability of the long standing Missouri soft wheat market was immediately impaired.

Prior to the introduction of Kawvale into Missouri, only such varieties as Fultz, Fulcaster, Michigan Wonder, Early Premium, Mediterranean and Dunbar had been grown. All of these possessed excellent soft wheat milling and baking qualities. There had been little need previously for studies similar to these, since a wheat quality problem had not existed heretofore in Missouri. It was soon learned that there was no ready answer to the question "What constitutes good soft wheat quality?" Even the millers disagreed on this fundamental question, yet all were in agreement that something must be done to alleviate the trouble then current in order to maintain a profitable outlet for Missouri soft wheat production. Furthermore, the evaluation of new varieties and experimental strains also appeared to be essential since hybridization between hard and soft wheats was being pursued extensively in the wheat improvement program at the Missouri Agricultural Experiment Station in an effort to obtain higher yielding, more winter hardy, and disease resistant forms.

Practical benefits that might result from these studies are briefly: (a) development and testing of methods of evaluating soft wheats and soft wheats varieties; (b) evaluation of currently grown varieties in the light of these methods; (c) prevention of the recommendation, or distribution from our wheat breeding nursery, of strains with inferior milling quality; (d) assurance to the Missouri farmer of a continuing market at the highest possible price through the marketing of a product uniformly high in quality; (e) assurance to the baker and the housewife of a plentiful supply of superior quality cake and pastry flours.

#### PREVIOUS WORK ON SOFT WHEAT QUALITY

No attempt will be made here to review the voluminous literature on wheat quality. Appropriate references will be made during the description of methods and the discussion of results. Mention will be made at this point only of soft wheat studies from other stations similar to those to be presented here.

Earliest work at the Missouri Station was reported by Davis (8)\* and Davis and Cline (7) on the use of Missouri soft wheat flour for bread baking purposes. Results of these experiments indicated that bread could be made from soft wheat flours by the housewife with modifications in proportion of ingredients and procedure.

\*Figures in parenthesis refer to literature cited, p. 37.

The most comprehensive studies of soft wheat quality are those being made at the Soft Wheat Quality Laboratory, Wooster, Ohio, a cooperative undertaking between the United States Department of Agriculture and various state agricultural experiment stations, including the Missouri station. The results of this work have been reported annually (5, 18, 16, 6) since its inception in 1936. The research of this Federal Laboratory has served as a guide for much of the work reported here. Close cooperation between this project and the Soft Wheat Quality Laboratory has been maintained with duplicates of a few of the variety samples studied here also being included each year in the cooperative quality studies of the Federal Laboratory for comparison of results. Milling and baking studies of wheat varieties grown in the Western United States have also been reported (9, 10, 3). These studies, now conducted in the Western Wheat Quality Laboratory, Pullman, Washington, are similar to the studies conducted at Wooster on soft red winter wheats.

In addition to these Federal-State cooperative studies on wheat quality individual baking studies on soft wheats have been reported from Maryland (12), Montana (20), and Ohio (4). The Maryland studies were with soft red winter varieties, and the Montana report was on white wheats. The Ohio study dealt primarily with influence of climate, soil and fertilizers upon the quality of soft wheat, but variety studies were also included.

A preliminary report on the Missouri studies was made previously in Missouri Agricultural Experiment Station Bulletin 487 (19).

#### **LOCATION OF TESTS WHERE WHEAT VARIETIES WERE GROWN**

The wheat variety samples studies here were obtained from experimental yield test plots grown on the Agricultural Experiment Station farms at Columbia, Sikeston, Lathrop, and Elsberry, Missouri.

The main group of varieties came from Columbia each year during the period 1941 through 1947, except in 1942. In the latter season rain prevented seeding the Columbia plots and only wheat from Sikeston was used. Beginning in 1944, duplicate samples from Columbia and Sikeston were milled in order to study the quality of wheat varieties grown under different environments. These environment studies were continued in 1945 and again in 1947 with samples from both Sikeston and Lathrop in addition to the Columbia samples.

In 1947 grain from Columbia, Sikeston and Lathrop was composited and the composite milled and studied for quality in comparison with the same variety grown at each separate location. It appeared that the composite offered a good means of studying quality



of a variety growing at several locations and reduced the total number of samples to be tested. Use of the composite made it possible to test a larger number of varieties without increasing the total number of samples. Beginning in 1948, a composite, made by mixing equal amounts of grain grown at Columbia, Sikeston, Lathrop, and Elsberry, was used except for three varieties grown only at the Sikeston Station.

### VARIETIES STUDIED

A total of 33 varieties and experimental strains have been studied for milling and baking quality. These represent (a) standard varieties grown commercially in Missouri, (b) standard varieties grown in other states which are being tested in Missouri to learn about their adaptation and quality under our environment, and (c) new experimental strains which are being tested to determine their possible usefulness as varieties.

Only three varieties, Early Premium, Clarkan, and Kawvale, have been grown at all of the locations in each season. They were selected as checks with which all other varieties and selections could be compared. From previous experience by Missouri millers, as well as limited tests at the Soft Wheat Quality Laboratory prior to the initiation of this project, it was known that Early Premium was a soft wheat with excellent cake baking qualities while Kawvale was inferior for this purpose. Information at that time also indicated that Clarkan was intermediate in quality to Early Premium and Kawvale. It thus appeared that these three varieties would give a wide range in quality and were admirably suited for use as check varieties. Experiments reported here have demonstrated these varieties to be an excellent choice for this purpose.

Most of the other varieties and experimental strains have been included only for limited periods. If either their field performance or quality were unsatisfactory, they were immediately dropped from the tests and new strains substituted in their place. Since most of the strains were grown in a limited number of seasons, their quality characteristics can best be appraised by comparison with the quality characteristics of the three check varieties grown at the same location and in the same season. All of the varieties and strains are soft red winter wheats, except Pawnee and Triumph, two hard red winter varieties which are grown commercially in some areas of Missouri, and Forty Fold, a white wheat which was tested in 1943.

In these studies standard commercial varieties of known milling qualities have been freely used, since the learning of simple methods whereby good milling varieties could be easily distinguished from poor varieties was one of the original objectives of this research. Future studies will be more generally limited to comparisons of new experimental strains with a few standard commercial varieties whose quality characteristics have now been well established.

### MILLING OF WHEAT SAMPLES

When this project was initiated, it was planned to have the wheat samples milled by the Soft Wheat Quality Laboratory or a suitable commercial laboratory. Labor shortages during the early years of the war period made it necessary to engage the service of several different laboratories in order to mill the samples. Milling records and procedures on most of these early samples are incomplete. In 1941 the milling was performed by the Soft Wheat Quality Laboratory on a Buhler mill. Information accompanying the samples states: "The first and second break streams and first and second reductions were blended. The blended flours were then rebolted through a 14XX silk. The 'throughs' were bleached to a pH of 5.0-5.2 using Beta Chloro."

In 1942 and 1943 the samples were milled by the Department of Milling Industry, Kansas State College. A Buhler mill was used and the procedure was similar to that outlined by the Soft Wheat Quality Laboratory in 1941. Flours were bleached to a pH of 5.0-5.2 with Beta Chloro. The 1944 samples were milled on an Allis mill in the laboratories of the Commander-Larabee Milling Company, Kansas City, Missouri. The 1945, Lathrop, Missouri samples were milled by the Kansas Flour Mills Company in their Kansas City Laboratory. "Straight" flours (unbleached long patents) were obtained on certain varieties in 1943 and 1944 in addition to the 70 per cent patent flours.

Samples from Columbia and Sikeston in 1945 and all samples in later years have been milled by the experimental laboratories of the Scott County Milling Company, Sikeston, Missouri on an Allis mill. The milling procedure, outlined by Lyman Bowman, Jr., is as follows:

"The wheat is cleaned on a milling separator and scoured. For correct tempering, moisture is determined on the dry wheat and sufficient water (less 30 ml.) added to 4000 grams of the cleaned wheat to raise the moisture to 14.5 per cent on the soft type wheats, and to 15.0 per cent on the hard wheats or flinty type soft wheats. After standing 24 hours at 80-85 degrees Fahrenheit, 30 ml. of water are added and the wheat scoured again. Two lots of 1750 grams are weighed and ground separately on the breaks as the sifter will not handle the entire sample. The flow sheet (Fig. 1) shows where the stock from each separation goes. As much stock as possible should be made to go through the 70 GG (third middling) on the breaks sizing, and first and second middlings. This stock is so large that it must be divided before the sifter will bolt properly.

"The flour from the third middlings and the fourth middlings are kept separate until the weights of all the flour are determined. All the third middlings flour goes into the 70 per cent patent unless an excess is available, in which case the excess goes into the cutoff. If it is necessary, part of the fourth middling is used to obtain the 70 per cent patent.

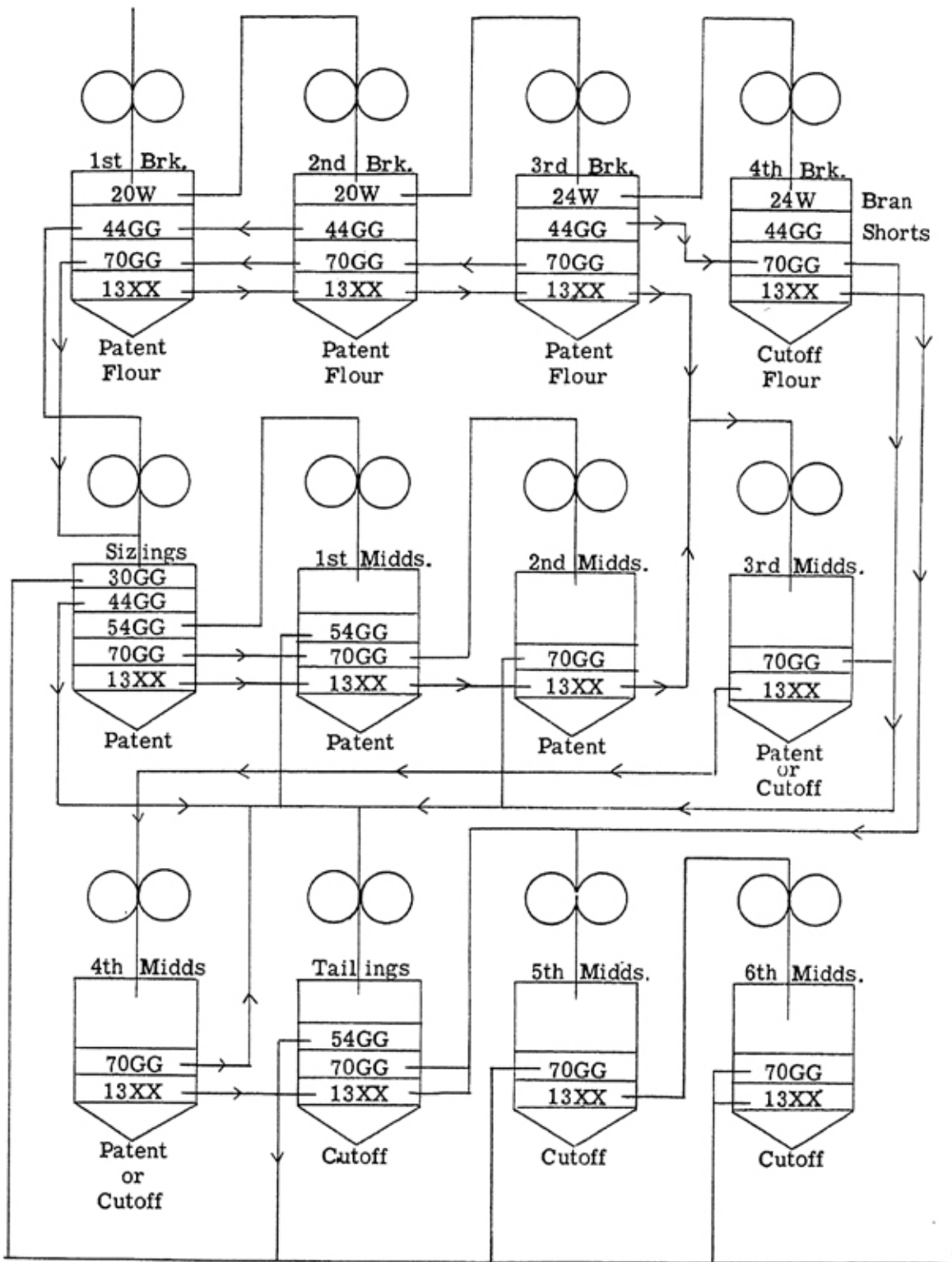


Figure 1.—Mill flow sheet showing the milling procedure used by Mr. Bowman on an Allis experimental mill, Scott County Milling Co., Sikeston, Missouri.

"The 'patent' and the 'cutoff' are then rebolted through a 10XX flour silk."

The 70 per cent patent flour obtained by the above milling procedure is bleached and used in determinations of viscosity, mixogram area, and in cake-baking tests. Three parts by weight of the "cutoff" are mixed with seven parts of "unbleached patent" to make what is called a "straight" flour. The "straight" flour is used in determinations of viscosity and mixogram area and for the baking of cookies.

Flour yields on samples milled by the Scott County Milling Company have been calculated by dividing the total flour production (70% patent + 30% cutoff) by the total out run (flour + shorts + bran).

### BLEACHING OF FLOUR SAMPLES

Flour samples studied during the years 1941 through 1945 were bleached by the laboratory performing the milling operation as outlined above. Since 1946, the patent flours used for viscosity, mixogram and cake-baking studies were bleached by the Department of Home Economics to a pH of 5.1 to 5.2 using chlorine. An experimental bleacher obtained from the Wallace and Tiernan Sales Corporation was used for this purpose.

### QUALITY TESTS ON THE WHEAT GRAIN

Test weight, pearling-index, protein, ash and moisture determinations have been made on the wheat samples studies here. Methods for each are described briefly.

1. *Test-weight*—The test-weight of all samples has been determined using standard weight-per-bushel equipment and procedures. Samples were recleaned in a small "Clipper" cleaner before test-weight determinations were made.

2. *Pearling-index*—The pearling-index was determined by using a Strong-Scott barley-pearler similar to the methods outlined by Taylor, Bayles, and Fifield (22). For these tests a 10 x 10 mesh bronze wire Tyler screen with .041 inch diameter was used. A charge of 10 grams of grain was run for two minutes with a machine speed of 1150 R.P.M. In 1946 and succeeding years the speed of the barley pearler was increased to 1435 R.P.M. to increase the severity of the pearling. The pearling-index is expressed as the per cent pearled off by this procedure.

3. *Protein, Ash and Moisture*—Protein, ash and moisture determinations have been made according to standard methods outlined by the American Association of Cereal Chemists (23). Analyses of samples prior to 1945 were made by the Department of Agricultural Chemistry, University of Missouri. Since 1945 all analyses

have been made by the experimental laboratory of the Scott County Milling Company. Protein analyses have been made of all wheat samples. Ash analyses were run on samples for the years 1941 through 1944, and on the Lathrop samples in 1945. In later years wheat ash composition has not been determined. Results reported here have been corrected to a 14 per cent moisture basis.

#### DESCRIPTION OF QUALITY TESTS ON THE FLOUR SAMPLES

The quality tests on the flour samples were used to measure the adaptability of various varieties of wheat for culinary purposes. These tests included protein, ash and moisture analyses of the flour, mixogram areas, viscosity values and baking tests with both cakes and cookies. Procedures are briefly described here.

1. *Protein, Ash and Moisture*—Protein, ash and moisture determinations on the "70 per cent patent" and the "cutoff" flours have been made according to standard methods by the Department of Agricultural Chemistry, University of Missouri and the experimental laboratory of the Scott County Milling Company, Sikeston, Missouri, as reported for the wheat samples. Protein and ash analyses were made on the 70 per cent patent flour before it was bleached. Analyses of the "straight flour" were calculated according to the amounts of "70 per cent patent" and "30 per cent cutoff" that were mixed. All percentages have been corrected to a 14 per cent moisture basis.

2. *Mixogram Area*—Mixogram areas have been determined on straight flour and bleached 70 per cent patent flours using a National micro-recording dough mixer (Swanson 21). The mixogram curves were made using 35 grams of flour on a 14 per cent moisture basis, plus 54 per cent constant moisture absorption, with the machine operating at 86 R.P.M., a spring tension of 8, temperature at 80 degrees Fahrenheit, and a mixing time of seven minutes. The area under the curve is measured with a planimeter and reported as square centimeters according to the method outlined by Morris, Bode, and Heizer (17). Two mixogram curves were run on each flour sample and the average is reported here.

3. *Viscosity Values*—Viscosity values have been obtained from straight flours and bleached 70 per cent flours using the MacMichael viscosimeter according to the method "Viscosity of Acidulated Flour Suspensions" as outlined in *Cereal Laboratory Methods* (23, p. 105). The procedure differed here from that described in that the quantity of flour was computed on a two-gram, moisture-free protein basis. The flour water suspension was digested for one hour. At the end of the digestion period a normal strength solution of lactic acid was added in increments of 1 ml., 2 ml., 2 ml., and 2 ml. (total of 7 ml.). After each addition of acid, the mixture was stirred, the swinging dampened, and then viscosity values were read. Duplicates were required to check within 2 degrees or the test was repeated.

4. *Cooky Baking Tests*—The cooky baking test originally used was similar to that outlined by Bayfield, *et al.* (5) in the 1937 report of the Soft Wheat Quality Laboratory, and by Hanson (11) in the 1941-42 report. Since 1947 the following formula has been used:

Ingredients	Grams
Flour	225 (14% moisture basis)
Sugar	135
Hydrogenated fat	67.6
Salt	2.5
Sodium bicarbonate	2.3
Ammonium bicarbonate	1.7
Dry skim milk	6.8
Water	51.8 (plus water correction)

The sugar, shortening and soda were creamed for 3 minutes and 25 seconds, in a Hobart Model No. C 210 mixer set at speed 2. The dry skim milk was mixed thoroughly with the water. The salt and ammonium bicarbonate were dissolved in the skim milk suspension and this mixture was added gradually to the creamed sugar-shortening mixture during 1 minute of mixing at low speed. The batter was scraped down and mixing was continued 1 minute and 8 seconds at speed 2. The entire quantity of flour was added and mixed in for 2 minutes at low speed. (The machine was stopped and the dough was scraped from the sides of the bowl after each  $\frac{1}{2}$  minute of mixing). The cooky dough was removed from the mixer, divided into six portions and placed at well-spaced points on a metal cooky sheet ( $8\frac{3}{4}$ " x  $13\frac{3}{4}$ " x 7 mm. in height). For rolling, the cooky sheet was placed in a specially designed wooden gauge to control the thickness of the dough (7mm.). After rolling, the cookies were cut with a cutter 6 cm. in diameter. Scraps of dough were carefully cut with a knife and then removed from the cooky sheet, thus leaving the cut cookies intact and ready to be baked. The cooky sheet was lifted from the wooden gauge and the cookies were baked in an electric rotary Despatch oven at a temperature of 400°F for 10 minutes. After baking, the cookies were removed from the baking sheet and left to cool 1 hour at room temperature. Total diameter and total thickness of a sample of six cookies were then measured. The cooky spread factor ( $\frac{\text{diameter of 6 cookies}}{\text{thickness of 6 cookies}}$ ) was computed according to the method of Bayfield *et al.* (5).

Unbleached "straight" flours were used for the cooky baking tests in 1943 and 1944. Since 1945 straight flours have been prepared by mixing 7 parts by weight of "70 per cent patent" flour (unbleached) with 3 parts of the "cutoff."

5. *Cake Baking Tests*—White cakes were baked from all of the wheat variety samples in order to determine the suitability of each variety for cake flours. Bleached, "70 per cent patent flours" were used for the cake baking tests. Several different types of cakes and formulas were tested during the first years of this investigation. Since 1945 the cake baking test has been standardized, using the following white cake formula\*:

Ingredients	Method
187.5 g. cake flour	Cream in mixer† for 5 minutes. (Set mixer at speed 2. Mix 1 minute and scrape down; repeat after each minute of mixing).
101.2 g. high ratio shortening	
82.5 cc. milk	Mix thoroughly and sift together the sugar, salt and baking powder. Add this mixture and the milk to the flour fat mixture and mix for 5 minutes. (Set mixer at speed 1, mix 1 minute and then scrape down; repeat after each minute of mixing.)
243.7 g. sugar	
6.7 g. salt	
11.2 g. baking powder	
112.5 g. egg white	Add vanilla to milk. Add $\frac{1}{2}$ the egg white and $\frac{1}{2}$ the milk to the cake batter and mix until smooth. Add remainder of egg white and milk and continue mixing with mixer set at speed 1, for 5 minutes. (Mix batter 1 minute and then scrape down; repeat after each minute of mixing).
112.5 cc. milk	
1 teaspoon vanilla	

The cake batter was weighed into two types of pans; round layer cake pans (7" in diameter and  $1\frac{1}{2}$ " deep) and loaf cake pans ( $7\frac{1}{2}$ " x  $3\frac{1}{2}$ " at top,  $6\frac{1}{2}$ " x  $2\frac{3}{4}$ " at bottom, and  $2\frac{1}{4}$ " deep). The cakes were baked in an electric rotary Despatch oven at 360°F. until the cakes would spring back when touched lightly with the finger. The time varied slightly ranging from 27 to 31 minutes. After cooling, the cakes were wrapped in waxed paper and stored at room temperature. The following day the cakes were scored and tested.

#### INGREDIENTS

*Egg Whites:* Special effort was exerted to obtain uniform ingredients. Fresh frozen egg whites were purchased from the same source in 30-pound lots. The frozen egg whites were divided into

\*This formula was obtained from Lowell Armstrong, Ballard & Ballard Co., Louisville, Kentucky.

†A Hobart "Kitchen Aid" household mixer Model No. 38.

aliquot portions for each test series. For each series of cake tests frozen egg whites were first defrosted in tightly closed tin containers at room temperature. Before weighing aliquot samples for each cake, the composite sample was mixed thoroughly.

*Shortening:* The same well-known brand of hydrogenated shortening was used throughout. Sufficient quantity of shortening for an entire series of cake tests was purchased at one time. The shortening was stored at room temperature.

*Milk:* The same brand of evaporated milk was used throughout these tests. For each series of cakes a composite sample of milk was prepared by diluting the evaporated milk with an equal portion (by measure) of water.

*Baking Powder:* Different types of baking powders were used in preliminary baking tests. Since 1943, however, the same standard brand of combination baking powder has been used exclusively.

*Control Flour:* A standard brand of commercial cake flour was employed as a standard reference flour. A quantity sufficient for all of the cake baking tests each year was purchased at one time. All of the flour was mixed thoroughly to form a composite sample and thus to eliminate variation in the control or reference flour.

*Procedures:* All ingredients were brought to room temperature (21 to 25°C) before the cakes were combined. The room temperature varied ranging from 21 to 25°C during the mixing process. At the beginning of the investigations, ten replicate cake-baking tests were made from each test flour. The results of these studies showed that when using the white cake formula, procedure variations between flours could be reproduced quite accurately and variations within lots were nominal. Hence, in 1944 and during subsequent years the number of cake baking tests for each sample of flour was reduced to two.

*Cake Volume:* The index of volume of each layer cake was measured according to the procedure described by Halliday and Noble (*Food Chemistry and Cookery*, p. 109). The index of volume readings were recorded as square inches.

*Breaking Angle:* The device used to gauge the thickness of cake slices for the breaking angle test is shown in Figure 2. The breaking angle apparatus is illustrated in Figure 3. The breaking angle represents the number of degrees registered on this apparatus when a standard one-inch slice began to break.

