changed qualitatively as shown by the ratio of acid formed to lactose destroyed. With these preservatives it was found that occasional exposure of the samples to air, especially when the quantity of preservative present was small, led to irregular results, the final acidity sometimes exceeding that in the control samples to which no preservative had been added.

In the experiment with samples preserved by boric acid and borax or by hydrogen peroxide such irregularities did not appear. The boron preservative had no apparent influence upon the nature of the acid fermentation. The experiments with hydrogen peroxide are only preliminary.

Experiments upon the development of ammonia in milk under the influence of these preservatives and a further study of hydrogen peroxide are being undertaken in this laboratory. Discussion of the effects of preservatives upon the wholesomeness of milk will be deferred until the completion of these and other experiments.

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TESTING WHEAT FLOUR FOR COMMERCIAL PURPOSES.

BY HARRY SNYDER.

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AT PRESENT no standards have been adopted by either commercial bodies or chemists for the purpose of determining the commercial value of wheat flour. The United States Department of Agriculture, however, has adopted standards as to purity and for the purpose of detecting adulterations. Various attempts have been made to adapt chemical and allied tests to purposes of determining the commercial value of flour, but, owing to the complex nature of wheat flour, none of these tests have been found to be generally applicable.

When wheat is subjected to the roller process of milling, different grades of flour are secured, as first and second patents, straight grade, and first and second clear, also "Red dog," which is sometimes used as human food but is more extensively used for animal-feeding purposes.[1]

As is well known, different kinds of wheat make distinct types of flour, which have different values for bread-making purposes, and wheat grown in the same locality during different years may,

[1] U. S. Dept. Agr., Office of Experiment Stations, Bull. 101, pp. 7–8.

owing to variations in climatic conditions, show wide ranges in bread-making value.

In the testing of flour it frequently happens that two samples have practically the same percentage of proteids but decidedly different values for bread-making purposes, and that flours of lower proteid content produce better bread than those of higher proteid content. A few examples bearing upon this point, taken from the work of the Minnesota Agricultural Experiment Station,[1] are here given:

No.	Grade of flour.	Protein. Per cent.	Size of loaf. Inches.	Commercial. rank.
94	First patent	13.19	29×26.25	1
86	" "	13.34	28¼×25½	2
106	" "	14.47	28.6×24.75	2
110	" "	13.17	28.6×25.25	1
82	Second "	14.15	28.5×25.5	5
111	" "	15.32	28×25	9
22	First "	12.63	29.1×26	1
15	Second "	14.44	28.5×25	9

The determinations that have given the best satisfaction in flour-testing are moisture, ash, total nitrogen, gliadin nitrogen, granulation, absorptive capacity, and color.

The ash determination is exceedingly useful in establishing the commercial grade of flour. The first and second grades of patent flour, for example, invariably contain less than 0.48 per cent. of ash; in case a flour contains 0.5 per cent. of ash, it would not be entitled to rank with the patent grades. Straight grade flour rarely contains more than 0.55 per cent. of ash, while the first and second clear grades contain higher amounts, 0.8 and 1.75 per cent. respectively. Many of the standard brands of flour found on the market are made by combining different percentage amounts of the standard grades, and this is one reason why there is such a large difference in flours made from the same types of wheat. Data in regard to the relation of ash to grade of flour will be found in the bulletins of the Minnesota Experiment Station.[2]

The determination of moisture is especially helpful as an indication of the keeping qualities of the flour, as an excessive moisture content, above 13, has a tendency to induce fermentation changes. Flours of the best bread-making qualities contain

[1] Minn. Agr. Expt. Station, Bull. 85, pp. 202–210.

[2] Minn. Agr. Expt. Station, Bulls. 85 and 90; also Bulletins of the U. S. Dept. of Agr., Office of Expt. Stations, Nos. 101 and 126.