*Compressibility Tests:* The compressibility test represents the depression made in a slice of cake one-inch thick with the pressure of a 100-gram weight. Compressibility measurements were made when using the apparatus appearing in Figure 4. A cylindrical cutter 2½ inches in diameter was used to cut a uniform section from slices of cake cut one-inch thick. This section was placed on the platform, and the platform was then adjusted in height until the top of the slice of cake just touched the depressor. A 100-gram weight rests in the right scale pan and a chain weighing exactly 100-grams rests



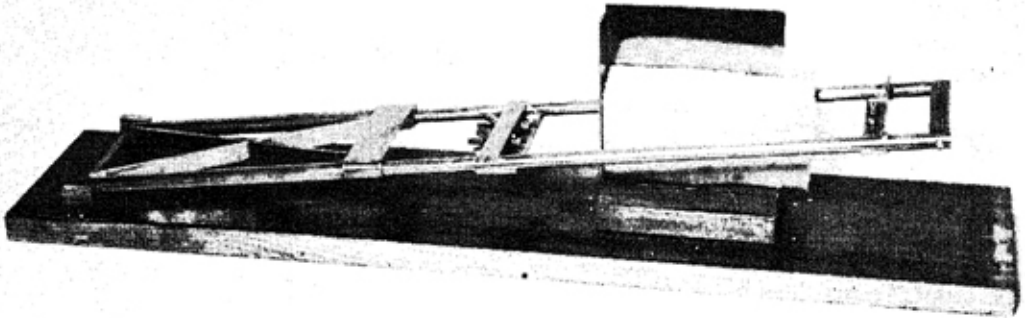


Figure 2.—Cutting a one-inch slice of cake to measure breaking angle and compressibility.

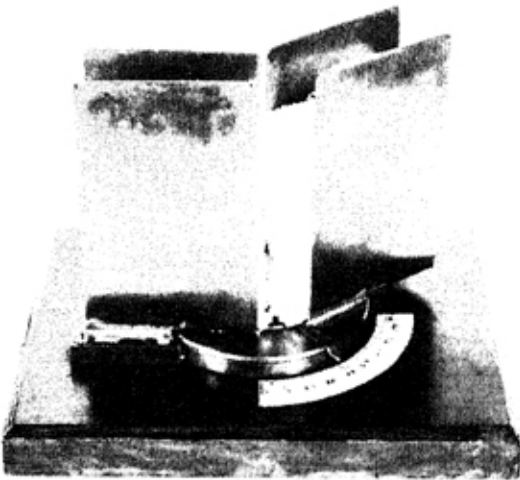


Figure 3.—Breaking angle is measured as the number of degrees at which the one-inch slice of cake begins to break.

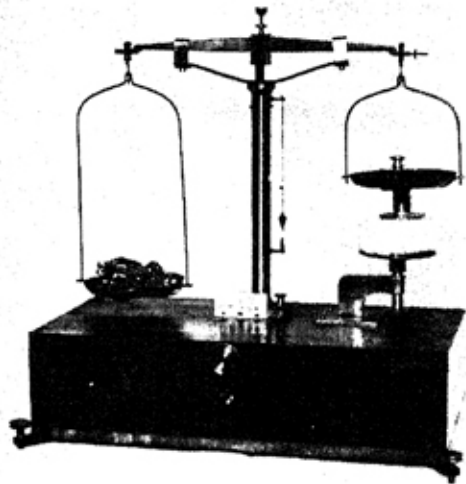


Figure 4.—The compressibility test measures the depression made by a 100-gram pressure into a one-inch slice of cake and is registered by the deflection of the needle on a millimeter scale.

in the left scale pan. The chain is slowly lifted out of the scale pan, lowering the 100-gram weight onto the cake gradually. The deflection of the needle, as the depression is made in the cake, is registered on a millimeter scale. These values are read and recorded as the compressibility.

Each cake was evaluated and scored individually by four members of the staff of the Department of Home Economics. The four individual scores were averaged and cake scores as reported here represent the mean value.

### RESULTS OF QUALITY TESTS ON THE WHEAT GRAIN

Tests, using the wheat grain, that measure or reflect the milling and baking properties of the wheat and flour are limited in number and application. In these studies test-weight, ash and protein of the wheat grain and pearling-index have been used. The results are described briefly.

1. *Test-weight*—Test-weight has long been considered an index to flour yield (Bailey 2). Where comparisons are made within a rather homogeneous lot of wheat, test-weight, being a measure of kernel plumpness, does reflect flour yield. But where comparisons are being made between varieties grown under similar conditions and the difference in test-weight is primarily an inherent varietal characteristic, it does not follow necessarily that test-weight differences will be reflected in the flour yields. For example, the average test-weights of the three check varieties for the years 1946 through 1948, as reported in Table 4 are Early Premium, 58.2 lbs., Clarkan, 60.5 lbs. and Kawvale, 57.4 lbs. Average flour yields of the same wheat samples (Table 21) are Early Premium, 72.24 per cent, Clarkan, 68.65 per cent, and Kawvale, 72.86 per cent. Clarkan, which has the highest test-weight, has the lowest flour yield.

Neither can test-weight be used as an index to milling and baking quality since Early Premium, which will be shown to be superior to both Clarkan and Kawvale, averaged 2.3 pounds per bushel less than Clarkan and averaged only 0.8 pounds above Kawvale, a much inferior milling wheat. Wheats high in test-weight will be plump and well-filled. Thus test-weight does relate some useful information. But it gives no information as to the nature of the gluten and can therefore serve only as a supplementary test which reflects market grade of the wheat rather than baking quality of the flour.

2. *Pearling-Index*—The pearling-index of each wheat sample studied is reported in Table 5. This test has been extremely useful in separating hard-textured and inferior baking strains from softer and superior strains, as may be illustrated by comparison of the pearling-index of the three check varieties. The average index for the 14 samples of each are Early Premium, 39.1 per cent, Clarkan, 32.3 per cent, and Kawvale, 24.3 per cent. These results rate the check varieties in the same order as do the actual baking tests. A comparison of other varieties with the check varieties is of interest here. Pawnee and Triumph, both hard wheats, have low pearling-indexes as do W5220, Fulcaster x Early Premium selection, and Coker Hardired. Varieties with high pearling-indexes include Forty Fold (a white wheat), W5488, and Vigo. All of the latter will be shown to have excellent soft wheat milling and baking properties.

The relation between kernel texture as measured by the pearling test and the nature of the gluten is not clearly understood. But this

test has proven to be useful in obtaining information on probable quality without actually milling the wheat. It has proven to be a useful test for the wheat breeder who wants preliminary information on a large number of wheat strains quickly, and where the quantity of the seed is generally limited.

3. *Wheat Ash*—Ash analyses were obtained on the wheat samples studied in the years 1941 through 1944 and the samples from Lathrop in the 1945 season. These are given in Table 6. Ash analyses of the wheat grain were then discontinued inasmuch as they were not giving information useful in evaluating quality differences between the wheat varieties.

4. *Wheat Protein*—Wheat protein analyses have been made on all samples studied and are recorded in Table 7. Strength in otherwise uniform lots of wheat increases with protein content. Protein analyses are therefore useful to the wheat trade for evaluation of gross strength. It is less useful here, where individual varieties grown under similar soil and climatic conditions are being compared, because of the small protein variations. The average protein content of the three check varieties grown in the 14 tests during the eight-year period were: Early Premium, 9.96 per cent, Clarkan, 10.49 per cent, and Kawvale, 10.09 per cent. Early Premium differed from Kawvale by only 0.13 per cent, yet it was greatly superior to Kawvale in soft wheat milling and baking properties. Clarkan, intermediate in milling and baking properties, exceeded the other checks in protein content. By inspection of the data in Table 7, it may easily be observed that protein differences between locations, and especially between seasons, greatly exceeded differences between varieties grown in a similar environment, a fact that has long been known.

## RESULTS OF QUALITY TESTS ON FLOUR

The results of the quality tests on the flour are presented here briefly. In these studies ash and protein analyses of the flours, mixogram areas, viscosity values, and cooky and cake baking tests were made.

1. *Ash Analyses*—Ash analyses of the straight flours are presented in Table 8 and analyses of the 70 per cent patent flours in Table 9. These analyses are not especially useful here in evaluating flour quality, since (a) the ash percentages in the flours do not follow the pattern of quality established by the baking tests or other well established criteria such as pearling index or mixogram area, (b) the ash content varies greatly in the flours grown in different seasons and at different locations, and (c) since uniform milling procedures were not available until 1945, the ash content fluctuates with the variations in milling.

If only the analyses of the three check varieties, Early Premium, Clarkan, and Kawvale, are examined, it will be seen that a definite

relation is established between ash analyses and known baking performance. These three varieties were grown in each season and at each location. With one exception only, Early Premium, a superior quality soft wheat, was lowest in ash content, and in every case the inferior Kawvale was highest in ash content. But this relation does not hold throughout the other variety samples analyzed. For example, Mediterranean and Forty Fold, high quality soft wheats, have very high ash contents, while Triumph, a hard wheat variety, has a rather low ash content. Pawnee, also a hard wheat, is intermediate in ash content. Ash content in a flour is generally regarded as an index to the grade of the flour (2, 13). The impairment in baking quality of flour with high ash generally results, however, from less refinement in the milling and the inclusion of less desirable fractions in the flour, rather than to the presence of the higher ash content itself. The latter has been suggested to the writers by several soft wheat millers as the reason for the high ash content of the experimentally milled Kawvale flour. The straight flours reported here were higher in ash than the 70 per cent patent, as would be expected. The straight flours include more of the outer endosperm which has been shown by Morris *et al.* (15), and others to contain a higher percentage of ash than does the center of the kernel.

2. *Protein Analyses*—The protein analyses of the straight flour samples are reported in Table 10 and protein contents of the 70 per cent patent flours in Table 11. Comparisons of protein content can only be made where the wheats have been grown at the same location and in the same season. Within each of the groups of varieties grown under similar environmental conditions, the variation in protein is small, and such variation as does exist is not necessarily related to the known baking performance of these varieties. For example, in the check varieties the average protein content of Kawvale exceeds that of Early Premium by only 0.35 per cent. Clarkan which is intermediate in baking performance has a higher average protein content than either Early Premium or Kawvale. Other varieties have not been carried through a sufficient number of seasons to permit similar comparisons.

Protein content is important as a measure of gluten strength (2, 13) insofar as it indicates the quantity of gluten present in the flour. It does not give any information regarding the quality of the gluten. In comparing varieties grown in similar environments, and therefore similar in protein contents, other tests must be used to measure differences in strength due to protein or gluten quality.

It will be noted in the data here that protein content of the straight flours is higher than that of 70 per cent patent flours from corresponding wheat samples. This agrees with the report of Morris, Pascal and Alexander (15) and others that the protein concentration in the wheat grain is greater in the peripheral zones and that the

more desirable mill streams produce flour with the lowest protein content.

3. *Mixogram Areas*—The use here of mixograms for the evaluation of gluten characteristics in soft wheat varieties has followed the procedures outlined by Morris, Bode, and Heizer (17). The mixogram areas for the straight flours are reported in Table 12 and for the 70 per cent patent flours in Table 13.

The check varieties may be ranked in quality by comparison of the average mixogram areas. These are as follows (70 per cent patent flour): Early Premium, 57.18 sq. cm., Clarkan, 68.36 sq. cm., and Kawvale, 69.79 sq. cm. The mixogram areas indicate Early Premium to be superior to Clarkan, and Kawvale, since small mixogram area is associated with weak gluten. They do not show as wide a differentiation in quality between the two latter varieties as does the pearling-index, viscosity values, or the cooky and cake baking tests. Other varieties and strains which compare favorably with Early Premium by this test are Fulcaster, Fairfield, W5488 White Federation x Early Premium, W5590 Kawvale x Early Premium, CI 12454, Vigo, CI 12530, and Butler. Varieties and strains which have undesirable soft wheat gluten characteristics by this test are W5220 Fulcaster x Early Premium, Mediterranean, W5400 Kawvale x Currell<sup>2</sup>, W5477 Purplestraw-Chinese-Michigan Amber, Moking, Coker Hardired, Triumph and Royal.

A comparison of straight and 70 per cent patent flour mixograms is made in Figure 5. Straight flour mixograms rank the varieties in a similar manner to the 70 per cent patent flour, although the individual values are somewhat higher. This might be expected since the protein content of the straight flours is higher than in the 70 per cent patent flours. Morris (14) has shown that mixogram areas increase with flour protein percentages and in reports of the Federal Soft Wheat Laboratory for 1946, 1947, and 1948 (16, 6), mixogram areas have been calculated to a constant 9 per cent protein basis by using a family of protein-area regression curves. In the data presented here, mixogram areas for the various varieties and strains can be compared only to check varieties grown under similar conditions, since there is a wide variation in areas for any variety in different seasons and locations. The characteristics of the curve for each variety remain relatively constant in succeeding years and at different locations as illustrated in Figures 8, 9, and 10.

4. *Viscosity*—The viscosity values of acidulated flour water suspensions have been determined and the results for the straight flours are reported in Table 14 and for the 70 per cent patent flours in Table 15. A rather wide spread in the three check varieties is observed in the 70 per cent patent flour, ranging in value from 95° MacMichael in Early Premium to 138° in Kawvale. Clarkan was even lower than Early Premium, averaging 88° in the fourteen samples.

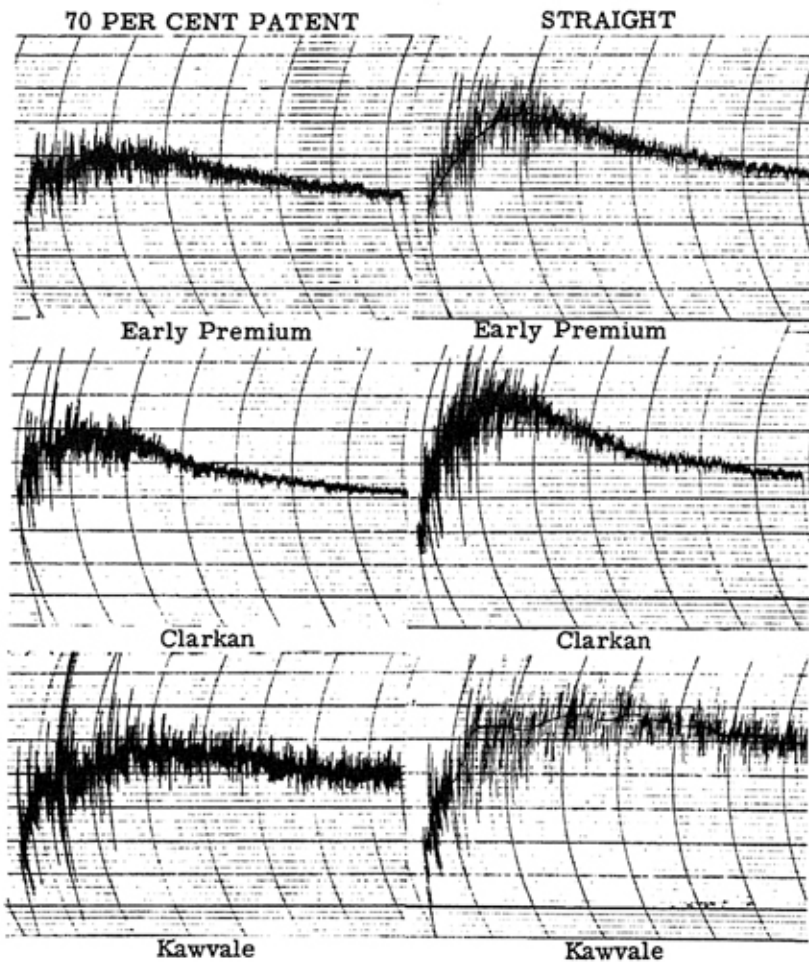


Figure 5.—Comparison of mixograms from 70 per cent patent flour and straight flour. (All varieties were grown at Sikeston in 1945).

Other varieties with low viscosity values are Michigan Wonder, Fulcaster, W5400 Kawvale x Currell<sup>2</sup>, W5477 Purplestraw-Chinese-Michigan Amber, CI 12454, Vigo, Coker Redhart, CI 12530 and Butler. Varieties and strains with high viscosity values in addition to Kawvale are W5220 Fulcaster x Early Premium, W5254 Kawvale x Early Premium, W5478 Purplestraw-Chinese-Michigan Amber, Pawnee, Coker Hardired, Triumph and Royal.

As with mixogram areas, viscosity increases with protein content (14). To compensate for protein differences in the samples, the quantity of flour used here was adjusted to a two-gram protein, moisture-free basis. This method was suggested as being more desirable for measuring differences in the strength of flours of different varieties. The straight-flour viscosity values are considerably larger than for the 70 per cent patent flour. This may be expected with the higher protein percentage. Considerable variation is apparent in the viscosity values for the 70 per cent patent flour. Two factors perhaps

contribute to these variations in addition to the varietal differences: environmental influences and variability in milling procedure. It may be noted that there is less variability in the three check varieties after 1945 with the adoption of uniform milling procedures.

5. *Cooky Spread Factor*—The cooky spread factors (diameter 6 cookies/thickness 6 cookies) are reported in Table 16. This test is believed to be a good measure of soft wheat baking quality. Varieties with satisfactory baking qualities will show a greater spread factor than poorly adapted varieties. This may be observed by comparing the data for the three check varieties. In eleven comparisons Early Premium has an average spread factor of 8.08, while Clarkan averaged 7.81 and Kawvale 7.37. Typical differences are illustrated in Figure 6. Other varieties with favorable spread factors are Fulcaster, Fairfield, Dunbar, Wabash, Forty Fold, W5253 Kawvale x Early Premium, W5400 Kawvale x Currell<sup>2</sup>, W5488 White Federation x Early Premium, W5590 Kawvale x Early Premium, CI 12454, Vigo, CI 12530, Butler and Royal. Varieties distinctly unsatisfactory on the basis of the cooky spread factor, in addition to Kawvale, are W5477 Purplestraw-Chinese-Michigan Amber, W5478 Purplestraw-Chinese-Michigan Amber, and Coker Hardired.

The cookies used in this test are baked from straight flour. It is believed that this may be more useful in measuring varietal differences than would be the baking of cookies from patent flours in which only the more favorable fractions of the wheat kernel are retained. The rating of the various flours in this study by the cooky test is similar to previously known performance of the commercial varieties and to the rating of experimental strains by other tests made here. A comparison of cookies baked from several varieties during the years 1945 to 1948 is made in Figures 11, 12, and 13.

6. *Cake Baking Tests*—From the cake baking tests, data were obtained on volume (Table 17), breaking angle (Table 18), compressibility (Table 19), and baking score (Table 20). These will be discussed separately.

a. *Volume*—The determination of volume of the baked cakes has proven to be the most useful and satisfactory test used in these studies for the determination of soft wheat quality. Flours from varieties known to be excellent in baking quality are readily distinguished from inferior flours by the use of the modified Lowell Armstrong formula. In these tests only two flours have been rated superior to the Early Premium check variety, Michigan Wonder (one season's results only) and W5253 Kawvale x Early Premium. Several varieties and strains have given cakes with volumes closely approaching that of the Early Premium variety, notably W5488 White Federation x Early Premium, Fairfield, Mediterranean and Vigo. Clarkan has been intermediate and Kawvale inferior with respect to volume. Varieties which have given smaller volumes than

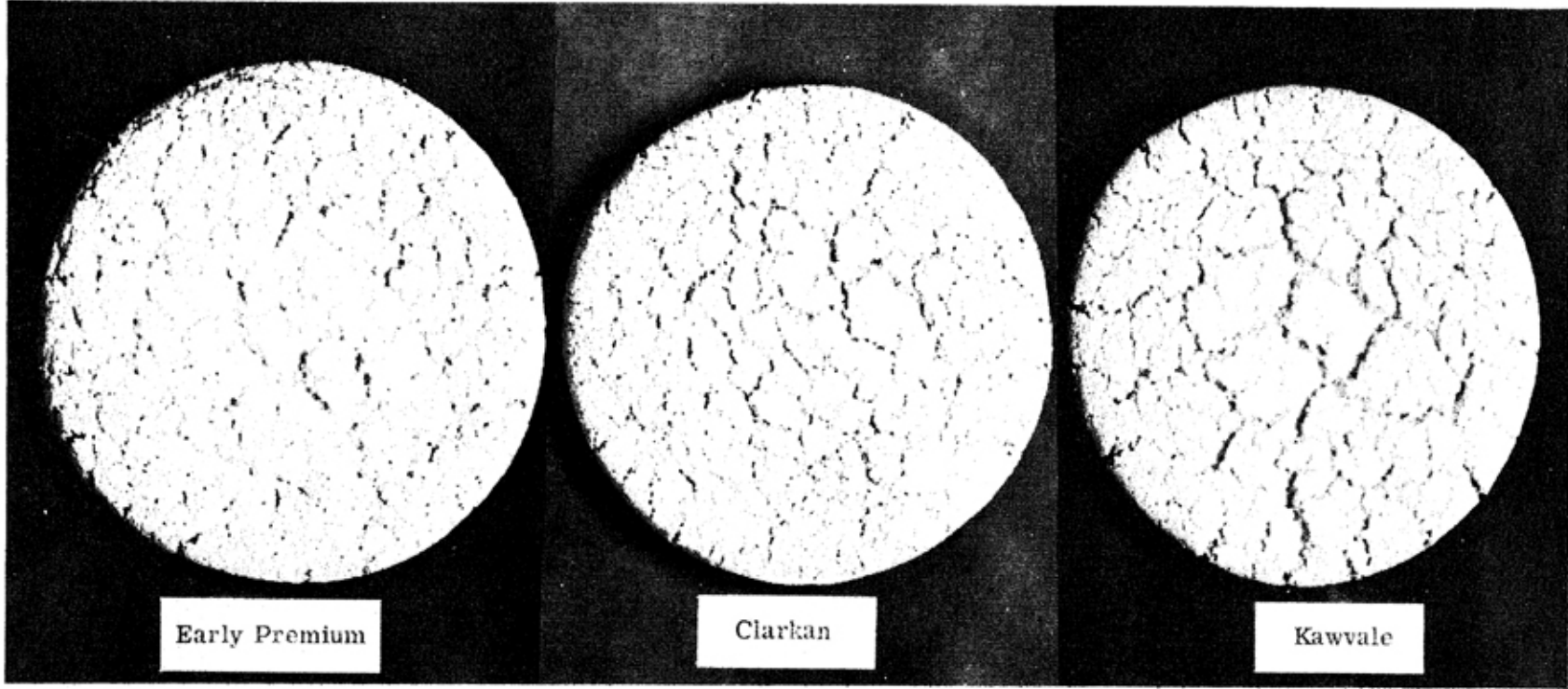


Figure 6.—Comparison of cookies baked from Early Premium, Clarkan, and Kawvale varieties of wheat.



Kawvale are W5477 Purplestraw-Chinese-Michigan Amber, Coker Hardired and Triumph, while Pawnee, Royal and Coker (Gemeinhart) have barely exceeded the volume of the Kawvale variety. A comparison of cross-sections of cakes baked from the three check varieties is shown in Figure 7. Cross-sections of a large number of cakes baked from different varieties during the years 1945 to 1948 are shown in Figures 14, 15, and 16.

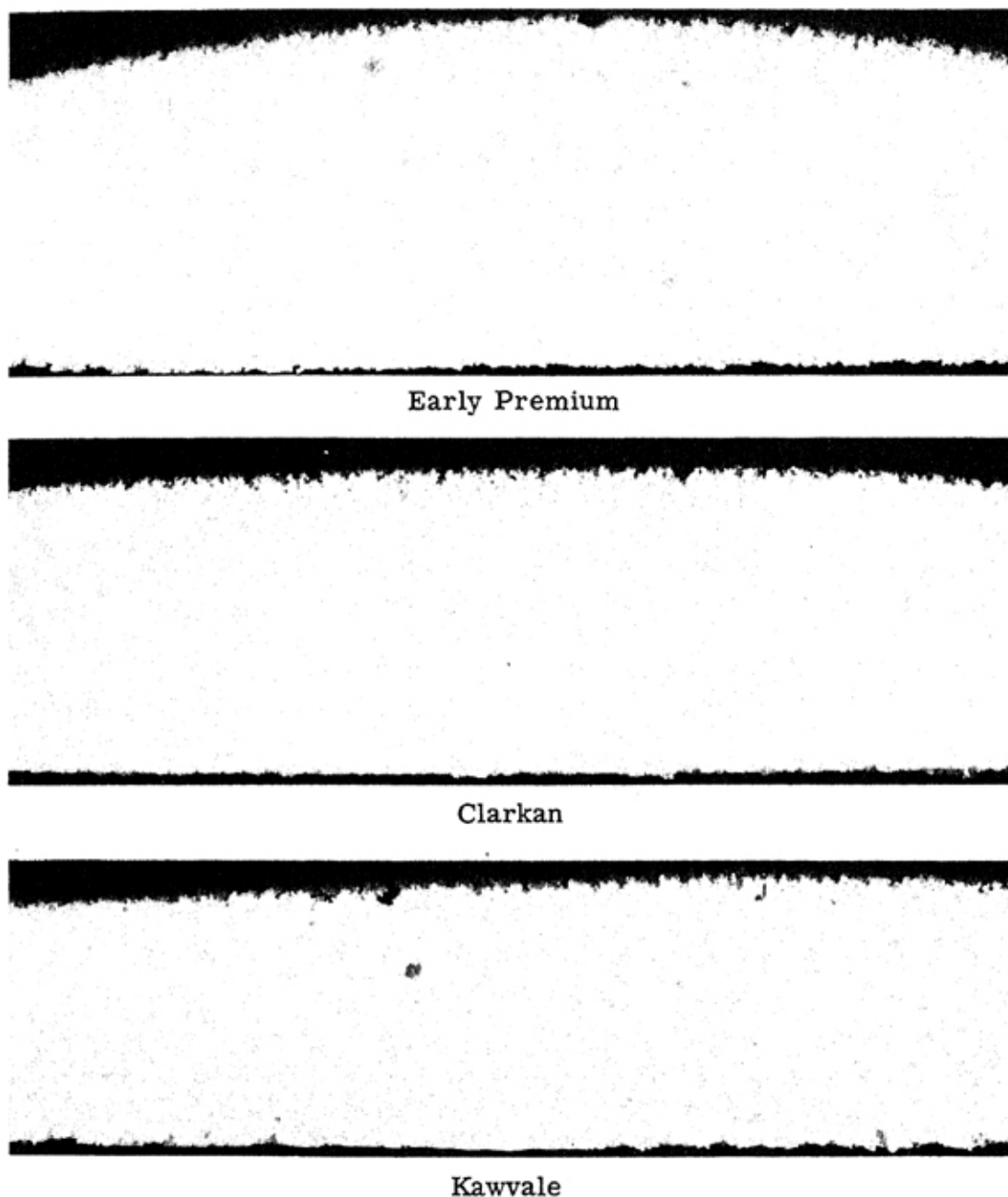


Figure 7.—Comparison of center slices of cakes baked from Early Premium, Clarkan, and Kawvale varieties of wheat.

b. Breaking Angle—The breaking angle is the angle at which the slice of cake begins to break. This test was set up to see if it were possible to distinguish cakes that were moist, tender, and possessing good eating qualities from cakes dry and less desirable. It has not proven especially useful. The range in values here is from 11 to 21, although most frequent occurring values are 15 to 17. The values obtained do not appear to differentiate between the good and poor varieties as established here by other tests.

c. Compressibility—Compressibility is a measure of the firmness of the texture in the cakes. It was thought that if flours from certain varieties produced cakes that were light in texture, in contrast to a firm or heavy texture from flour of other varieties, that this difference could be measured by the compressibility test. Insofar as the check varieties are considered, this has not been the case since the average differences between the Early Premium and Kawvale varieties have been only 0.2 mm. (arbitrary scale, Fig. 4). While varieties have shown differences in compressibility from year to year, the results have not been consistent with such well established measures of quality as the mixogram areas or baking tests.

d. Baking Scores—The baking scores are arbitrary values assigned on the basis of flavor, texture, grain, volume, moisture and general appearance of the cakes. On the basis of baking score, cakes baked from Early Premium have consistently been given the highest score, cakes from Kawvale a low score, while cakes from Clarkan are intermediate although closer to the scores of the Early Premium than to the Kawvale cakes. Other varieties which have generally produced high scoring cakes are Fairfield, W5253 Kawvale x Early Premium, W5488 White Federation x Early Premium, Vigo and Butler. Varieties with low scoring cakes in addition to Kawvale are Pawnee, Coker Hardired, and Triumph. Rating the cakes by the baking score has approached very closely the ratings by volume measurement; while the baking score gives overall consideration to more characteristics than volume, it is a subjective measurement and therefore less accurate than volume measurements.

### FLOUR YIELDS

Information on flour yields were obtained from the milling laboratories in 1942, 1944, 1945 (Lathrop samples only) and 1946 to 1948. The 1942, 1944 and 1945 (Lathrop) samples were each milled by separate laboratories and show considerable variation. The flour yields for the years 1946 to 1948 were obtained by uniform milling procedures and more accurately reflect the comparative yields of the varieties and strains being tested. Only the yields for the three latter years will be considered here. They are reported in Table 21.

In comparing the three check varieties, it will be noted that Clarkan has uniformly given the lowest flour yields, averaging 68.65

per cent as compared to 72.24 per cent for Early Premium and 72.86 per cent for Kawvale. This low flour yield from Clarkan has been observed in commercial mills and, according to Mr. Bowman, "results from a thick bran and fibrous endosperm which makes it difficult to bolt out the flour." Other varieties and strains which have given low flour yield are W5400 Kawvale x Currell<sup>2</sup> selection and CI 12454 Trumbull-W38-Fultz-Hungarian selection. High flour yields have been obtained from W5254 Kawvale x Early Premium selection and Coker Hardired.

High flour yield is a desirable characteristic in a wheat variety and increases the value of that wheat. In the above samples (1946-1948) it would have required 14.5 pounds more wheat of the Clarkan than of the Missouri Early Premium variety to mill 200 pounds of flour. This is an important economic consideration to the miller. While flour yield is a distinctive milling characteristic it does not necessarily reflect baking quality of a wheat variety, as illustrated by the higher yield of flour from Kawvale than from Early Premium.

#### VARIETY COMPARISONS FOR THE YEARS 1945 TO 1948

A primary objective of these studies was to characterize and evaluate the quality of standard wheat varieties grown commercially in Missouri and of new experimental strains being developed and tested in the wheat breeding nursery. These varieties and new strains can best be characterized by comparing them with the performance of varieties with known quality characteristics that were grown under similar environmental conditions. Early Premium, Clarkan and Kawvale have been used as the standards of comparison here. The average performance of these varieties for the years 1945 to 1948 is given in Table 1.

TABLE 1--QUALITY CHARACTERIZATION OF  
EARLY PREMIUM, CLARKAN, AND KAWVALE VARIETIES  
OF WHEAT DURING THE YEARS 1945 THROUGH 1948. (TOTAL OF 8 COMPARISONS)

Variety	Pearling index %	Mixogram-area		Viscosity		Cooky factor d/t	Cake volume sq. in.	Baking score %	Flour yield** %
		straight sq. cm.	70% patent sq. cm.	straight* °MacM	70% patent °MacM				
Early Premium	41.9	64.73	54.56	155	87	7.98	10.36	94.56	72.24
Clarkan	34.0	79.31	64.49	130	77	7.86	10.08	93.86	68.65
Kawvale	26.2	74.16	63.59	150	143	7.49	9.12	81.84	72.86

\* 1947 and 1948 only.

\*\* 1946, 1947, and 1948.

The tests that have proven most useful in differentiating quality differences between varieties grown in similar environments have been pearling index, mixogram area, viscosity, cooky factor, cake volume, and baking score. These together with flour yield are used as the basis for comparisons here. Early Premium was superior to

both Clarkan and Kawvale in every respect except viscosity and flour yield. Kawvale was inferior to the other varieties in all respects except mixogram area, straight flour viscosity and flour yield. Clarkan was intermediate in pearling index, cooky factor, cake volume, and baking score, inferior to Kawvale in mixogram area, and superior to Early Premium in viscosity values. In flour yield Clarkan was considerably lower than the other varieties.

These comparisons of the three check varieties agree with information from commercial sources regarding their utilization. Early Premium has always proven superior as a cake flour. Clarkan is acceptable for that purpose and will produce cakes with good volume, but its low flour yield makes it less desirable. Kawvale is generally unsuited for cake baking purposes.

Comparisons will be made here of the other varieties and experimental strains with Early Premium, Clarkan and Kawvale grown under similar conditions in 1945 through 1948 (except Lathrop 1945 samples). The comparisons are limited to these years since milling procedures and methods of testing have been more generally standardized since 1945 and results are therefore more accurate.

**1945, Columbia**—Two standard varieties, Fairfield and Mediterranean, and one experimental strain, W5226 Fulcaster x Early Premium, were tested from Columbia in 1945 in addition to the three check varieties. Fairfield was somewhat softer textured than Early Premium, as measured by pearling index. Its mixogram area was smaller and its viscosity value was higher. Cookies and cakes were generally satisfactory, although cake volume was somewhat lower than Early Premium and Clarkan. Mediterranean was comparable to Clarkan in pearling index, mixogram area, and cooky factor, although a little higher in viscosity and lower in cake volume and baking score. W5226 was similar to Clarkan in pearling index and mixogram area, higher in viscosity, and generally unsatisfactory in cooky factor, cake volume and baking score.

**1945, Sikeston**—Fulcaster, Fairfield, and W5226 were tested from Sikeston. Fulcaster was slightly more granular than Clarkan as measured by the pearling test. The mixogram area was small but viscosity was high. In baking qualities Fulcaster was intermediate between Early Premium and Kawvale. Fairfield, as at Columbia, was high in pearling index and low in mixogram area, but relatively high in viscosity. Baking characteristics were generally satisfactory, although less desirable than those of Early Premium. W5226 again was similar to Clarkan in pearling index and mixogram area and higher in viscosity. Cooky factor and cake volume were relatively better than at Columbia and were similar to results from Clarkan. W5226, which had been tested for several years, was dropped from the nursery after 1945 since it was not outstanding in either yield or quality.

**1946, Columbia**—All wheats tested in 1946 were grown at Columbia. Two varieties, Fairfield and Mediterranean, were again tested along with six new experimental strains. Fairfield, as in both tests in 1945, was softer in texture than Early Premium, gave smaller mixogram areas, but was higher in viscosity. Baking qualities of Fairfield were excellent, as it equalled Early Premium in cooky factor and surpassed it in cake volume and baking score. Mediterranean was similar to Clarkan in pearling index, but in contrast to 1945, was higher in 70 per cent patent mixogram area, and slightly lower in viscosity. It was intermediate in cooky factor and baking score, but relatively high in volume. Fairfield and Mediterranean, in the two seasons they have been tested, have compared favorably with Early Premium in soft wheat quality. Of the two Kawvale x Early Premium selections, W5253 was superior in baking qualities. W5253 was superior to Early Premium in cooky factor and baking score and similar in cake volume. Both selections were similar to Clarkan in pearling index and mixogram area, but W5254 was somewhat higher in viscosity. W5400 Kawvale x Currell<sup>2</sup> selection was similar to Clarkan in texture, gave large mixogram areas, but low viscosity values. W5400 gave a larger cooky spread than Early Premium and was similar in cake volume and baking score. W5477 and W5478, selections from the cross Purplestraw-Chinese-Michigan Amber made at the Indiana Experiment Station, were relatively unsatisfactory in baking qualities. Both were similar to Clarkan in mixogram area but gave small cooky spread factors and cake volumes. Although W5478 was softer textured it was much higher in viscosity, equalling Kawvale in this respect. The selection W5488, from the cross White Federation x Early Premium, was excellent in all respects, being similar to Early Premium in pearling index, viscosity, baking score and cake volume and superior in mixogram area and cooky factor. Flour yields were high for Kawvale, Mediterranean, W5254 and W5478. Clarkan was lowest in yield of flour.

**1947, Columbia**—Two varieties, Moking, Pawnee, and seven experimental selections grown at Columbia were tested for quality in addition to the check varieties. This was the first test here of these varieties for quality. Moking is similar in origin to Clarkan. It was similar to Clarkan in pearling index, mixogram area, somewhat higher in viscosity, and also higher in cooky factor and cake volume. It is not as good as Early Premium in the two latter respects. Pawnee is a hard wheat variety of Kawvale parentage. It was more granular than Kawvale as measured by pearling index, intermediate in mixogram area, extremely high in viscosity, only slightly better than Kawvale in cake volume and baking score, but satisfactory in cooky spread factor. Pawnee can be rated as generally unsatisfactory for cake flour. W5253 Kawvale x Early Premium again compared favorably with Early Premium for cakes and cookies. It was

equal or superior to Early Premium in all respects except viscosity and pearling index, but was superior to Clarkan in the latter. W5400 was similar to Clarkan in pearling index and mixogram area, slightly higher in viscosity, but less favorable in cake volume and baking score. The cooky spread factor for W5400 was very good. The Purplestraw-Chinese-Michigan Amber strains were slightly better in comparative baking qualities than in 1946. Both were superior to Clarkan in pearling index and mixogram area but less desirable with respect to cake volume and baking score. W5478 was again very high in viscosity values. W5488, as in 1946, demonstrated excellent cake and cooky baking qualities although in this season it was slightly inferior to Early Premium in mixogram area, cake volume and baking score. A new selection, W5590, Kawvale x Early Premium, was similar to Early Premium in pearling index, mixogram area, and cooky factor, but had a very large viscosity value and a low baking score. Cake volume was comparable to that of Clarkan. CI 12454 was similar to Early Premium in pearling index, mixogram area and viscosity, was low in cooky factor and baking score, and in cake volume it was comparable to Clarkan.

Flour yields were high for Early Premium and yields from Clarkan were again low; all others were intermediate.

1947, Sikeston—Three varieties from Sikeston, Vigo, Hardired, and Redhart, were tested for quality in addition to the checks. Vigo proved to be high in quality, being superior to Early Premium in pearling index, mixogram area, viscosity, and cooky factor. Cake volume and baking score were satisfactory although not as good as for Early Premium. Redhart was the more desirable of the two Coker strains. Hardired was rather granular in texture, high in viscosity and low in cake volume and baking score. In the latter respects it was inferior to Kawvale. Redhart was superior to Hardired in baking score and cake volume but inferior to Clarkan. The flour yield of Hardired was exceptionally high.

1947, Lathrop and Composites—In addition to milling samples of Early Premium, Clarkan, and Kawvale from Columbia and Sikeston, a sample of each from Lathrop was also milled, as well as a composite of each variety made by mixing equal weights of grain from each of the three locations. A comparison of the results from each station with that of the composite is made in Table 2.

These data indicate the results obtained by running quality tests on a wheat sample composited from several locations to be very similar to the average of results obtained by testing the wheat from each location separately. Composites from several locations have previously been used by the Soft Wheat Quality Laboratory (5, 18) to study quality of strains grown in uniform nurseries and have also been used by Ausemus *et al.* (1) in comparing varieties for quality at the Minnesota Agricultural Experiment Station. It is anticipated that in the future, composites of grain from several locations will be

TABLE 2--QUALITY COMPARISONS OF EARLY PREMIUM, CLARKAN, AND KAWVALE VARIETIES OF WHEAT GROWN AT THREE LOCATIONS IN 1947 AND OF A COMPOSITE OF EACH MADE BY MIXING EQUAL PARTS OF GRAIN BY WEIGHT FROM THE THREE LOCATIONS.

Variety	Station	Pearling index %	Mixogram-area		Viscosity		Cooky factor d/t	Cake volume sq. in.	Baking score %	Flour yield %
			straight sq. cm.	70% patent sq. cm.	straight °MacM	70% patent °MacM				
Early Premium	Columbia	46.6	47.36	42.78	150	87	9.43	10.25	92.58	72.44
	Sikeston	42.5	57.43	49.65	140	97	8.16	10.13	95.46	73.24
	Lathrop	40.9	76.59	55.20	153	71	7.55	10.80	95.23	72.53
	Average	43.3	60.46	49.21	148	85	8.38	10.39	94.42	72.74
	Composite	43.8	60.97	61.30	141	67	8.22	10.37	91.55	72.60
Clarkan	Columbia	35.5	79.04	57.62	148	70	8.36	9.92	96.82	68.95
	Sikeston	36.4	68.81	63.20	105	69	8.40	10.07	93.47	70.11
	Lathrop	32.9	91.97	64.56	120	66	7.25	10.20	91.45	68.34
	Average	34.9	79.94	61.79	124	68	8.00	10.06	93.91	69.13
	Composite	33.9	83.81	74.20	111	58	7.77	10.02	91.01	68.96
Kawvale	Columbia	30.0	56.39	41.20	185	197	8.96	8.81	81.20	71.77
	Sikeston	26.3	67.43	61.75	131	125	7.33	9.14	85.28	73.94
	Lathrop	26.7	95.43	69.91	139	132	6.80	9.66	84.57	71.95
	Average	27.7	73.08	57.62	152	151	7.70	8.54	83.68	72.40
	Composite	28.0	68.33	62.97	135	113	7.82	9.11	82.86	71.35

\* Index of volume.

used almost exclusively in wheat quality studies here. New experimental strains can thereby be tested by compositing seed from several rod row trials without the necessity of increasing the strain to field plots before making preliminary baking studies. This procedure will also reduce the total number of samples to be studied.

**1948, Composites**—In 1948, composites were made of seven varieties and seven experimental strains, in addition to the three check varieties, by mixing equal parts by weight of grain grown at Columbia, Lathrop, Sikeston and Elsberry, Missouri. Three of the varieties had been tested in 1947. Moking did not compare as favorably with Clarkan as in 1947. It was similar in pearling index, slightly higher in mixogram area and lower in cooky factor, cake volume and baking score. Pawnee, a hard wheat variety, was similar to Kawvale in pearling index, viscosity, cooky factor, cake volume and baking score. Mixogram area was similar to that of Clarkan. Vigo again proved to have excellent soft wheat quality being equal or superior to Early Premium in all respects except cake volume. In the latter it was similar to Clarkan. Triumph, a hard wheat variety, was included in the quality tests for the first time since a limited acreage was not being grown in Missouri. Like Pawnee it was generally unsatisfactory, being similar to Kawvale in pearling index, mixogram area, viscosity, and baking score, but was poorer in cake volume. Purcam was similar to Clarkan in pearling index, mixogram area and viscosity, but was less desirable in cooky spread factor, cake volume and baking score. Butler, a new variety from Ohio, was found to be satisfactory in all respects except cake volume, while Royal, an Illinois variety, was similar to Clarkan in pearling index and mixogram area, but somewhat lower in cake volume and baking score. Royal was very high in viscosity.

Six of the experimental strains had been tested previously. W5253 Kawvale x Early Premium was superior to Early Premium in cooky spread factor and cake volume and similar in other respects except viscosity, which was rather high. This performance is similar to that in 1946 and 1947. W5477 and W5478 also gave results similar to previous years. Both were similar to Clarkan in pearling index and mixogram area, although inferior in cooky factor, cake volume and baking score. As in previous years, viscosity of W5478 was somewhat higher than W5477. W5488 was again excellent in quality, being superior to Early Premium in pearling index, mixogram area, cooky factor, and similar in viscosity, cake volume and baking score. It is not probable that any of the four experimental strains just described will be used as varieties, but all are being used as parent material in the breeding program and it is desirable that their quality characteristics be identified.

W5590 Kawvale x Early Premium was tested for the second year. It was superior to Early Premium in pearling index and cooky factor, similar in mixogram area, and as in 1947, high in viscosity and



low in cake volume. The strain does not appear to be as desirable in quality as the other Kawvale x Early Premium strain, W5253. CI 12454 and CI 12530 are selections from the same cross made at the Indiana Station. Both are high in pearling index, indicating soft texture, similar to Early Premium in mixogram area and very low in viscosity. They have a good cooky spread factor but are both slightly below Clarkan in cake volume and baking score. These results do not indicate any appreciable quality difference between the strains and are similar to the results of CI 12454 in 1947.

High flour yields were obtained from Kawvale, W5478, Moking and Pawnee. Clarkan gave the lowest yield of flour and a low yield was also obtained from CI 12454.

**1948, Sikeston**—In 1948 three varieties were tested that had been grown at the Sikeston station only. All three originated from the Coker Seed Company. Seed of two, Hardired and Redhart, had been obtained direct; the third, also a Redhart strain, had been obtained from Mr. Gemeinhart near Sikeston and differs agronomically from the other Redhart strain. Hardired is generally unsatisfactory, performing like a hard wheat with respect to pearling index, mixogram area, viscosity, cooky factor and cake volume. The Redhart strain obtained direct from Coker was soft in texture, as measured by the pearling index, similar to Clarkan in mixogram area, viscosity and cooky factor and similar to Early Premium in cake volume. The Gemeinhart strain was lower in pearling index and cake volume but otherwise similar to the Redhart from Coker.

Flour yield of Hardired, as in 1947, was very high, while yield from Redhart (Coker) was low.

#### **CORRELATION COEFFICIENTS BETWEEN QUALITY FACTORS**

Correlation coefficients were calculated between factors used here to measure quality differences in soft wheat varieties. These correlation coefficients are recorded in Table 3. They were calculated from the performance of 67 variety samples grown from 1945 through 1948, using data from all varieties and stations for those years (except the 1945 Lathrop samples). Although both good and poor varieties are represented, all varieties were not grown at each station in each year.

As these wheat quality studies progressed, the writers have given more and more emphasis to high cake volumes as the best criteria for measuring good soft wheat baking quality. Therefore it is of interest to examine the correlations between each of the other quality factors measured and cake volume. Pearling index and cooky factor are shown to be positively correlated and viscosity values negatively correlated with cake volume. Each of these correlations exceed the value required for significance at the one-per cent level. Flour ash (70 per cent patent flour), flour protein and mixogram area were not significantly correlated with cake volume. It

TABLE 3--CORRELATIONS BETWEEN QUALITY FACTORS USED IN THE TESTING OF SOFT WHEAT VARIETIES.

	Flour Ash		Flour Protein		Mixogram-area		Viscosity	Cooky factor	Cake volume	Baking score
	straight	70% patent	straight	70% patent	straight	70% patent	70% patent			
Pearling index . . . . .	-.4390	-.6167	-.1352	-.3926	-.6239	-.5271	-.3149	+.5487	+.5203	+.3858
Flour ash, straight. . . . .		+.8892	+.1108	-.0743	-.4580	+.4316	+.0956	-.5610	-.3082	-.3667
Flour ash, 70% patent . . . . .			+.2295	+.5208	+.6532	+.6538	+.1659	-.4516	-.1072	-.1544
Flour protein, straight. . . . .				+.5371	+.2602	+.5155	-.5292	-.1496	+.0646	+.0776
Flour protein, 70% patent . . . . .					-.4564	+.7682	-.4223	-.5534	-.0488	-.0417
Mixogram area, straight. . . . .						+.6602	-.1508	-.7765	-.0134	-.0152
Mixogram area, 70% patent . . . . .							-.2277	-.4115	-.0298	-.0673
Viscosity, 70% patent . . . . .								-.0197	-.5496	-.5147
Cooky factor . . . . .									+.3509	+.1317
Cake volume . . . . .										+.1300

Value required for significance at 5 percent level with 65 degrees of freedom = .2402

Value required for significance at 1 percent level with 65 degrees of freedom = .3118

has already been pointed out that variations in the ash content of certain variety flour samples did not conform to the known baking performance of those varieties. Also it has been shown that protein content varied only slightly in different varieties grown under similar environmental conditions. If sufficient data were available, it would be of interest to determine the correlation between protein content and cake volume in one variety grown under different environmental conditions. The failure of mixogram areas to be correlated with cake volume is somewhat surprising, since it has been used successfully by other workers (17) to measure soft wheat quality.

The cooky test has also been believed to be a desirable criteria of soft wheat quality. This test uses only the straight flour. In these studies pearling index and cake volume were positively correlated with cooky factor, and flour ash (straight flour) and mixogram area (straight flour) was negatively correlated, all correlations exceeding the 1 per cent level of significance. Straight flour protein was not correlated with cooky factor. Viscosity determinations were made on only part of the straight flours under consideration here and correlation coefficients were not calculated, but there was no correlation between the viscosity values of the 70 per cent patent flour and cooky factor.

One other group of correlations are of interest. The pearling test was correlated with all other quality factors, except straight flour protein; correlations exceeding the 1 per cent level of significance in each case. The pearling test is a simple mechanical test performed on the wheat kernel, and has been found to be especially useful to the plant breeder for distinguishing between good and poor quality strains of soft wheat.

In the above data it will be observed, except for the correlations with pearling index, that there is considerable magnitude in the variations of the correlation coefficients between well known tests for measuring soft wheat quality such as cake volume, cooky factor, viscosity, and mixogram area. While each of these tests provides useful information, each is measuring different components of soft wheat quality. Variations in quality, as measured by one test, are not necessarily related to variations as measured by another test. These results also suggest that no single test used here is adequate to measure the complex characteristics which we attempt to cover in the term soft wheat quality.

#### DISCUSSION AND SUMMARY

The original purpose of this research was to find simple tests and procedures useful in evaluating soft wheat flour for the making of cakes and cookies, to learn the quality characteristics of wheat varieties grown in Missouri, and to study the effect of environmental

conditions during the growth of the wheat plant on flour quality. The methods and variety characteristics have been presented here.

The quality tests considered to be most useful in this study for the evaluation of soft wheat quality in varieties grown in similar environments are listed below.

1. *Pearling test*. This is a simple test which measures the granularity of the wheat kernel. Only a few grams of seed are required, which makes it useful in evaluation of experimental strains. Results of the pearling test are highly correlated with other important measures of quality in this study.

2. *Mixogram area*. The mixogram areas are useful in measuring flour strength. Only a small amount of flour is needed and results are easily duplicated. Differences between certain varieties could be readily distinguished by this test, although results did not always correlate with viscosity values and cake baking tests.

3. *Viscosity values*. Viscosity is widely used in the flour trade as a measure of flour strength. In these tests high viscosity values are negatively correlated with cake volume. Viscosity values are difficult to duplicate with the result that less confidence is generally placed in this test than in the others used.

4. *Cooky baking test*. This test was useful in differentiating quality in wheat varieties. It is simple in procedure and does not require bleached flour. Results are correlated with results from the cake baking test.

5. *Cake volume*. The volume of the cake is considered to be the most reliable test used here for the evaluation of cake making quality in soft wheat varieties. The cake baking test is laborious and requires a substantial quantity of bleached flour, but the results are without doubt the best differentiation of varietal quality.

Several tests used, while giving essential information, are not necessarily closely related to the baking performance. These include:

1. *Flour ash* was not a reliable index of quality. Ash of the Kawvale variety was consistently high, but the ash content of some of the desirable varieties did not always show a constant relationship.

2. *Wheat and flour protein* are not useful in differentiating quality here since varieties compared from the same location and grown in the same season varied little in protein content.

3. *Compressibility and breaking angle* varied with different varieties but the relationship is not consistent with other tests known to be reliable indexes of soft wheat quality.

Thirty-three varieties and strains were tested during the course of the eight-year period. Three—Early Premium, Clarkan, and Kawvale—represented a range from very good to poor in quality. These were used as checks and were grown each year at every station. Other varieties and experimental strains were then compared with these three check varieties.

Early Premium consistently produced the best cake volume and is perhaps the best cake flour variety tested. Other varieties and experimental strains found to be excellent were Michigan Wonder, Fultz, Fairfield, Mediterranean, Dunbar, Wabash, W5253 Kawvale x Early Premium, W5488 White Federation x Early Premium, Vigo, and Butler.

Varieties distinctly unsatisfactory were W5216 Fulcaster x Early Premium, W5226 Fulcaster x Early Premium, Pawnee, Coker Hardired, and Triumph. Of these, Pawnee and Triumph are hard wheat varieties.

Commercial varieties acceptable, although not excellent, in soft wheat quality were Fulcaster, Clarkan, Moking and Royal. A number of the experimental strains fell in this classification. Such strains were soon dropped from the testing program, and will not be increased for distribution.

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# APPENDIX

EARLY PREMIUM

CLARKAN

KAWVALE

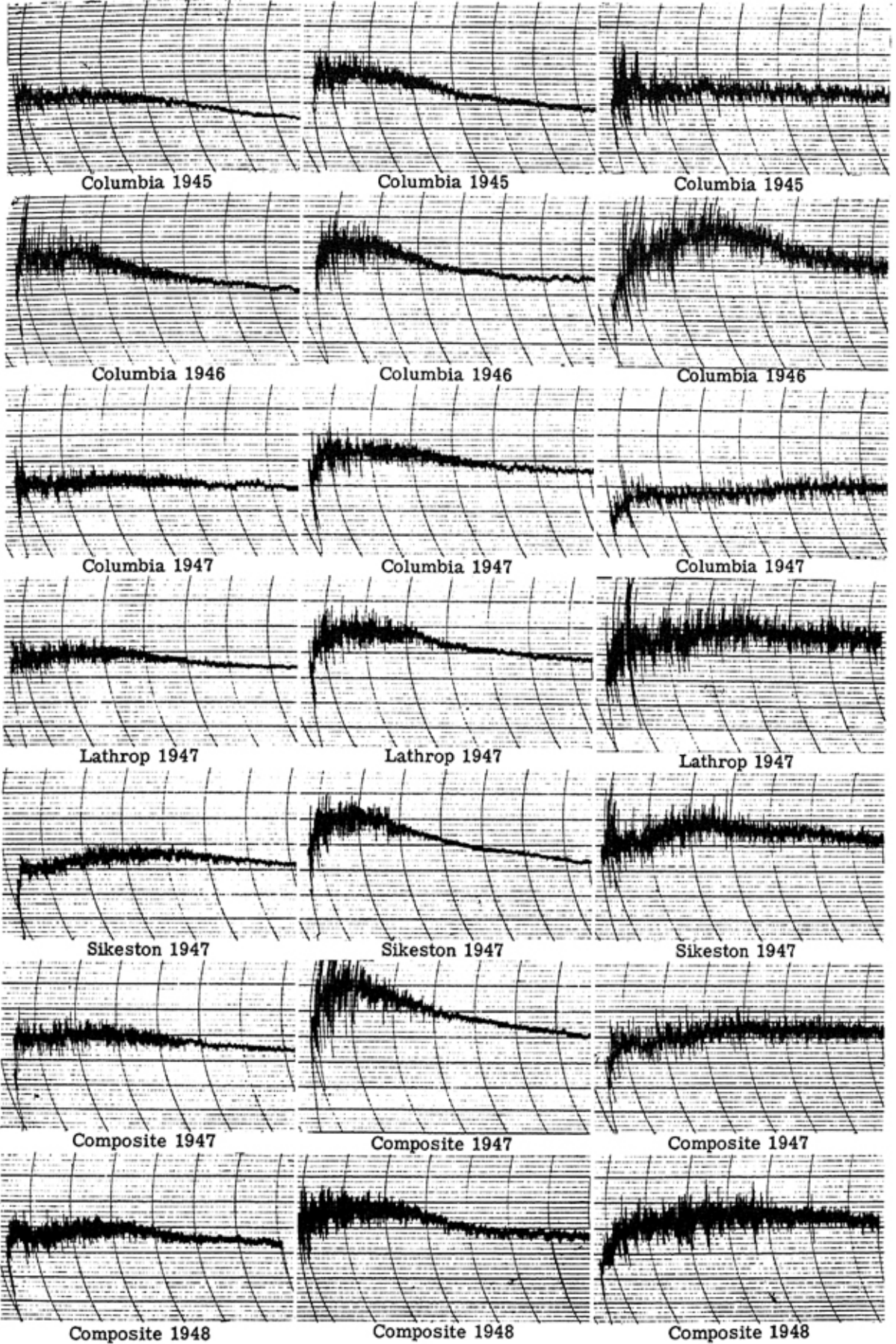


Figure 8.—Mixograms (70 per cent patent flour) from Early Premium, Clarkan, and Kawvale varieties of wheat during 1945 to 1948.

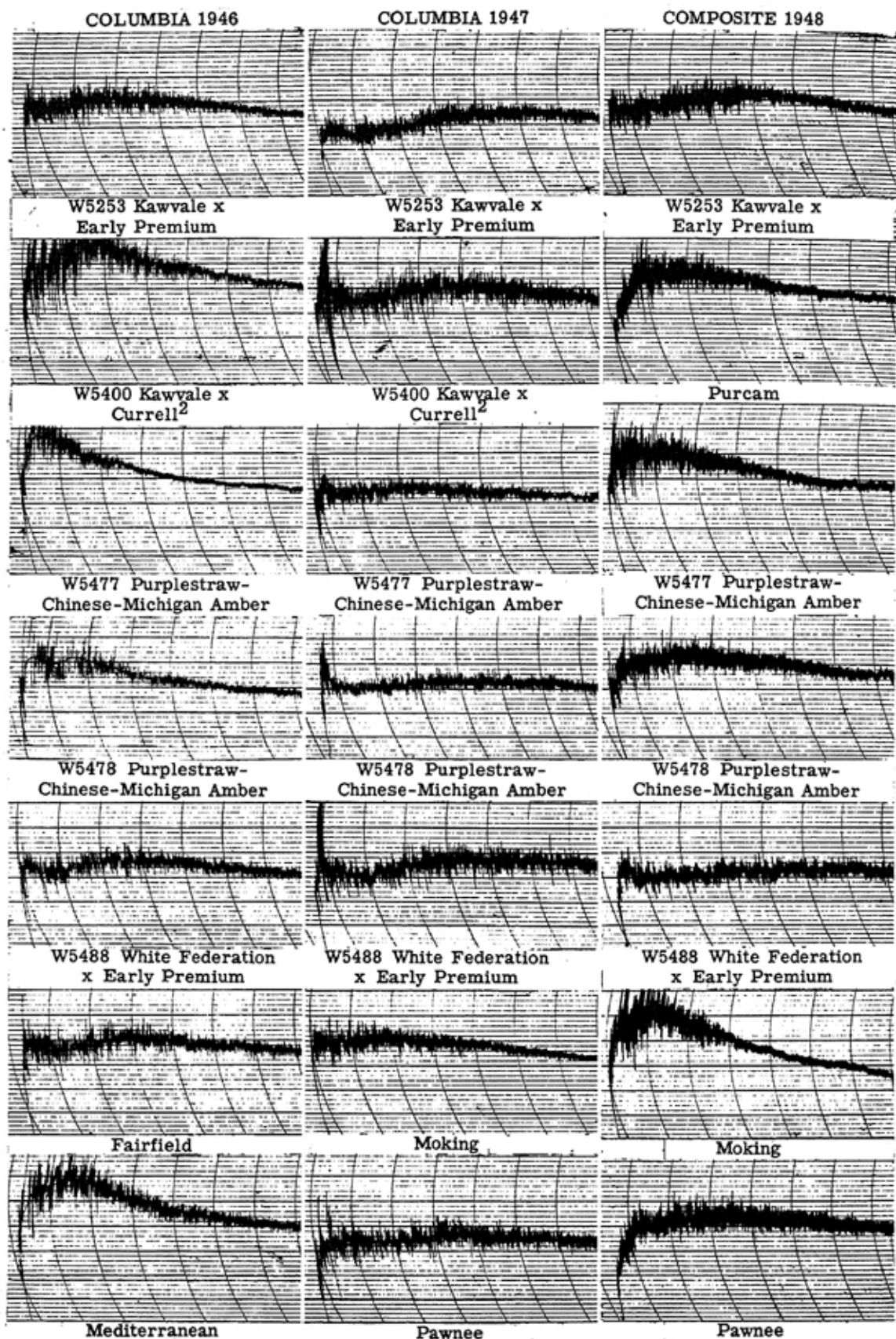


Figure 9.—Mixograms (70 per cent patent flour) from wheat varieties grown at Columbia 1946, Columbia 1947, and a composite from four locations in 1948.



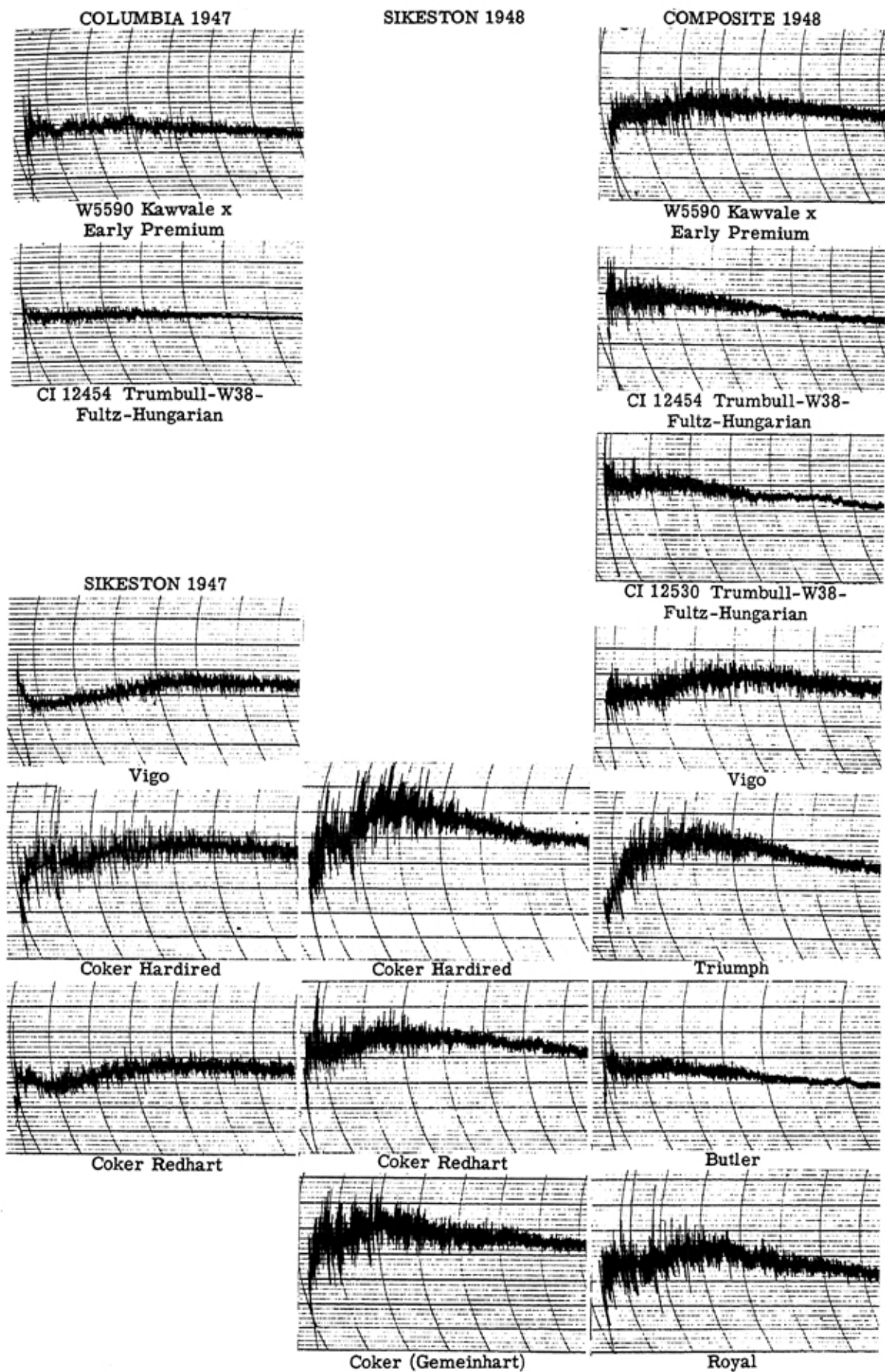
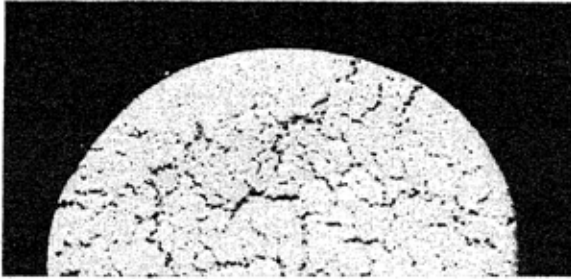


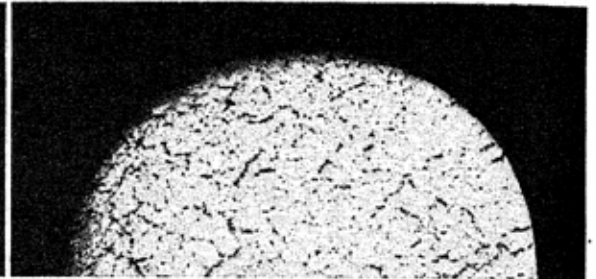
Figure 10.—Mixograms (70 per cent patent flour) from wheat varieties grown at Columbia 1947, Sikeston 1947, Sikeston 1948, and a composite from four locations in 1948.

## EARLY PREMIUM

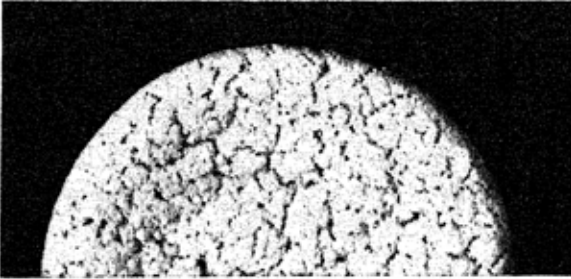
## CLARKAN



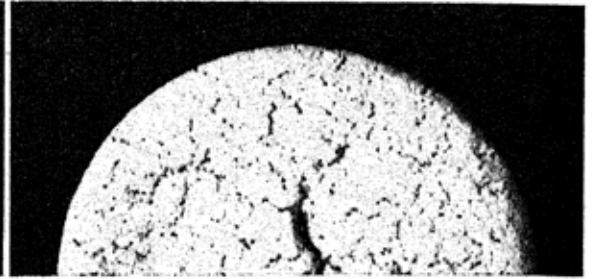
Columbia 1945



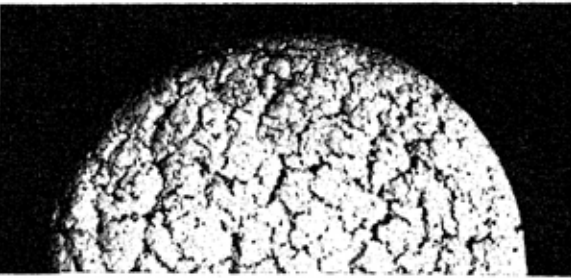
Columbia 1945



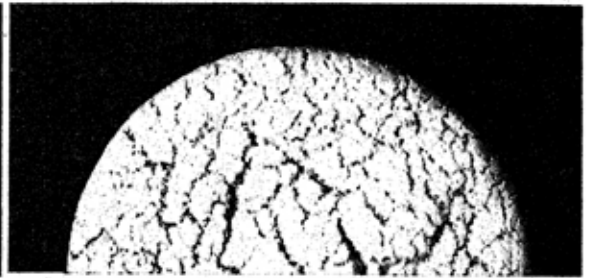
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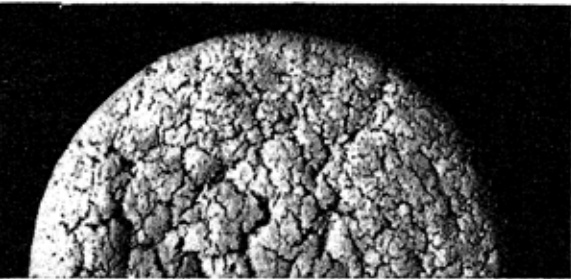
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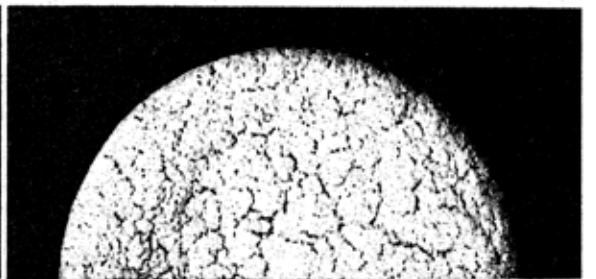
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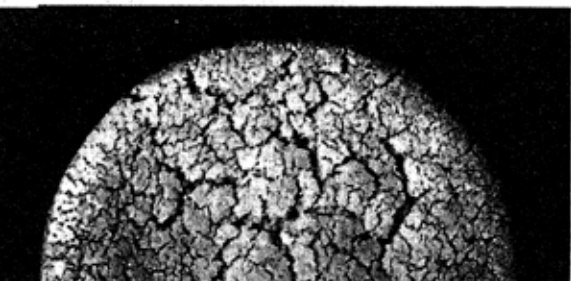
Columbia 1947



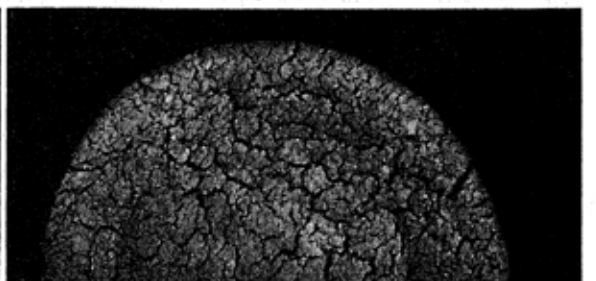
Composite 1947



Composite 1947



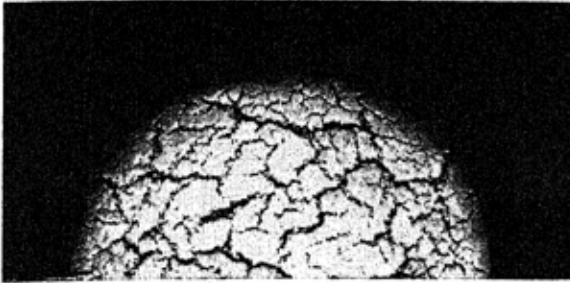
Composite 1948



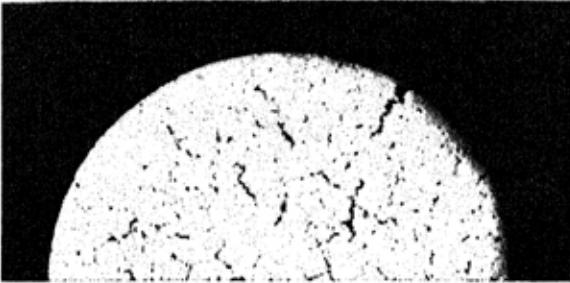
Composite 1948

Figure 11.—Cookies baked from Early Premium, Clarkan, and Kawvale varieties of wheat grown during 1945 to 1948.

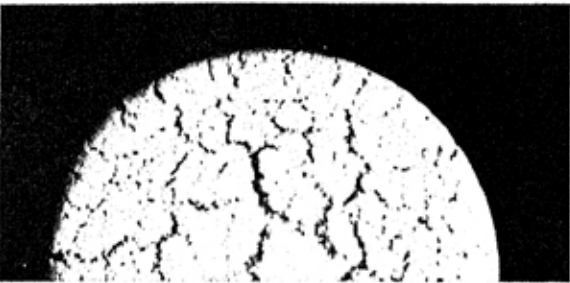
KAWVALE



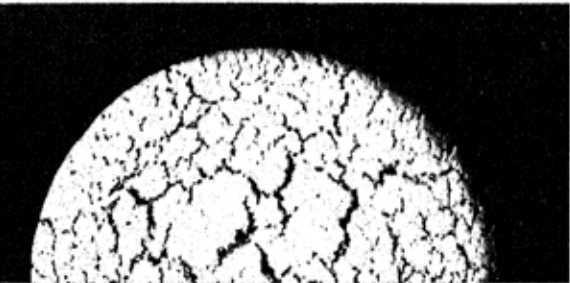
Columbia 1945



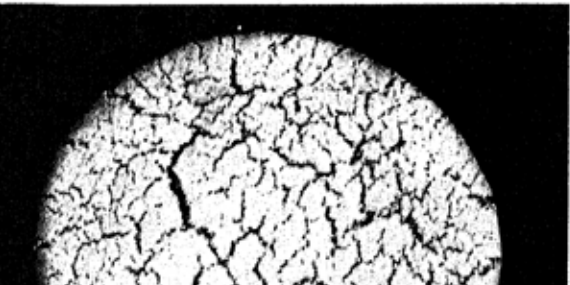
Columbia 1946



Columbia 1947



Composite 1947

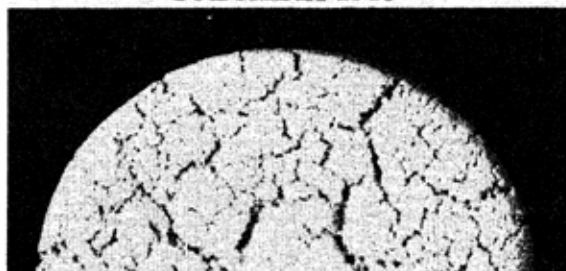
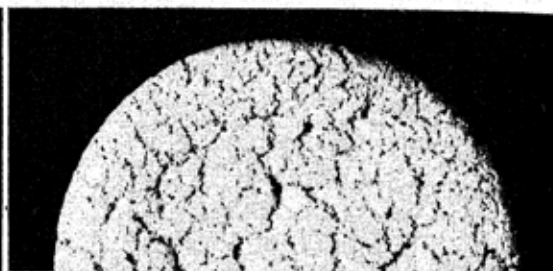
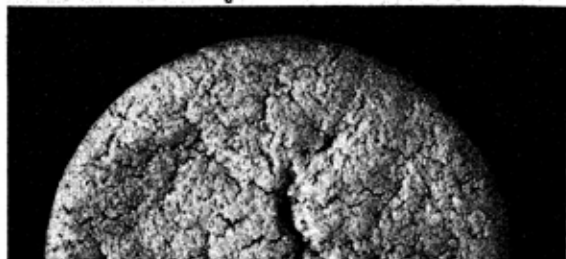


Composite 1948

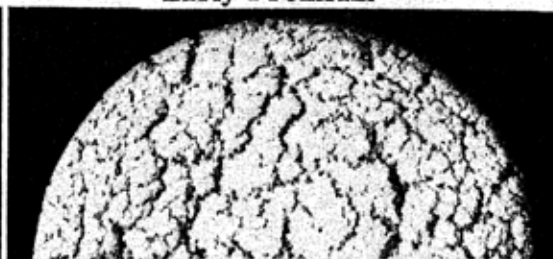
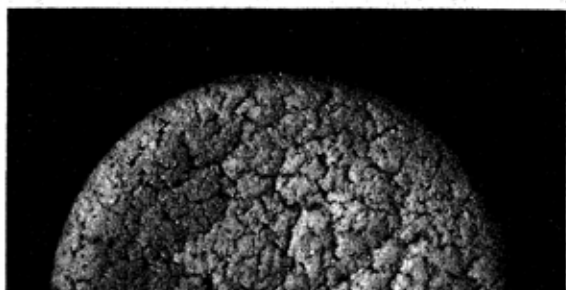
Figure 11.—(Continued)

COLUMBIA 1946

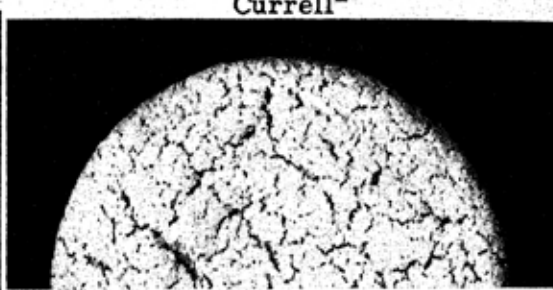
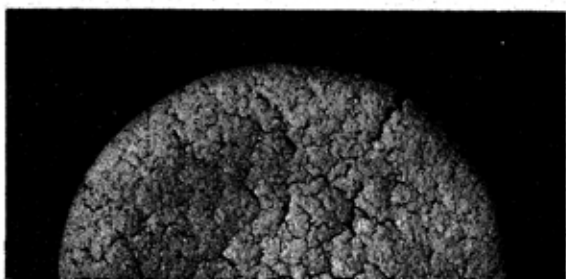
COLUMBIA 1947

W5254 Kawvale x  
Early PremiumW5253 Kawvale x  
Early Premium

Clarkan

W5400 Kawvale x  
Currell

Early Premium

W5477 Purplestraw-  
Chinese-Michigan Amber

Kawvale

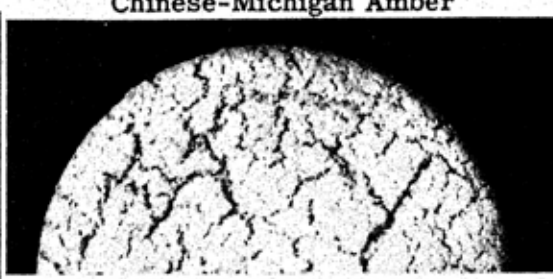
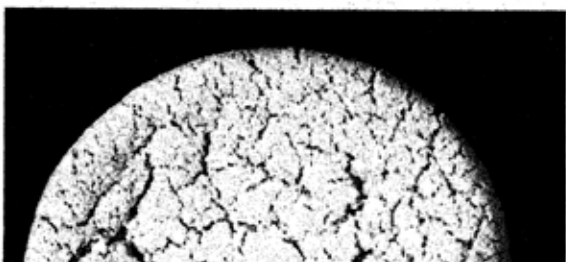
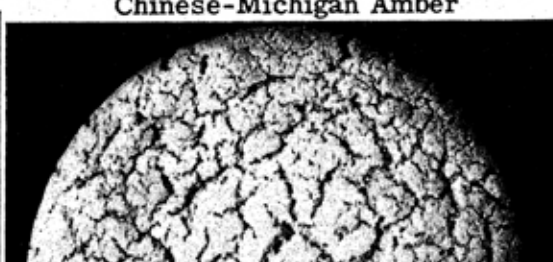
W5478 Purplestraw-  
Chinese-Michigan AmberW5488 White Federation  
x Early PremiumW5488 White Federation  
x Early Premium

Figure 12.—Cookies baked from wheat varieties grown at Columbia 1946, Columbia 1947, Columbia 1948, and a composite from four locations in 1948.

COLUMBIA 1948

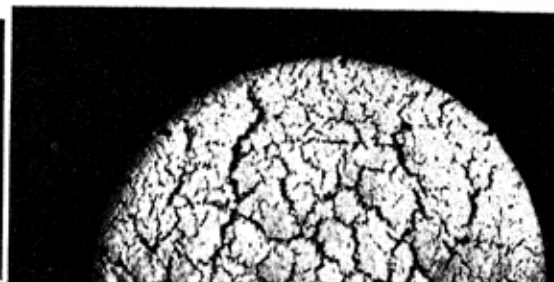
COMPOSITE 1948

W5253 Kawvale x  
Early Premium

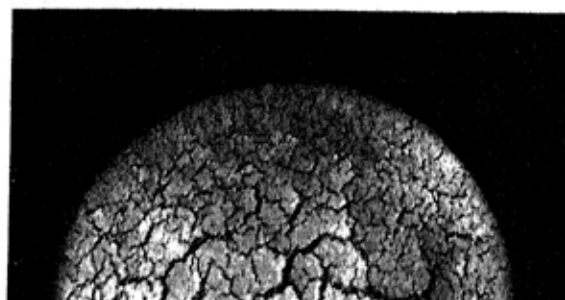
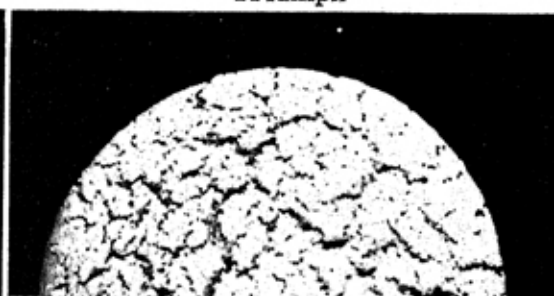
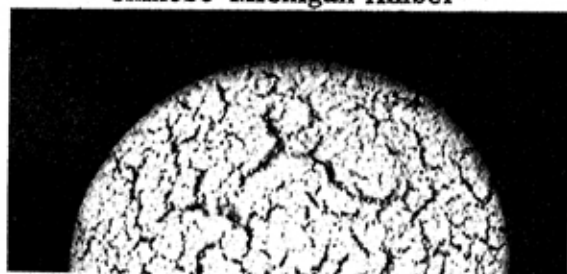
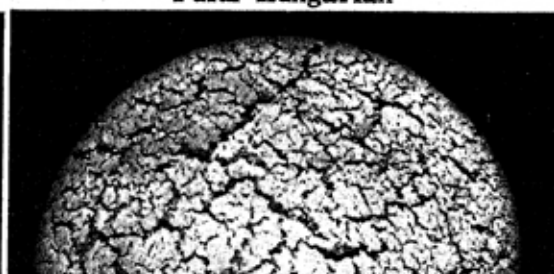
Royal



Purcam



Triumph

W5477 Purplestraw-  
Chinese-Michigan AmberCI 12530 Trumbull-W38-  
Fultz-HungarianW5478 Purplestraw-  
Chinese-Michigan Amber

Butler

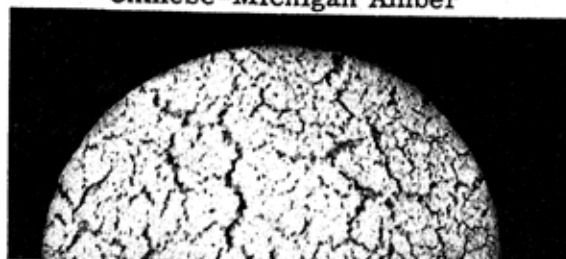
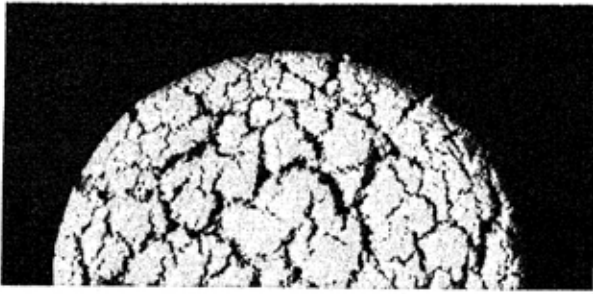
W5488 White Federation  
x Early Premium

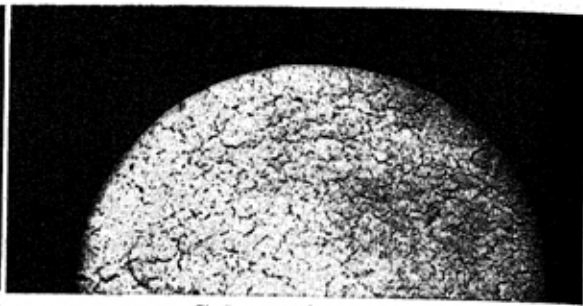
Figure 12.—(Continued)

SIKESTON 1947

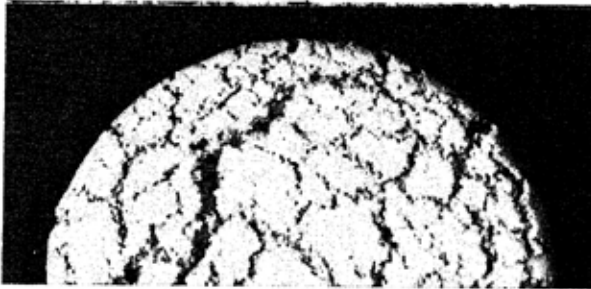


Coker Hardired

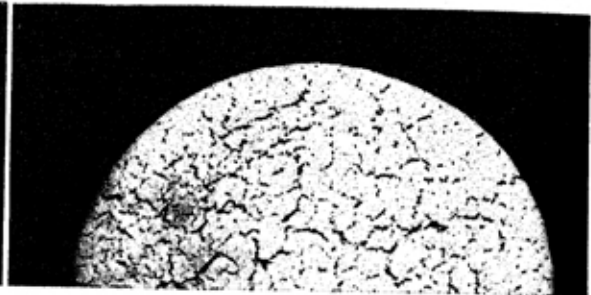
SIKESTON 1948



Coker Hardired



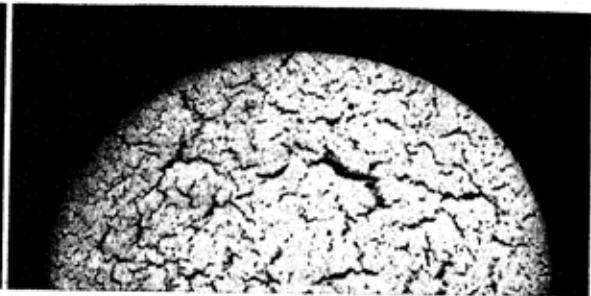
Coker Redhart



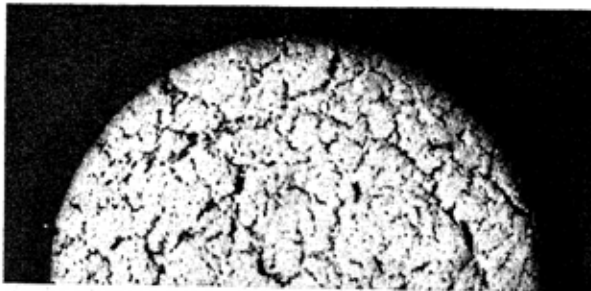
Coker Redhart



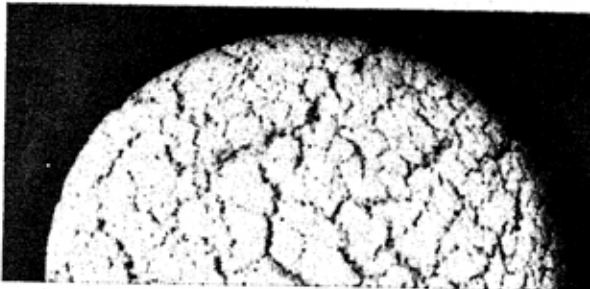
Early Premium



Coker Gemeinhart



Clarkan

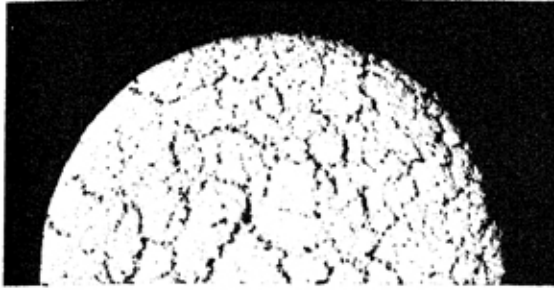


Vigo

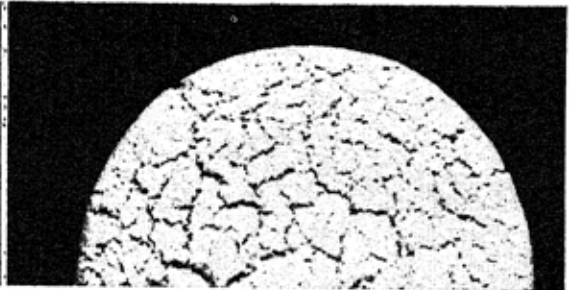
Figure 13.—Cookies baked from wheat varieties grown at Columbia 1947, Sikeston 1947, Sikeston 1948, and a composite from four locations in 1948.

COLUMBIA 1947

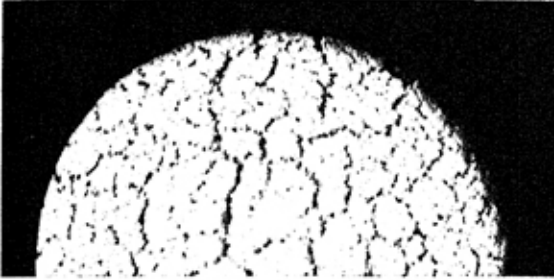
COMPOSITE 1948



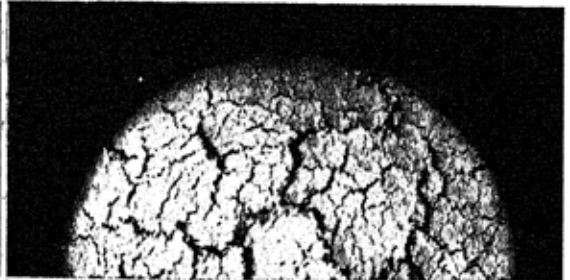
Moking



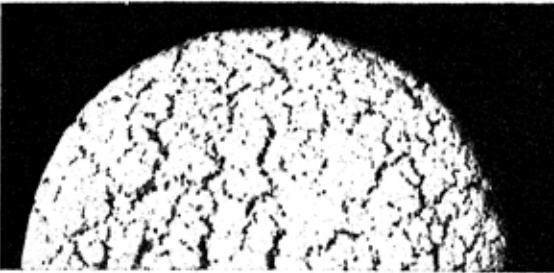
Moking



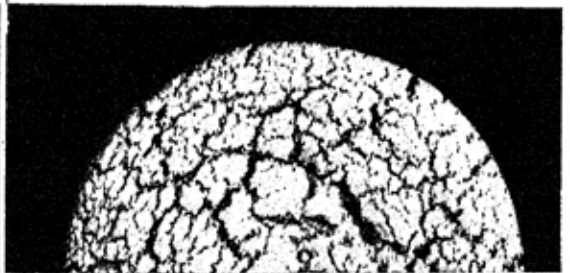
Pawnee



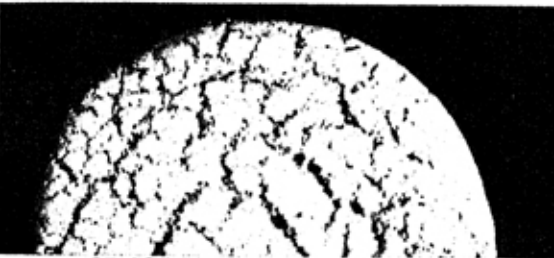
Pawnee



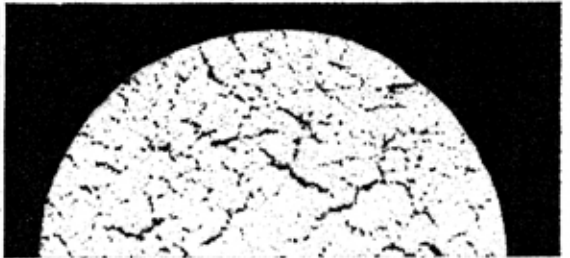
W5590 Kawvale x  
Early Premium



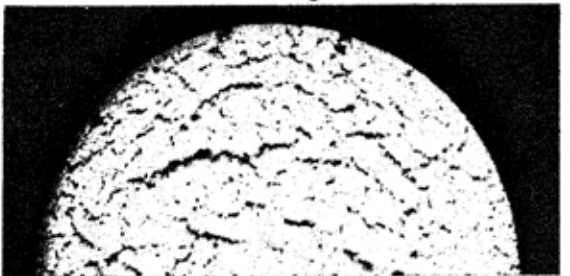
W5590 Kawvale x  
Early Premium



CI 12454 Trumbull-W38-  
Fultz-Hungarian



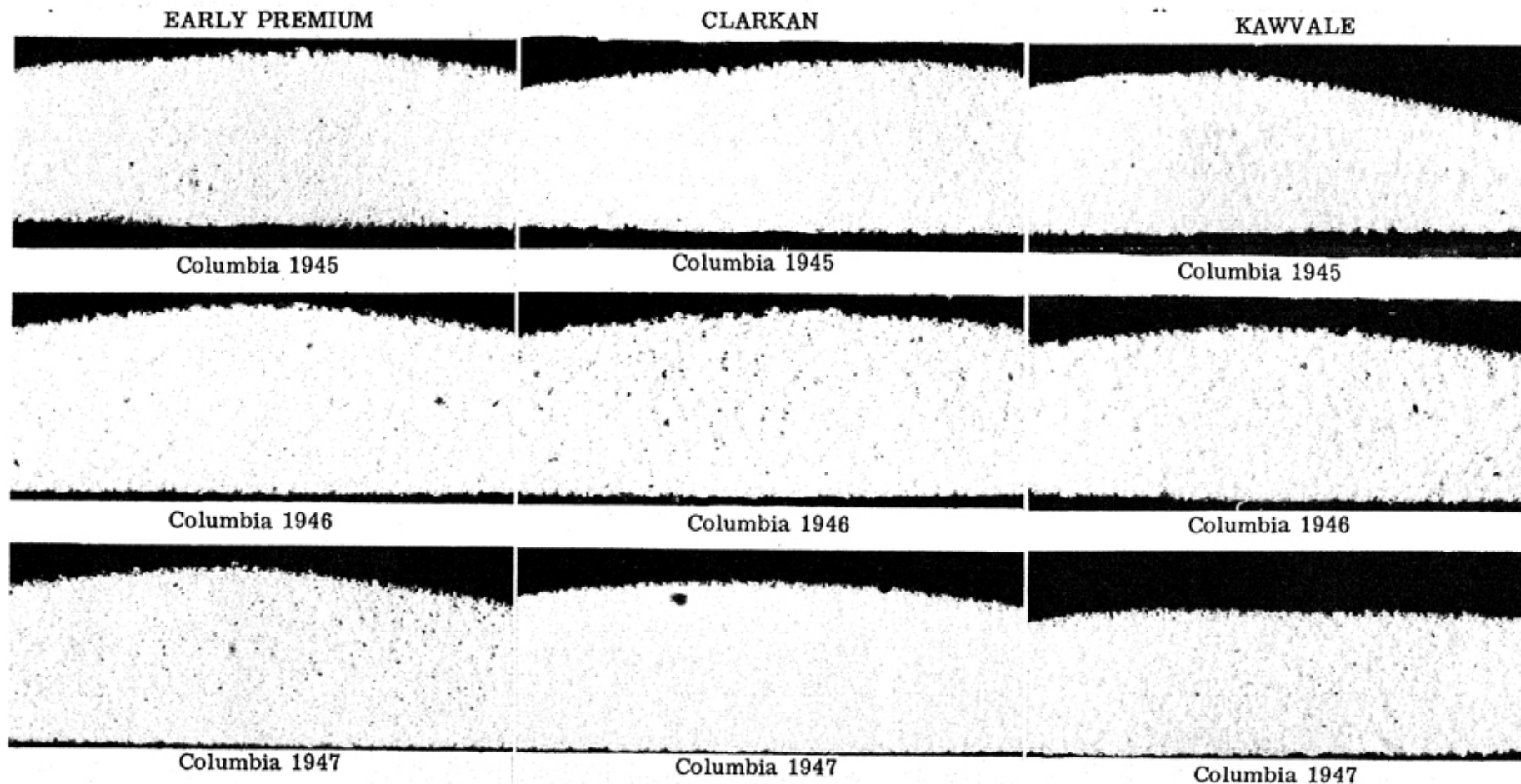
CI 12454 Trumbull-W38-  
Fultz-Hungarian



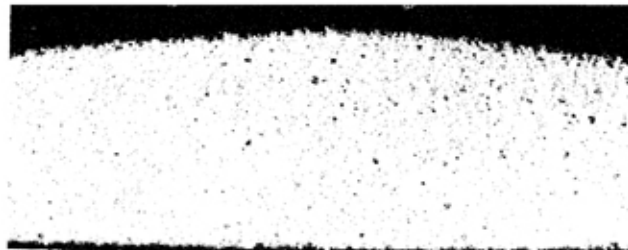
Vigo

Figure 13.—(Continued)

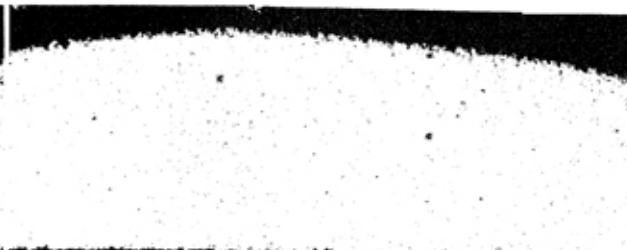
Figure 14.—Cakes baked from Early Premium, Clarkan, and Kawvale varieties of wheat during 1945 to 1948.







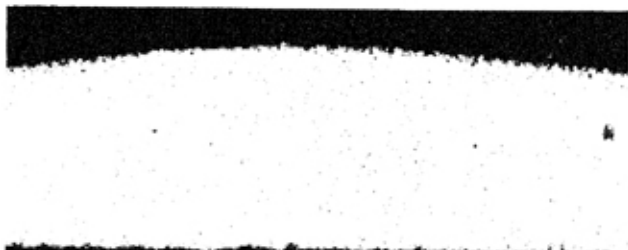
Lathrop 1947



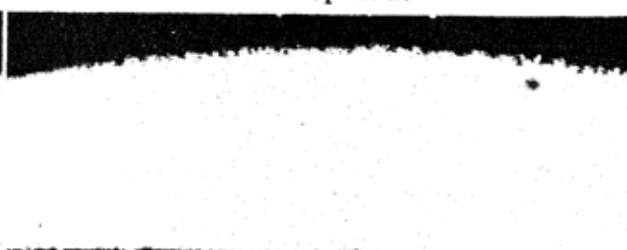
Lathrop 1947



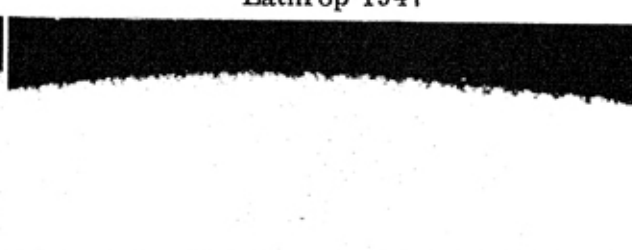
Lathrop 1947



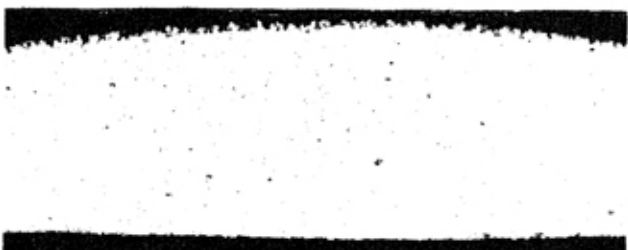
Sikeston 1947



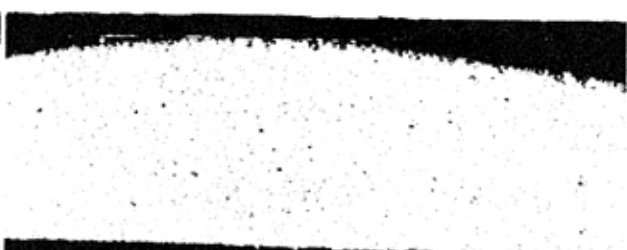
Sikeston 1947



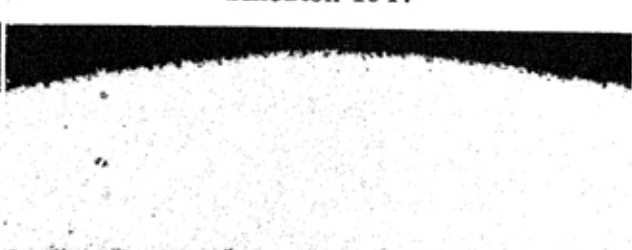
Sikeston 1947



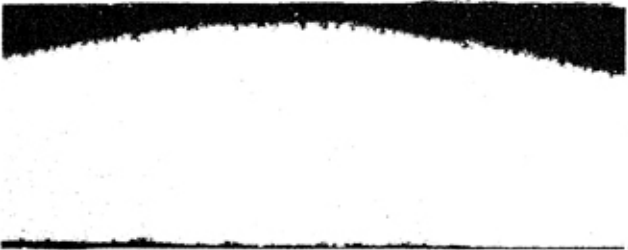
Composite 1947



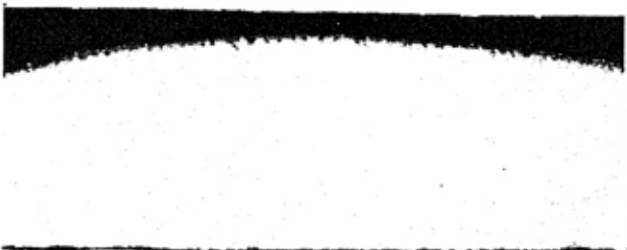
Composite 1947



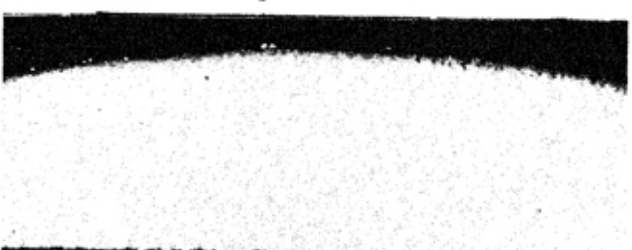
Composite 1947



Composite 1948

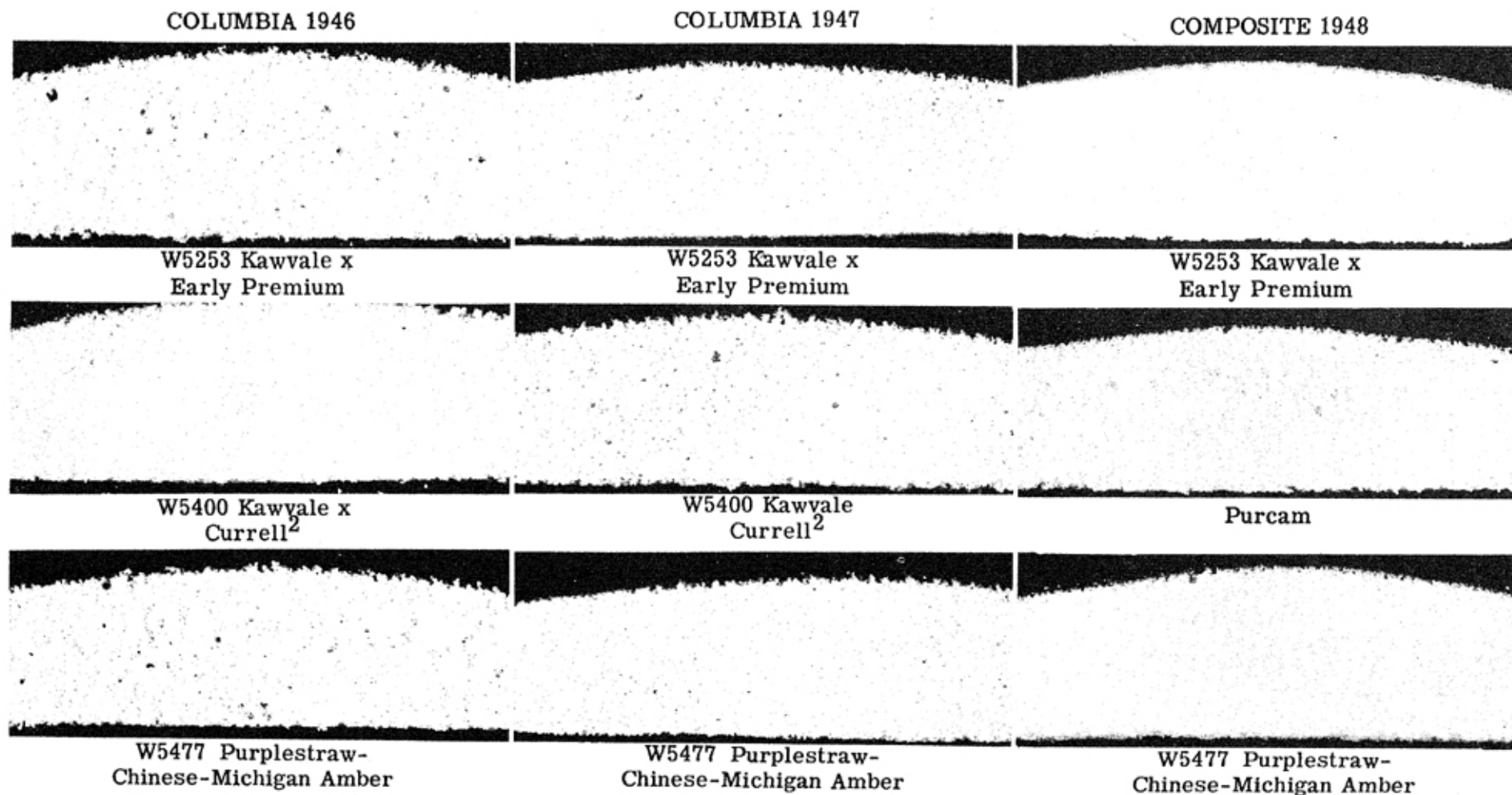


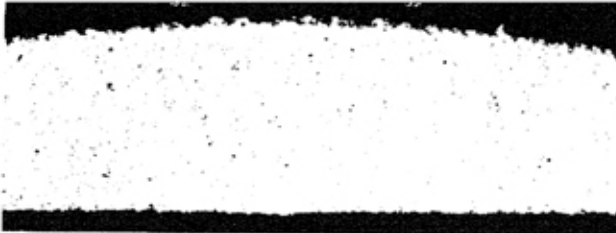
Composite 1948



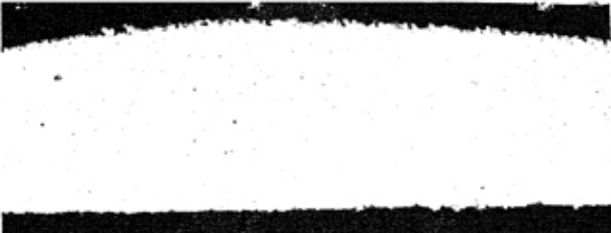
Composite 1948

Figure 15.—Cakes baked from wheat varieties grown at Columbia 1946, Columbia 1947, and a composite from four locations in 1948.

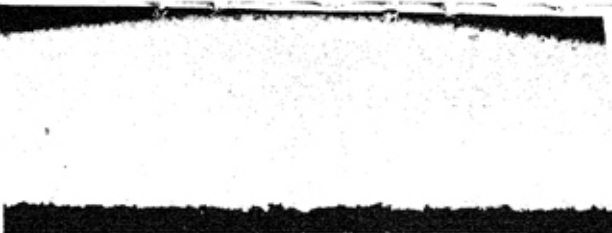




W5478 Purplestraw-  
Chinese-Michigan Amber



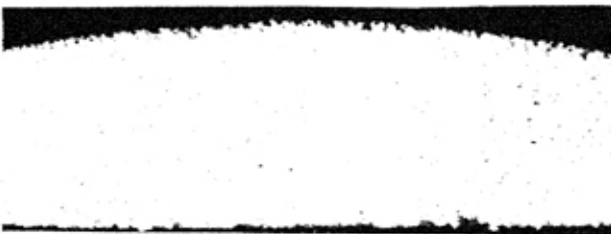
W5478 Purplestraw-  
Chinese-Michigan Amber



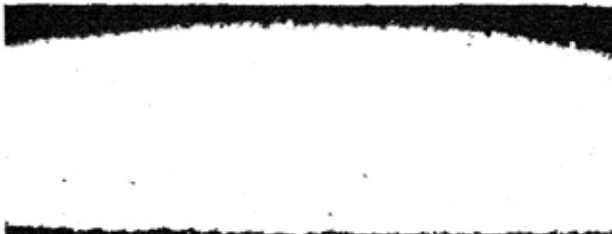
W5478 Purplestraw-  
Chinese-Michigan Amber



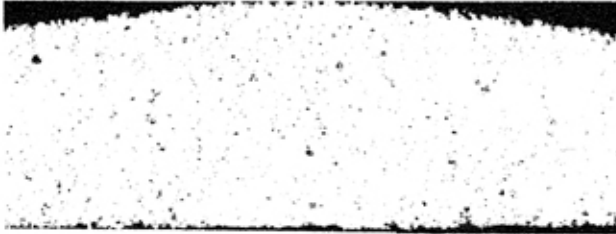
W5488 White Federation  
x Early Premium



W5488 White Federation  
x Early Premium



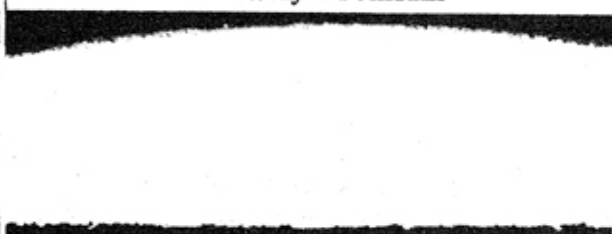
W5488 White Federation  
x Early Premium



Fairfield



Moking



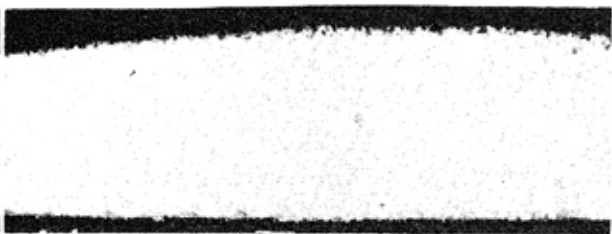
Moking



Mediterranean

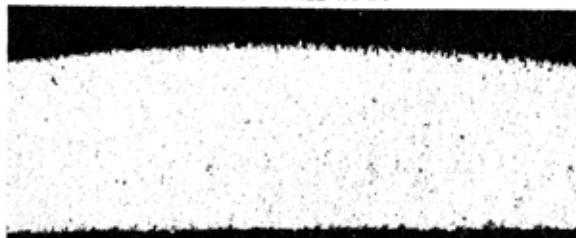


Pawnee

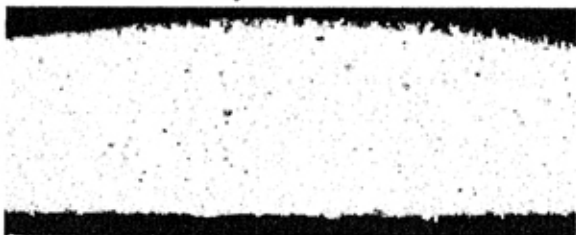


Pawnee

COLUMBIA 1947

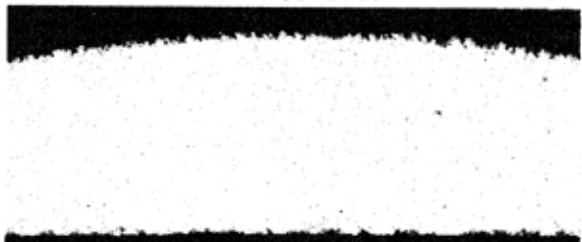


W5590 Kawvale x  
Early Premium



CI 12454 Trumbull-W38-  
Fultz-Hungarian

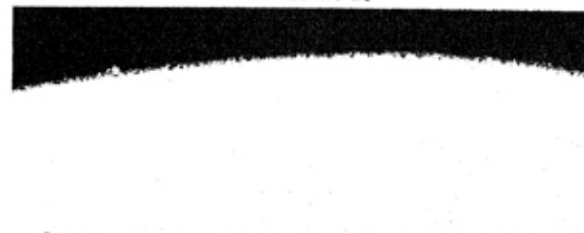
SIKESTON 1947



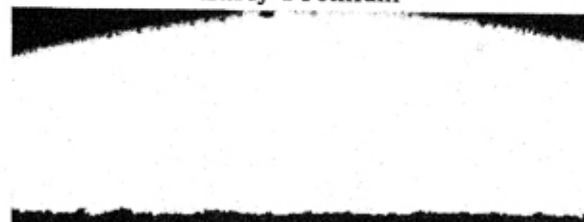
Vigo

SIKESTON 1948

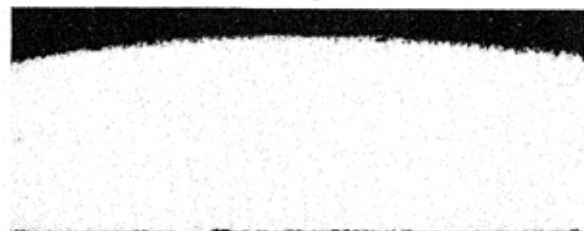
COMPOSITE 1948



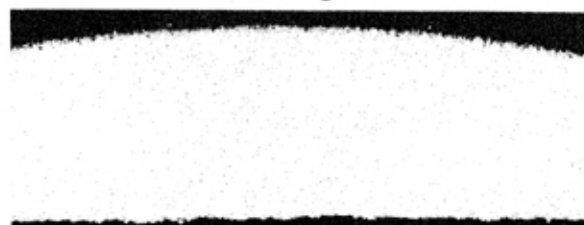
W5590 Kawvale x  
Early Premium



CI 12454 Trumbull-W38-  
Fultz-Hungarian



CI 12530 Trumbull-W38-  
Fultz-Hungarian



Vigo

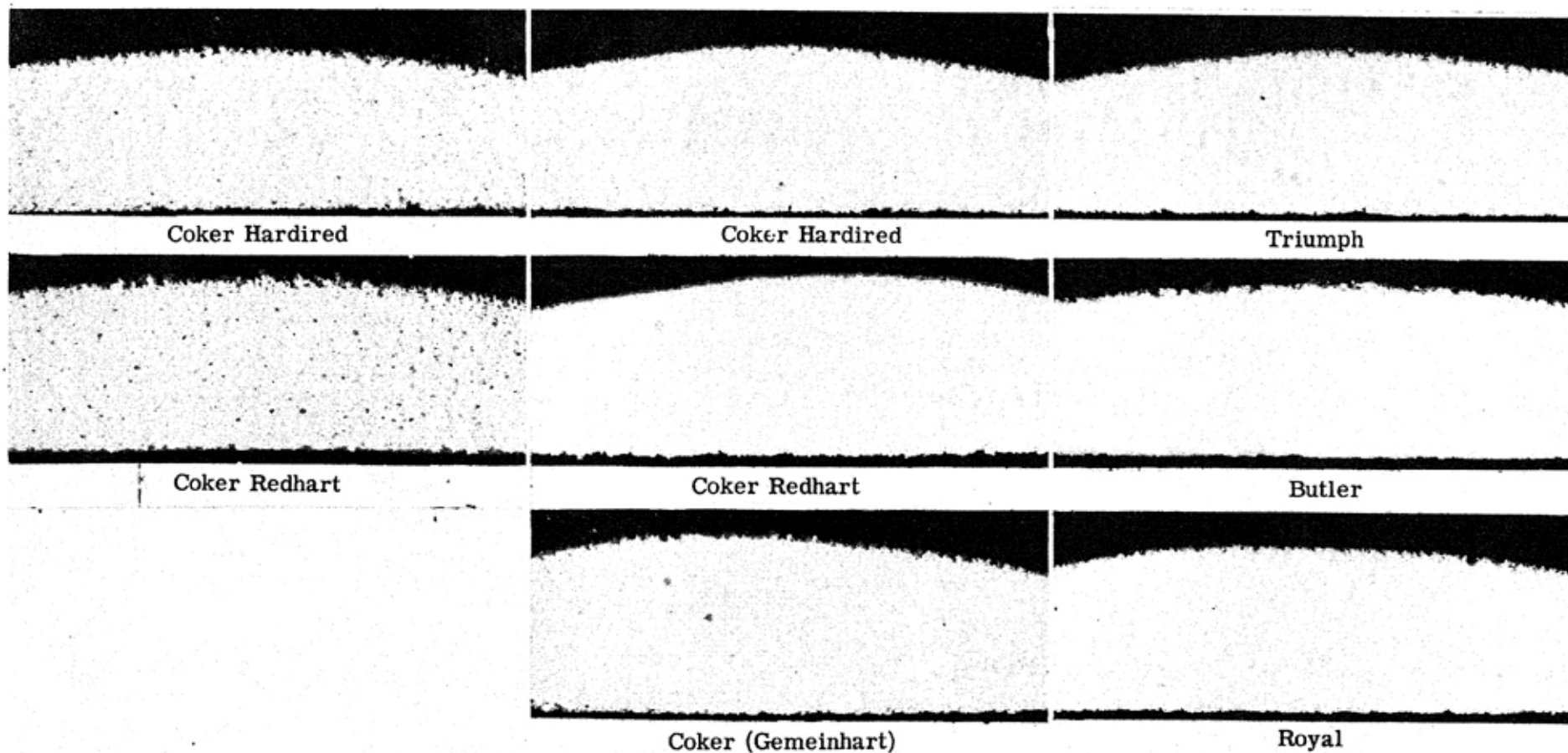


Figure 16.—Cakes baked from wheat varieties grown at Columbia 1947, Sikeston 1947, Sikeston 1948, and a composite from four locations in 1948.

TABLE 4--TEST WEIGHTS (LBS. PER BU.)

Variety	1941	1942	1943	1944		1945			1946	1947				1948		Av.
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	
1. Early Premium . . . . .	60.0	60.5	56.0	60.0	57.0	58.0	56.0	58.0	58.4	57.5	58.0	58.5	58.0		59.0	58.2
2. Clarkan . . . . .	62.0	59.0	61.0	62.5	61.0	61.0	58.0	59.0	60.1	60.0	60.5	60.5	61.9		60.0	60.5
3. Kawvale . . . . .	59.0	57.0	56.0	60.0	56.5	56.0	57.0	56.0	58.4	57.0	58.0	58.0	57.4		57.0	57.4
4. Michigan Wonder . . . . .		56.0	59.0													
5. Fulcaster . . . . .		56.0	60.0					58.0								
6. W5220, Fulcaster x Early Premium . . . . .		60.0														
7. W5216, Fulcaster x Early Premium . . . . .			55.0	62.5	59.0											
8. W5226, Fulcaster x Early Premium . . . . .			56.0	63.0	59.0	59.0	57.5	58.0								
9. Fultz . . . . .			58.5													
10. Fairfield . . . . .			56.5			55.0	53.0	53.0	57.0							
11. Mediterranean . . . . .			59.0			58.0			59.1							
12. Dunbar . . . . .			59.0													
13. Wabash . . . . .			58.5													
14. Forty Fold . . . . .			57.0													
15. W5253, Kawvale x Early Premium . . . . .									60.1	57.0						
16. W5254, Kawvale x Early Premium . . . . .									60.1						59.0	
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .									61.4	58.0						
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .									61.8	57.5						
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .									59.9	58.0					60.0	
20. W5488, White Federation x Early Premium . . . . .									59.3	58.5					59.5	
21. Moking . . . . .										62.5					56.0	
22. Pawnee . . . . .										58.5					60.5	
23. W5590, Kawvale x Early Premium . . . . .										58.5					60.0	
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .										58.5					59.0	
25. Vigo . . . . .										58.5					56.0	
26. Coker, Hardired . . . . .												58.0			56.5	
27. Coker, Redhart . . . . .												59.0		54.5		
28. Purcam . . . . .												58.5		53.0		
29. Triumph . . . . .															57.5	
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .															61.0	
31. Butler . . . . .															56.5	
32. Royal . . . . .															55.5	
33. Coker, (Gemeinhart) . . . . .															59.5	
* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.															56.5	

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

TABLE 5--PEARLING INDEX (PER CENT PEARLED OFF)

Variety	1941	1942	1943	1944		1945			1946	1947				1948		Av.
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	
1. Early Premium . . . . .	33.4	30.2	38.4	41.4	34.6	40.8	34.8	33.9	42.6	46.6	40.9	42.5	43.8	43.7	39.1	
2. Clarkan . . . . .	26.0	27.7	33.2	31.5	29.8	32.4	32.2	30.3	35.2	35.5	32.9	36.4	33.9	35.2	32.3	
3. Kawvale . . . . .	19.9	19.8	22.1	23.9	21.6	23.6	23.9	21.0	27.3	30.0	26.7	26.3	28.0	26.3	24.3	
4. Michigan Wonder . . . . .		23.6	30.9													
5. Fulcaster . . . . .		29.6	35.5					28.0								
6. W5220, Fulcaster x Early Premium . . . . .		26.5														
7. W5216, Fulcaster x Early Premium . . . . .			37.4	34.4	34.5											
8. W5226, Fulcaster x Early Premium . . . . .			36.2	32.8	35.0	33.1	34.2	29.2								
9. Fultz . . . . .			37.5													
10. Fairfield . . . . .			44.5			44.3	34.5	34.0	46.7							
11. Mediterranean . . . . .			38.3			35.8			39.6							
12. Dunbar . . . . .			40.2													
13. Wabash . . . . .			43.9													
14. Forty Fold . . . . .			46.8													
15. W5253, Kawvale x Early Premium . . . . .									35.4	41.1				42.3		
16. W5254, Kawvale x Early Premium . . . . .									36.8							
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .									35.7	36.7						
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .									32.1	40.6				34.3		
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .									38.7	42.7				40.2		
20. W5488, White Federation x Early Premium . . . . .									42.8	46.9				48.6		
21. Moking . . . . .										34.2				33.2		
22. Pawnee . . . . .										28.2				27.7		
23. W5590, Kawvale x Early Premium . . . . .										42.0				52.0		
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .										42.5				48.9		
25. Vigo . . . . .												47.6		47.9		
26. Coker, Hardired . . . . .												27.9		27.2		
27. Coker, Redhart . . . . .												37.1		42.3		
28. Purcam . . . . .														37.8		
29. Triumph . . . . .														30.4		
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .														49.3		
31. Butler . . . . .														44.9		
32. Royal . . . . .														38.1		
33. Coker, (Gemeinhart) . . . . .														35.7		

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

TABLE 6--WHEAT ASH (PER CENT)†

Variety	1941	1942	1943	1944		1945			1946	1947				1948		Av.
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	
1. Early Premium . . . . .	1.89	1.92	1.95	2.06	2.38		1.86									2.01
2. Clarkan . . . . .	2.14	2.03	2.52	2.20	2.22											2.14
3. Kawvale . . . . .	1.89	1.95	1.86	1.88	2.43		2.01									2.00
4. Michigan Wonder . . . . .		2.09	1.83													
5. Fulcaster . . . . .		1.88	1.82													
6. W5220, Fulcaster x Early Premium . . . . .		2.00														
7. W5216, Fulcaster x Early Premium			1.99	2.19	2.63											
8. W5226, Fulcaster x Early Premium			1.95	2.07	2.52		1.83									
9. Fultz . . . . .			1.93													
10. Fairfield . . . . .			1.83				1.88									
11. Mediterranean . . . . .			1.89													
12. Dunbar . . . . .			2.40													
13. Wabash . . . . .			1.69													
14. Forty Fold . . . . .			1.84													
15. W5253, Kawvale x Early Premium																
16. W5254, Kawvale x Early Premium																
17. W5400, Kawvale x Currell <sup>2</sup>																
18. W5477, Purplestraw-Chinese-Michigan-Amber																
19. W5478, Purplestraw-Chinese-Michigan-Amber																
20. W5488, White Federation x Early Premium																
21. Moking																
22. Pawnee																
23. W5590, Kawvale x Early Premium																
24. CI 12454, Trumbull-W38-Fultz-Hungarian																
25. Vigo																
26. Coker, Hardired																
27. Coker, Redhart																
28. Purcam																
29. Triumph																
30. CI 12530, Trumbull-W38-Fultz-Hungarian																
31. Butler																
32. Royal																
33. Coker, (Gemeinhart)																

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

‡ 14 per cent moisture basis.



TABLE 7--WHEAT PROTEIN (PER CENT‡)

Variety	1941	1942	1943	1944		1945			1946	1947				1948		
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	Av.
1. Early Premium . . . . .	9.65	9.36	10.79	9.10	13.30	8.56	10.45	11.32	8.56	8.53	10.59	9.96	9.49	9.73	9.96	
2. Clarkan . . . . .	9.65	10.16	12.22	9.76	12.23	9.32	10.72	10.83	10.30	10.24	11.44	10.21	10.59	9.25	10.49	
3. Kawvale . . . . .	9.16	10.35	12.17	8.85	13.08	8.15	11.65	10.67	8.90	8.04	11.10	10.04	9.76	9.39	10.09	
4. Michigan Wonder . . . . .		9.86	10.22													
5. Fulcaster . . . . .		9.26	10.04					10.13								
6. W5220, Fulcaster x Early Premium . . . . .		9.86														
7. W5216, Fulcaster x Early Premium . . . . .			11.37	10.49	12.22											
8. W5226, Fulcaster x Early Premium . . . . .			11.34	10.39	11.77	9.80	11.05	10.66								
9. Fultz . . . . .			10.73													
10. Fairfield . . . . .			10.40			8.00	10.71	11.00	9.10							
11. Mediterranean . . . . .			10.48			9.21			9.91							
12. Dunbar . . . . .			10.37													
13. Wabash . . . . .			9.64													
14. Forty Fold . . . . .			9.53													
15. W5253, Kawvale x Early Premium . . . . .									8.92	9.32						
16. W5254, Kawvale x Early Premium . . . . .									8.94							9.58
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .									11.31	9.12						
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .									10.35	8.33						10.44
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .									9.08	8.05						9.20
20. W5488, White Federation x Early Premium . . . . .									8.72	8.34						8.53
21. Moking . . . . .										8.97						9.87
22. Pawnee . . . . .										8.11						9.59
23. W5590, Kawvale x Early Premium . . . . .										8.71						9.50
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .										8.71						9.95
25. Vigo . . . . .												9.36		11.18		8.93
26. Coker, Hardired . . . . .												9.90		10.62		
27. Coker, Redhart . . . . .												9.49				
28. Purcam . . . . .																9.85
29. Triumph . . . . .																9.81
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .																9.66
31. Butler . . . . .																8.67
32. Royal . . . . .																10.56
33. Coker, (Gemeinhart) . . . . .																10.40

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

‡ 14 per cent moisture basis.

TABLE 8--STRAIGHT FLOUR ASH (PER CENT†)

Variety	1941	1942	1943	1944		1945			1946	1947				1948		Av.
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	
1. Early Premium . . . . .		.393	.340	.350	.440	.290		.335	.338	.312	.369	.362	.342		.322	.349
2. Clarkan . . . . .		.432	.350	.400	.470	.328		.385	.372	.342	.430	.398	.404		.340	.388
3. Kawvale . . . . .		.495	.430	.460	.540	.382		.413	.442	.408	.450	.474	.425		.413	.446
4. Michigan Wonder . . . . .		.430	.360													
5. Fulcaster . . . . .		.501	.390					.404								
6. W5220, Fulcaster x Early Premium . . . . .		.441														
7. W5216, Fulcaster x Early Premium . . . . .			.350	.400	.430											
8. W5226, Fulcaster x Early Premium . . . . .			.360	.380	.430	.361		.385								
9. Fultz . . . . .			.360													
10. Fairfield . . . . .			.410			.330		.417	.348							
11. Mediterranean . . . . .			.430			.383			.419							
12. Dunbar . . . . .			.390													
13. Wabash . . . . .			.330													
14. Forty Fold . . . . .			.420													
15. W5253, Kawvale x Early Premium . . . . .									.216	.309						.326
16. W5254, Kawvale x Early Premium . . . . .									.375							
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .									.373	.354						
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .									.441	.323						.342
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .									.400	.323						.330
20. W5488, White Federation x Early Premium . . . . .									.376	.340						.324
21. Moking . . . . .										.298						.338
22. Pawnee . . . . .										.357						.395
23. W5590, Kawvale x Early Premium . . . . .										.295						.362
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .										.314						.305
25. Vigo . . . . .												.363				.311
26. Coker, Hardired . . . . .												.419		.395		
27. Coker, Redhart . . . . .												.365		.345		
28. Purcam . . . . .																.377
29. Triumph . . . . .																.295
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .																.333
31. Butler . . . . .																.339
32. Royal . . . . .																.339
33. Coker, (Gemeinhart) . . . . .															.369	

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

‡ 14 per cent moisture basis.

TABLE 9--70 PER CENT PATENT FLOUR ASH (PER CENT†)

Variety	1941	1942	1943	1944		1945			1946	1947				1948		Av.
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	
1. Early Premium . . . . .	.377	.360	.360	.340	.480	.252	.510	.273	.296	.255	.315	.300	.280	.287	.335	
2. Clarkan . . . . .	.480	.390	.440	.380	.500	.282	.490	.333	.325	.280	.364	.342	.346	.305	.375	
3. Kawvale . . . . .	.484	.510	.440	.450	.550	.313	.550	.382	.400	.348	.400	.403	.375	.358	.426	
4. Michigan Wonder . . . . .		.460	.360													
5. Fulcaster . . . . .		.430	.380					.343								
6. W5220, Fulcaster x Early Premium . . . . .		.470														
7. W5216, Fulcaster x Early Premium . . . . .			.340	.390	.480											
8. W5226, Fulcaster x Early Premium . . . . .			.380	.390	.490	.322	.530	.333								
9. Fultz . . . . .			.360													
10. Fairfield . . . . .			.410			.283	.540	.322	.295							
11. Mediterranean . . . . .						.312			.350							
12. Dunbar																
13. Wabash																
14. Forty Fold																
15. W5253, Kawvale x Early Premium . . . . .									.308	.268				.297		
16. W5254, Kawvale x Early Premium . . . . .									.315							
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .									.337	.304						
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .									.370	.288				.306		
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .									.325	.286				.278		
20. W5488, White Federation x Early Premium . . . . .									.323	.283				.277		
21. Moking . . . . .										.263				.286		
22. Pawnee . . . . .										.308				.328		
23. W5590, Kawvale x Early Premium . . . . .										.263				.315		
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .										.260				.270		
25. Vigo . . . . .													.303	.274		
26. Coker, Hardired . . . . .													.380	.351		
27. Coker, Redhart . . . . .													.308	.311		
28. Purcam . . . . .														.296		
29. Triumph . . . . .														.280		
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .														.278		
31. Butler . . . . .														.295		
32. Royal . . . . .														.293		
33. Coker, (Gemeinhart) . . . . .														.326		

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

‡ 14 per cent moisture basis.

TABLE 10--STRAIGHT FLOUR PROTEIN (PER CENT)†

Variety	1941	1942	1943	1944		1945			1946	1947				1948		Av.
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	
1. Early Premium . . . . .			9.41	7.58	11.69	7.01		9.65	7.45	7.02	9.20	8.33	7.99		8.35	8.52
2. Clarkan . . . . .			10.83	8.49	10.83	7.78		9.24	8.55	8.39	10.15	8.76	9.22		8.14	9.13
3. Kawvale . . . . .			10.60	7.47	11.00	6.50		8.91	8.58	6.29	9.81	8.65	8.28		8.20	8.57
4. Michigan Wonder . . . . .			8.66													
5. Fulcaster . . . . .			8.83					8.39								
6. W5220, Fulcaster x Early Premium																
7. W5216, Fulcaster x Early Premium			10.03	9.06	10.77											
8. W5226, Fulcaster x Early Premium			9.75	8.95	10.66	8.39		9.27								
9. Flutz . . . . .			9.01													
10. Fairfield . . . . .			8.32			6.26		9.28	7.72							
11. Mediterranean . . . . .			8.95			7.48			8.48							
12. Dunbar . . . . .			8.32													
13. Wabash . . . . .			8.04													
14. Forty Fold . . . . .			7.24													
15. W5253, Kawvale x Early Premium . . . . .									7.71	7.75					8.47	
16. W5254, Kawvale x Early Premium . . . . .									7.74							
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .									9.76	7.64						
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .									9.18	7.38					9.27	
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .									7.98	6.35					7.99	
20. W5488, White Federation x Early Premium . . . . .									7.34	7.92					7.22	
21. Moking . . . . .										7.80					9.05	
22. Pawnee . . . . .										6.68					8.21	
23. W5590, Kawvale x Early Premium . . . . .										6.27					8.04	
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .										7.46					8.53	
25. Vigo . . . . .												7.84			7.69	
26. Coker, Hardired . . . . .												8.68		9.95		
27. Coker, Redhart . . . . .												7.97		9.47		
28. Purcam . . . . .															8.74	
29. Triumph . . . . .															8.54	
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .															8.56	
31. Butler . . . . .															7.49	
32. Royal . . . . .															8.78	
33. Coker, (Gemeinhart) . . . . .															9.15	

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

‡ 14 per cent moisture basis.

TABLE 11--70 PER CENT PATENT FLOUR PROTEIN (PER CENT†)

Variety	1941	1942	1943	1944		1945			1946	1947				1948		Av.
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	
1. Early Premium . . . . .	8.10	7.75	9.06	7.47	11.91	6.80	8.95	9.45	7.21	6.55	8.47	7.82	7.30		7.94	8.20
2. Clarkan . . . . .	8.90	8.61	10.55	8.27	11.00	7.55	9.52	8.95	8.10	7.72	9.25	8.17	8.70		7.78	8.79
3. Kawvale . . . . .	7.80	8.83	10.43	7.35	12.03	6.45	10.66	8.92	8.31	5.83	9.34	8.10	7.80		7.88	8.55
4. Michigan Wonder . . . . .		7.98	8.38													
5. Fulcaster . . . . .		6.44	8.38					8.16								
6. W5220, Fulcaster x Early Premium . . . . .		8.55														
7. W5216, Fulcaster x Early Premium . . . . .			9.69	9.06	10.77											
8. W5226, Fulcaster x Early Premium . . . . .			9.52	9.06	10.66	8.09	10.14	9.00								
9. Fultz . . . . .			8.66													
10. Fairfield . . . . .			8.32			6.00	9.29	9.00	7.10							
11. Mediterranean . . . . .						7.17			7.85							
12. Dunbar																
13. Wabash																
14. Forty Fold																
15. W5253, Kawvale x Early Premium . . . . .									7.54	7.26					8.03	
16. W5254, Kawvale x Early Premium . . . . .									7.16							
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .									9.34	7.12						
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .									8.25	6.82					8.66	
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .									7.30	6.00					7.53	
20. W5488, White Federation x Early Premium . . . . .									6.70	7.40					6.78	
21. Moking . . . . .										7.20					8.60	
22. Pawnee . . . . .										6.36					7.88	
23. W5590, Kawvale x Early Premium . . . . .										5.72					7.66	
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .										6.83					8.00	
25. Vigo . . . . .												7.42			7.22	
26. Coker, Hardired . . . . .												8.44		9.92		
27. Coker, Redhart . . . . .												7.42		8.96		
28. Purcam . . . . .															8.07	
29. Triumph . . . . .															8.19	
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .															7.96	
31. Butler . . . . .															7.10	
32. Royal . . . . .															8.30	
33. Coker, (Gemeinhart) . . . . .															8.86	

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

‡ 14 per cent moisture basis.

TABLE 12--STRAIGHT FLOUR MIXOGRAMS (SQ. CM.)

Variety	1941	1942	1943	1944		1945			1946	1947				1948		Av.
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	
1. Early Premium						63.75		84.71	60.93	47.36	76.59	57.43	60.97		66.07	64.72
2. Clarkan						71.81		89.14	80.83	79.04	91.97	68.81	83.81		69.04	79.31
3. Kawvale						62.94		96.36	79.39	56.39	95.43	67.43	68.33		66.97	74.22
4. Michigan Wonder																
5. Fulcaster								76.80								
6. W5220, Fulcaster x Early Premium																
7. W5216, Fulcaster x Early Premium																
8. W5226, Fulcaster x Early Premium						88.26		82.60								
9. Fultz																
10. Fairfield						56.49		78.07	67.66							
11. Mediterranean						69.20			76.59							
12. Dunbar																
13. Wabash																
14. Forty Fold																
15. W5253, Kawvale x Early Premium									79.51	51.97					65.75	
16. W5254, Kawvale x Early Premium									72.45							
17. W5400, Kawvale x Currell <sup>2</sup>									82.85	59.23						
18. W5477, Purplestraw-Chinese-Michigan-Amber									88.90	58.49					76.78	
19. W5478, Purplestraw-Chinese-Michigan-Amber									74.97	54.59					61.42	
20. W5488, White Federation x Early Premium									56.71	61.55					38.39	
21. Moking										67.88					66.97	
22. Pawnee										66.10					68.20	
23. W5590, Kawvale x Early Premium										46.97					62.07	
24. CI 12454, Trumbull-W38-Fultz-Hungarian										54.78					54.65	
25. Vigo												63.36			44.84	
26. Coker, Hardired												67.52		69.62		
27. Coker, Redhart												78.46		65.17		
28. Purcam															62.13	
29. Triumph															75.42	
30. CI 12530, Trumbull-W38-Fultz-Hungarian															53.42	
31. Butler															44.65	
32. Royal															58.97	
33. Coker, (Gemeinhart)															63.81	

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

TABLE 13--70 PER CENT PATENT FLOUR MIXOGRAMS (SQ. CM.)

Variety	1941	1942	1943	1944		1945			1946	1947				1948		
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	Av.
1. Early Premium . . . . .	60.70	71.40	68.00	56.00		41.69	50.84	67.00	61.29	42.78	55.20	49.65	61.30	57.55	57.18	
2. Clarkan . . . . .	83.00	75.80	86.00	83.00		55.80	45.02	72.57	65.07	57.62	64.56	63.20	74.20	62.91	68.36	
3. Kawvale . . . . .	66.10	83.50	86.00	82.00		51.72	80.98	81.25	73.23	41.20	69.91	61.75	62.97	66.71	69.79	
4. Michigan Wonder . . . . .		73.30														
5. Fulcaster . . . . .		64.60						64.99								
6. W5220, Fulcaster x Early Premium . . . . .		80.30														
7. W5216, Fulcaster x Early Premium . . . . .			74.00	74.00												
8. W5226, Fulcaster x Early Premium . . . . .			70.00	78.00		52.96	68.32	70.47								
9. Fultz . . . . .																
10. Fairfield . . . . .						36.29	51.04	63.11	87.97							
11. Mediterranean . . . . .						52.74			76.75							
12. Dunbar . . . . .																
13. Wabash . . . . .																
14. Forty Fold . . . . .																
15. W5253, Kawvale x Early Premium . . . . .									64.62	43.42					60.13	
16. W5254, Kawvale x Early Premium . . . . .									63.00							
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .									76.65	58.04						
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .									69.00	49.62					68.59	
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .									67.36	45.72					58.58	
20. W5488, White Federation x Early Premium . . . . .									52.10	53.39					49.04	
21. Moking . . . . .										60.13					71.81	
22. Pawnee . . . . .										51.71					60.58	
23. W5590, Kawvale x Early Premium . . . . .										44.10					56.65	
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .										41.97					53.16	
25. Vigo . . . . .												47.45			53.36	
26. Coker, Hardired . . . . .												64.10		81.55		
27. Coker, Redhart . . . . .												51.46		67.88		
28. Purcam . . . . .															60.39	
29. Triumph . . . . .															68.59	
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .															54.20	
31. Butler . . . . .															51.81	
32. Royal . . . . .															65.17	
33. Coker, (Gemeinhart) . . . . .															73.68	

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

TABLE 14--STRAIGHT FLOUR VISCOSITY (DEGREES, MACMICHAEL)

Variety	1941	1942	1943	1944		1945			1946	1947				1948		Av.
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	
1. Early Premium . . . . .										150	153	140	141			155
2. Clarkan . . . . .										148	120	105	111			130
3. Kawvale . . . . .										185	139	131	135			150
4. Michigan Wonder																
5. Fulcaster																
6. W5220, Fulcaster x Early Premium																
7. W5216, Fulcaster x Early Premium																
8. W5226, Fulcaster x Early Premium																
9. Fultz																
10. Fairfield																
11. Mediterranean																
12. Dunbar																
13. Wabash																
14. Forty Fold																
15. W5253, Kawvale x Early Premium . . . . .																
16. W5254, Kawvale x Early Premium . . . . .										184						191
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .																
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .																
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .																162
20. W5488, White Federation x Early Premium . . . . .																180
21. Moking . . . . .																133
22. Pawnee . . . . .																134
23. W5590, Kawvale x Early Premium . . . . .																169
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .																162
25. Vigo . . . . .																127
26. Coker, Hardired . . . . .													123			151
27. Coker, Redhart . . . . .													154		156	
28. Purcam . . . . .													144		151	
29. Triumph . . . . .																126
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .																192
31. Butler . . . . .																115
32. Royal . . . . .																108
33. Coker, (Gemeinhart) . . . . .																167
																136

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.



TABLE 15--70 PER CENT PATENT FLOUR VISCOSITY (DEGREES, MACMICHAEL)

Variety	1941	1942	1943	1944		1945			1946	1947				1948		Av.
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	
1. Early Premium . . . . .	167	157	115	93	60	111	47	87	85	87	71	97	67		94	95.0
2. Clarkan . . . . .	185	112	106	111	71	96	37	76	84	70	66	69	58		96	88.0
3. Kawvale . . . . .	169	120	116	153	85	257	70	135	127	197	132	125	113		133	138.0
4. Michigan Wonder . . . . .		112														
5. Fulcaster . . . . .		110						108								
6. W5220, Fulcaster x Early Premium . . . . .		136														
7. W5216, Fulcaster x Early Premium . . . . .			105	110	87											
8. W5226, Fulcaster x Early Premium . . . . .			106	105	84	121		93								
9. Fultz . . . . .																
10. Fairfield . . . . .						156		108		111						
11. Mediterranean . . . . .						132				79						
12. Dunbar . . . . .																
13. Wabash . . . . .																
14. Forty Fold . . . . .																
15. W5253, Kawvale x Early Premium . . . . .									93	111					114	
16. W5254, Kawvale x Early Premium . . . . .									135							
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .									67	87						
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .									77	102					87	
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .									127	145					122	
20. W5488, White Federation x Early Premium . . . . .									85	95					109	
21. Moking . . . . .										115					79	
22. Pawnee . . . . .										171					138	
23. W5590, Kawvale x Early Premium . . . . .										153					120	
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .										74					78	
25. Vigo . . . . .												86			101	
26. Coker, Hardired . . . . .												134		140		
27. Coker, Redhart . . . . .												102		82		
28. Purcam . . . . .															102	
29. Triumph . . . . .															137	
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .															70	
31. Butler . . . . .															92	
32. Royal . . . . .															125	
33. Coker, (Gemeinhart) . . . . .															100	

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

TABLE 16--COOKY SPREAD FACTOR (DIAMETER/THICKNESS)

Variety	1941	1942	1943	1944		1945			1946	1947				1948		Av.
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	
1. Early Premium . . . . .			8.10	8.84	8.13	7.39		6.71	8.00	9.43	7.55	8.16	8.22		8.40	8.08
2. Clarkan . . . . .			7.49	7.85	7.70	7.39		7.01	7.60	8.36	7.25	8.40	7.77		9.10	7.81
3. Kawvale . . . . .			6.48	7.76	6.90	6.56		6.40	7.95	8.96	6.80	7.33	7.82		8.10	7.37
4. Michigan Wonder . . . . .			7.42													
5. Fulcaster . . . . .			8.16					6.87								
6. W5220, Fulcaster x Early Premium																
7. W5216, Fulcaster x Early Premium			8.17	8.22	7.86											
8. W5226, Fulcaster x Early Premium			8.57	8.30	8.18	6.79		7.04								
9. Fultz . . . . .			7.89													
10. Fairfield . . . . .			8.84			7.32		6.88	8.00							
11. Mediterranean . . . . .			8.33			7.27			7.80							
12. Dunbar . . . . .			8.85													
13. Wabash . . . . .			8.90													
14. Forty Fold . . . . .			9.04													
15. W5253, Kawvale x Early Premium . . . . .									8.15	9.44						8.55
16. W5254, Kawvale x Early Premium . . . . .									8.00							
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .									8.45	9.87						
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .									6.90	8.47						7.65
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .									7.45	8.85						8.35
20. W5488, White Federation x Early Premium . . . . .									8.90	9.21						9.60
21. Moking . . . . .										9.15						8.75
22. Pawnee . . . . .										9.50						8.30
23. W5590, Kawvale x Early Premium . . . . .										9.64						8.95
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .										8.86						9.05
25. Vigo . . . . .													8.91			9.70
26. Coker, Hardired . . . . .													7.69		8.15	
27. Coker, Redhart . . . . .													7.96		8.80	
28. Purcam . . . . .																8.85
29. Triumph . . . . .																8.40
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .																8.90
31. Butler . . . . .																9.15
32. Royal . . . . .																8.60
33. Coker, (Gemeinhart) . . . . .																8.70

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

TABLE 17--INDEX OF CAKE VOLUME (SQURE INCHES)

Variety	1941	1942	1943	1944		1945			1946	1947				1948		Av.
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	
1. Early Premium . . . . .	8.50	8.80	9.13	10.81	11.01	10.17	9.98	10.52	10.53	10.25	10.80	10.13	10.37		10.07	10.08
2. Clarkan . . . . .	8.85	9.03	8.50	10.27	10.15	10.14	9.47	9.97	10.59	9.92	10.20	10.07	10.02		9.74	9.85
3. Kawvale . . . . .	9.13	8.35	8.08	9.28	9.58	8.56	8.82	8.60	9.71	8.81	9.66	9.14	9.11		9.37	9.11
4. Michigan Wonder . . . . .		9.04	8.79													
5. Fulcaster . . . . .		8.80	8.44					9.60								
6. W5220, Fulcaster x Early Premium . . . . .		8.80														
7. W5216, Fulcaster x Early Premium . . . . .			8.93	10.81	11.11											
8. W5226, Fulcaster x Early Premium . . . . .			8.67	10.65	10.87	8.29	9.67	9.67								
9. Fultz . . . . .			8.96													
10. Fairfield . . . . .						9.65	9.46	9.88	11.06							
11. Mediterranean . . . . .						9.74			10.54							
12. Dunbar																
13. Wabash																
14. Forty Fold																
15. W5253, Kawvale x Early Premium . . . . .									10.34	10.33					10.26	
16. W5254, Kawvale x Early Premium . . . . .									9.60							
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .									10.50	9.56						
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .									8.93	9.63					9.48	
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .									9.13	9.64					9.81	
20. W5488, White Federation x Early Premium . . . . .									10.49	10.02					9.97	
21. Moking . . . . .										10.10					9.51	
22. Pawnee . . . . .										9.12					9.23	
23. W5590, Kawvale x Early Premium . . . . .										9.62					9.27	
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .										9.88					9.62	
25. Vigo . . . . .												9.78			9.70	
26. Coker, Hardired . . . . .												8.94		8.99		
27. Coker, Redhart . . . . .												9.51		10.05		
28. Purcam . . . . .															9.46	
29. Triumph . . . . .															8.92	
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .															9.65	
31. Butler . . . . .															9.19	
32. Royal . . . . .															9.33	
33. Coker, (Gemeinhart) . . . . .															9.30	

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

TABLE 13--70 PER CENT PATENT FLOUR MIXOGRAMS (SQ. CM.)

Variety	1941	1942	1943	1944		1945			1946	1947				1948		
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	Av.
1. Early Premium . . . . .	60.70	71.40	68.00	56.00		41.69	50.84	67.00	61.29	42.78	55.20	49.65	61.30		57.55	57.18
2. Clarkan . . . . .	83.00	75.80	86.00	83.00		55.80	45.02	72.57	65.07	57.62	64.56	63.20	74.20		62.91	68.36
3. Kawvale . . . . .	66.10	83.50	86.00	82.00		51.72	80.98	81.25	73.23	41.20	69.91	61.75	62.97		66.71	69.79
4. Michigan Wonder . . . . .		73.30														
5. Fulcaster . . . . .		64.60						64.99								
6. W5220, Fulcaster x Early Premium . . . . .		80.30														
7. W5216, Fulcaster x Early Premium . . . . .			74.00	74.00												
8. W5226, Fulcaster x Early Premium . . . . .			70.00	78.00		52.96	68.32	70.47								
9. Fultz . . . . .																
10. Fairfield . . . . .						36.29	51.04	63.11	87.97							
11. Mediterranean . . . . .						52.74			76.75							
12. Dunbar . . . . .																
13. Wabash . . . . .																
14. Forty Fold . . . . .																
15. W5253, Kawvale x Early Premium . . . . .									64.62	43.42					60.13	
16. W5254, Kawvale x Early Premium . . . . .									63.00							
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .									76.65	58.04						
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .									69.00	49.62					68.59	
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .									67.36	45.72					58.58	
20. W5488, White Federation x Early Premium . . . . .									52.10	53.39					49.04	
21. Moking . . . . .										60.13					71.81	
22. Pawnee . . . . .										51.71					60.58	
23. W5590, Kawvale x Early Premium . . . . .										44.10					56.65	
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .										41.97					53.16	
25. Vigo . . . . .												47.45			53.36	
26. Coker, Hardired . . . . .												64.10		81.55		
27. Coker, Redhart . . . . .												51.46		67.88		
28. Purcam . . . . .															60.39	
29. Triumph . . . . .															68.59	
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .															54.20	
31. Butler . . . . .															51.81	
32. Royal . . . . .															65.17	
33. Coker, (Gemeinhart) . . . . .															73.68	

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

TABLE 17--INDEX OF CAKE VOLUME (SQUARE INCHES)

Variety	1941		1942		1943		1944		1945		1946		1947			1948			
	Co-lumbia	Sikes-ton	Co-lumbia	Sikes-ton	Co-lumbia	Sikes-ton	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite	Av.
1. Early Premium . . . . .	8.50	8.80	9.13	8.80	10.81	11.01	10.17	9.98	10.52	10.53	10.25	10.80	10.13	10.37	10.07	10.08	10.07	10.08	10.08
2. Clarkan . . . . .	8.85	9.03	8.50	10.27	10.15	10.14	9.47	9.97	8.60	9.71	8.81	9.66	9.14	9.11	9.37	9.85	9.74	9.85	9.85
3. Kawvale . . . . .	9.13	8.35	8.08	9.28	9.58	8.56	8.82	8.60	9.71	8.81	9.66	9.14	9.11	9.37	9.85	9.74	9.85	9.85	9.85
4. Michigan Wonder . . . . .	9.04	8.79	8.79	9.04	8.79	9.04	8.79	9.04	8.79	9.04	8.79	9.04	8.79	9.04	8.79	9.04	8.79	9.04	8.79
5. Fulcaster . . . . .	8.80	8.44	8.44	8.80	8.44	8.80	8.44	8.80	8.44	8.80	8.44	8.80	8.44	8.80	8.44	8.80	8.44	8.80	8.44
6. W5220, Fulcaster x Early Premium . . . . .	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80
7. W5216, Fulcaster x Early Premium . . . . .	8.93	10.81	10.81	11.11	11.11	10.87	8.29	9.67	9.67	10.34	10.33	10.26	10.26	10.26	10.26	10.26	10.26	10.26	10.26
8. W5226, Fulcaster x Early Premium . . . . .	8.67	10.65	10.65	10.87	10.87	8.29	9.67	9.67	10.34	10.33	10.26	10.26	10.26	10.26	10.26	10.26	10.26	10.26	10.26
9. Fultz . . . . .	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96	8.96
10. Fairfield . . . . .	9.65	9.46	9.46	9.88	9.88	11.06	10.54	10.54	10.54	10.54	10.54	10.54	10.54	10.54	10.54	10.54	10.54	10.54	10.54
11. Mediterranean . . . . .	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74
12. Dunbar . . . . .	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74
13. Wabash . . . . .	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74
14. Forty Fold . . . . .	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74	9.74
15. W5253, Kawvale x Early Premium . . . . .	10.34	10.33	10.34	10.33	10.34	10.33	10.34	10.33	10.34	10.33	10.34	10.33	10.34	10.33	10.34	10.33	10.34	10.33	10.34
16. W5254, Kawvale x Early Premium . . . . .	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60	9.60
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .	10.50	9.56	9.56	9.56	9.56	9.56	9.56	9.56	9.56	9.56	9.56	9.56	9.56	9.56	9.56	9.56	9.56	9.56	9.56
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .	8.93	9.63	9.63	9.63	9.63	9.63	9.63	9.63	9.63	9.63	9.63	9.63	9.63	9.63	9.63	9.63	9.63	9.63	9.63
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .	9.13	9.64	9.64	9.64	9.64	9.64	9.64	9.64	9.64	9.64	9.64	9.64	9.64	9.64	9.64	9.64	9.64	9.64	9.64
20. W5488, White Federation x Early Premium . . . . .	10.49	10.02	10.02	10.02	10.02	10.02	10.02	10.02	10.02	10.02	10.02	10.02	10.02	10.02	10.02	10.02	10.02	10.02	10.02
21. Moking . . . . .	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10
22. Pawnee . . . . .	9.12	9.12	9.12	9.12	9.12	9.12	9.12	9.12	9.12	9.12	9.12	9.12	9.12	9.12	9.12	9.12	9.12	9.12	9.12
23. W5590, Kawvale x Early Premium . . . . .	9.62	9.62	9.62	9.62	9.62	9.62	9.62	9.62	9.62	9.62	9.62	9.62	9.62	9.62	9.62	9.62	9.62	9.62	9.62
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .	9.88	9.88	9.88	9.88	9.88	9.88	9.88	9.88	9.88	9.88	9.88	9.88	9.88	9.88	9.88	9.88	9.88	9.88	9.88
25. Vigo . . . . .	9.78	9.78	9.78	9.78	9.78	9.78	9.78	9.78	9.78	9.78	9.78	9.78	9.78	9.78	9.78	9.78	9.78	9.78	9.78
26. Coker, Hardired . . . . .	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94
27. Coker, Redhart . . . . .	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51	9.51
28. Purcam . . . . .	9.46	9.46	9.46	9.46	9.46	9.46	9.46	9.46	9.46	9.46	9.46	9.46	9.46	9.46	9.46	9.46	9.46	9.46	9.46
29. Triumph . . . . .	8.92	8.92	8.92	8.92	8.92	8.92	8.92	8.92	8.92	8.92	8.92	8.92	8.92	8.92	8.92	8.92	8.92	8.92	8.92
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .	9.65	9.65	9.65	9.65	9.65	9.65	9.65	9.65	9.65	9.65	9.65	9.65	9.65	9.65	9.65	9.65	9.65	9.65	9.65
31. Butler . . . . .	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19	9.19
32. Royal . . . . .	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33	9.33
33. Coker, (Gemeinhart) . . . . .	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

TABLE 18--BREAKING ANGLE (DEGREES)

Variety	1941		1942		1943		1944		1945		1946		1947		1948		Av.	
	Co-lumbia	Sikes-ton	Co-lumbia	Sikes-ton	Co-lumbia	Sikes-ton	Co-lumbia	Sikes-ton	Lath-rop	Sikes-ton	Co-lumbia	Sikes-ton	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton		Com-posite†
1. Early Premium . . . . .		21	11	19	18	14	14	16	16	16	16	16	20	21	21	17	18	17
2. Clarkan . . . . .		23	12	20	19	16	15	16	16	19	19	20	17	18	21	14	18	18
3. Kawvale . . . . .		20	12	17	17	14	13	16	16	20	18	18	18	20	18	15	17	17
4. Michigan Wonder . . . . .		21	13															
5. Fulcaster . . . . .		19	12															
6. W5220, Fulcaster x Early Premium . . . . .		21																
7. W5216, Fulcaster x Early Premium . . . . .		13	13	20	16	15	13	16	18	17	17	17	17	17	17	14	14	14
8. W5226, Fulcaster x Early Premium . . . . .		12	12	16	20	15	15	16	18	17	17	17	17	17	17	14	14	14
9. Fultz . . . . .		11																
10. Fairfield . . . . .									16	16	17	18						
11. Mediterranean . . . . .									15									
12. Dunbar . . . . .																		
13. Wabash . . . . .																		
14. Forty Fold . . . . .																		
15. W5253, Kawvale x Early Premium . . . . .																		
16. W5254, Kawvale x Early Premium . . . . .																		
17. W5400, Kawvale x Currell2 . . . . .																		
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .																		
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .																		
20. W5488, White Federation x Early Premium . . . . .																		
21. Moking . . . . .																		
22. Pawnee . . . . .																		
23. W5590, Kawvale x Early Premium . . . . .																		
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .																		
25. Vigo . . . . .																		
26. Coker, Hardred . . . . .																18	15	14
27. Coker, Redhart . . . . .																19	15	14
28. Purcam . . . . .																20	14	16
29. Triumph . . . . .																		
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .																		
31. Butler . . . . .																		
32. Royal . . . . .																		
33. Coker, (Gemeinhardt) . . . . .																		

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.  
 † Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

TABLE 18--BREAKING ANGLE (DEGREES)

Variety	1941	1942	1943	1944		1945			1946	1947				1948		Av.
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	
1. Early Premium . . . . .		21	11	19	18	14	14	16	16	20	21	17	21		18	17
2. Clarkan . . . . .		23	12	20	19	16	15	16	19	20	17	18	21		14	18
3. Kawvale . . . . .		20	12	17	17	14	13	16	20	18	18	20	18		15	17
4. Michigan Wonder . . . . .		21	13													
5. Fulcaster . . . . .		19	12					15								
6. W5220, Fulcaster x Early Premium . . . . .		21														
7. W5216, Fulcaster x Early Premium . . . . .			13	20	16											
8. W5226, Fulcaster x Early Premium . . . . .			12	16	20	15	13	16								
9. Fultz . . . . .			11													
10. Fairfield . . . . .						16	16	17	18							
11. Mediterranean . . . . .						15			17							
12. Dunbar . . . . .																
13. Wabash . . . . .																
14. Forty Fold . . . . .																
15. W5253, Kawvale x Early Premium . . . . .									14	19						14
16. W5254, Kawvale x Early Premium . . . . .									15							
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .									15	16						
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .									16	19						16
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .									18	17						15
20. W5488, White Federation x Early Premium . . . . .									15	17						16
21. Moking . . . . .										18						15
22. Pawnee . . . . .										16						15
23. W5590, Kawvale x Early Premium . . . . .										16						15
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .										18						16
25. Vigo . . . . .																16
26. Coker, Hardired . . . . .												18				14
27. Coker, Redhart . . . . .												19		15		
28. Purcam . . . . .												20		14		
29. Triumph . . . . .																16
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .																14
31. Butler . . . . .																16
32. Royal . . . . .																14
33. Coker, (Gemeinhart) . . . . .																15
																14

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

TABLE 19--COMPRESSIBILITY (MILLIMETERS)

Variety	1941	1942	1943	1944		1945			1946	1947				1948		Av.
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	
1. Early Premium . . . . .		2.5	2.9	4.5	4.7	6.1	7.1	5.7	5.6	3.8	3.8	3.5	3.6		3.4	4.4
2. Clarkan . . . . .		3.4	2.3	4.3	4.3	5.9	6.9	5.5	5.7	3.5	3.2	3.4	3.5		3.0	4.3
3. Kawvale . . . . .		2.9	2.5	3.5	4.1	5.9	6.9	5.7	5.3	3.7	3.6	3.5	3.5		3.1	4.2
4. Michigan Wonder . . . . .		2.7	2.6													
5. Fulcaster . . . . .		3.1	2.3					5.6								
6. W5220, Fulcaster x Early Premium . . . . .		3.2														
7. W5216, Fulcaster x Early Premium . . . . .			2.6	3.8	4.7											
8. W5226, Fulcaster x Early Premium . . . . .			2.9	4.3	4.2	5.8	7.0	5.7								
9. Fultz . . . . .			2.3													
10. Fairfield . . . . .						5.9	6.9	5.2	5.5							
11. Mediterranean . . . . .						6.1			5.5							
12. Dunbar																
13. Wabash																
14. Forty Fold																
15. W5253, Kawvale x Early Premium . . . . .									5.6	3.2					3.5	
16. W5254, Kawvale x Early Premium . . . . .									5.4							
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .									5.3	3.2						
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .									5.3	3.6					3.1	
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .									5.3	3.2					3.0	
20. W5488, White Federation x Early Premium . . . . .									5.4	3.4					3.8	
21. Moking . . . . .										3.7					2.3	
22. Pawnee . . . . .										3.6					2.9	
23. W5590, Kawvale x Early Premium . . . . .										3.3					2.3	
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .										3.6					2.4	
25. Vigo . . . . .												3.7			2.5	
26. Coker, Hardired . . . . .												3.7		3.5		
27. Coker, Redhart . . . . .												3.0		3.7		
28. Purcam . . . . .															3.2	
29. Triumph . . . . .															2.9	
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .															2.4	
31. Butler . . . . .															3.5	
32. Royal . . . . .															3.6	
33. Coker, (Gemeinhart) . . . . .														3.5		

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.



TABLE 20--BAKING SCORE

Variety	1941	1942	1943	1944		1945			1946	1947				1948		Av.
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	
1. Early Premium . . . . .	86.50	86.30	94.90	96.90	95.30	98.47	94.88	98.12	92.66	92.58	95.23	95.46	91.55		92.45	94.02
2. Clarkan . . . . .	86.90	86.40	83.23	91.50	90.60	95.04	90.67	96.17	94.22	96.82	91.45	93.47	91.01		92.67	89.61
3. Kawvale . . . . .	90.10	82.10	74.58	74.00	70.60	75.91	77.29	80.15	81.34	81.20	84.57	85.28	82.86		83.43	80.23
4. Michigan Wonder . . . . .		87.09	84.37													
5. Fulcaster . . . . .		88.40	90.60					90.44								
6. W5220, Fulcaster x Early Premium . . . . .		85.90														
7. W5216, Fulcaster x Early Premium . . . . .		86.58	88.90	89.80												
8. W5226, Fulcaster x Early Premium . . . . .		88.52	87.50	87.80		73.89	93.44	94.92								
9. Fultz . . . . .			91.53													
10. Fairfield . . . . .						96.51	86.49	89.68	97.42							
11. Mediterranean . . . . .						92.24			86.16							
12. Dunbar																
13. Wabash																
14. Forty Fold																
15. W5253, Kawvale x Early Premium . . . . .									93.46	90.19					87.95	
16. W5254, Kawvale x Early Premium . . . . .									89.10							
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .									92.56	85.56						
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .									84.43	87.30					87.23	
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .									86.25	86.34					87.93	
20. W5488, White Federation x Early Premium . . . . .									91.74	87.15					92.41	
21. Moking . . . . .										92.28					88.38	
22. Pawnee . . . . .										81.88					82.48	
23. W5590, Kawvale x Early Premium . . . . .										84.04					88.07	
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .										82.39					86.74	
25. Vigo . . . . .												93.00			88.07	
26. Coker, Hardired . . . . .												88.26	86.86			
27. Coker, Redhart . . . . .												90.82	88.04			
28. Purcam . . . . .															87.03	
29. Triumph . . . . .															85.25	
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .															87.86	
31. Butler . . . . .															90.81	
32. Royal . . . . .															89.14	
33. Coker, (Gemeinhart) . . . . .													86.61			

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

TABLE 21--FLOUR YIELDS (PER CENT)

Variety	1941	1942	1943	1944		1945			1946	1947				1948		
	Co-lumbia	Sikes-ton	Co-lumbia	Co-lumbia	Sikes-ton	Co-lumbia	Lath-rop	Sikes-ton	Co-lumbia	Co-lumbia	Lath-rop	Sikes-ton	Com-posite*	Sikes-ton	Com-posite†	Av.‡
1. Early Premium . . . . .		69.25		80.50	80.20		81.70		72.94	72.44	72.53	73.24	72.60		72.70	72.24
2. Clarkan . . . . .		70.00		80.50	79.90		83.00		68.52	68.95	68.34	70.11	68.96		67.00	68.65
3. Kawvale . . . . .		77.00		80.70	81.80		82.60		74.86	71.77	71.95	73.94	71.35		73.30	75.92
4. Michigan Wonder . . . . .		70.75														
5. Fulcaster . . . . .		70.75														
6. W5220, Fulcaster x Early Premium . . . . .		71.00														
7. W5216, Fulcaster x Early Premium . . . . .				80.20	80.20											
8. W5226, Fulcaster x Early Premium . . . . .				80.00	79.50		79.00									
9. Fultz . . . . .																
10. Fairfield . . . . .							78.00									70.78
11. Mediterranean . . . . .																73.04
12. Dunbar . . . . .																
13. Wabash . . . . .																
14. Forty Fold . . . . .																
15. W5253, Kawvale x Early Premium . . . . .									72.81	70.72						72.60
16. W5254, Kawvale x Early Premium . . . . .									74.55							
17. W5400, Kawvale x Currell <sup>2</sup> . . . . .									70.50	67.65						
18. W5477, Purplestraw-Chinese-Michigan-Amber . . . . .									71.94	70.02						72.10
19. W5478, Purplestraw-Chinese-Michigan-Amber . . . . .									74.11	71.21						73.20
20. W5488, White Federation x Early Premium . . . . .									72.03	71.11						71.60
21. Moking . . . . .										70.67						73.00
22. Pawnee . . . . .										69.63						73.40
23. W5590, Kawvale x Early Premium . . . . .										70.15						72.80
24. CI 12454, Trumbull-W38-Fultz-Hungarian . . . . .										70.49						69.30
25. Vigo . . . . .												71.45				70.50
26. Coker, Hardired . . . . .												75.41		73.70		
27. Coker, Redhart . . . . .												70.91		69.30		
28. Purcam . . . . .																72.60
29. Triumph . . . . .																70.40
30. CI 12530, Trumbull-W38-Fultz-Hungarian . . . . .																71.10
31. Butler . . . . .																70.90
32. Royal . . . . .																72.60
33. Coker, (Gemeinhart) . . . . .																71.00

\* Mixture of equal parts of wheat grown at Columbia, Lathrop, and Sikeston.

† Mixture of equal parts of wheat grown at Columbia, Lathrop, Elsberry, and Sikeston.

‡ Averages for 1946, '47, and '48 only.