11.5 to 13 per cent. of proteid material ($N \times 6.25$). The nitrogen content of flour is, however, only a general index of bread-making value. A low nitrogen content, less than 1.5 per cent., indicates deficiency in gluten, and this results in a lower absorptive capacity of the flour, lack of expansion in the loaf, and poorer physical properties of the bread. Flours containing more than 12.5 or 13 per cent. of proteid materials do not, as a rule, have improved bread-making values, as an excessive amount of gluten does not appear to be beneficial for bread-making purposes. Extensive data upon this point will be found in the bulletins previously quoted. The composition of proteids or glutinous material has more influence upon the bread-making value of flour than has the total amount of proteids. Since the principal proteids of wheat flour are gliadin and glutenin, it is believed by many that the ratio in which these two proteids are present determines largely the value of the glutinous material for bread-making purposes. The work that has been done in this line shows that with flours milled from sound normal wheats there is a definite relation of gliadin to glutenin, and that either an excessive or a scant amount of gliadin will give abnormal bread-making qualities to flour. Girard, Guthrie and others have attempted to determine the ratio which gliadin should bear to glutenin for bread-making purposes. The work done in this direction indicates that the gliadin percentages of flour from wheats of different years and produced under different conditions are subject to material variations. The author has found that during some years as high as 70 per cent. of the total nitrogenous material of wheat is soluble in 70 per cent. alcohol, while in other years flour from wheat grown under similar conditions contains as low as 45 per cent. of its proteids soluble in 70 per cent. alcohol, and that these differences have been associated with only minor variations in the size of the loaf or general bread-making value of the flour.

The gliadin determination, however, has been found very helpful in determining abnormal conditions in the composition of wheats, and the results available at the present time indicate that the percentage amount of gliadin in a flour is of more importance than the gliadin-glutenin ratio. In comparing different grades of flour milled from the same wheat, differences are observed in the gliadin percentage, the lower grades of flour having a tendency to contain proportionately less gliadin than the higher grades. In the investigation conducted at the Minnesota Experiment Station on the 1902 wheat crop, it was found that the clear grades of flour contained nearly 4 per cent. more proteids than the patent grades, but that the percentage of total nitrogen in the form of gliadin was about 7 per cent. lower than was found in the patent grades, which made a loaf 4 inches larger and of better physical qualities than the clear grades.

	Ash. Per ct.	Protein. Per ct.	Gliadin. No.	Acidity. Per. ct.	Size of loaf. Inches.	Commercial rank.
	Average of 11 tests, Mill 1:					
First patent flour	0.39	13.56	59.07	0.07	28.62×25.32	I
Second patent flour	0.47	14.70	56.25	0.08	28.67×25.72	II
Clear grade flour	0.84	17.27	54.21	0.12	24.29×21.09	III
	Average of 8 tests, Mill 2:					
Patent	0.44	15.05	58.33	0.09	29.47×26.42	I
Clear	0.82	18.01	54.88	0.14	24.29×20.83	III
	Average of 14 tests, Mill 3:					
First patent	0.35	12.90	58.28	0.09	28.51×25.39	I
Second patent	0.46	14.17	56.20	0.10	28.62×25.31	II
Clear	0.86	17.01	50.03	0.15	23.91×20.43	III

In the study of the gliadin content of wheat and flour, the author has found that any slight increase in the acidity of the grain materially influences the gliadin percentage, and this undoubtedly accounts in part for the variable results that have been secured. The gliadin from different types of flour has not been found as uniform in composition as could be desired. Differences of 1 per cent. or more have been observed in the nitrogen content of gliadin from different wheats milled under similar conditions. This suggests that gliadin is lacking in definite chemical composition. Whether this is due to wheat flour containing more than one proteid soluble in 70 per cent. alcohol or to other causes the author is not prepared to say, but from the results obtained it is evident that wheat gliadin obtained under similar conditions from different types of wheat and flour is not as constant in chemical composition or physical properties as would be expected of a definite chemical compound. Consequently, the general application of gliadin results is necessarily restricted.

Various attempts have been made to assign to wheat and flour a commercial value proportional to its nitrogen content.[1] A literal interpretation of the nitrogen results would then mean that

[1] A. D. Hall: *Journal Board of Agriculture*, London, pp. 321–333.

the lower grades of flour, as first and second clear and red dog, would have a higher bread-making value than the patent grades of flour, which, of course, is an erroneous conclusion. Neither is it possible to assign to flours of the same grade a comparative value on the basis of the nitrogen determination alone, because, as previously noted, two patent flours may have the same nitrogen content and possess entirely different bread-making values. While a large amount of work has been done in studying the wheat proteids, the unique properties which give to wheat flour its high bread-making value are but imperfectly understood.

A number of fermentation changes induced by enzymes take place in wheat after it is harvested and when stored in elevators, and these changes affect the bread-making value of the flour.

The amount of acid in combination with the wheat proteids and the degree of hydration of the proteids are undoubtedly factors which materially influence the bread-making value of flours, but as yet no methods have been devised for accurately determining either acidity or hydration.

In commercial transactions color is one of the main factors in determining flour value, as each type of wheat has a tendency to produce flour of a distinct shade. Hard Northwestern wheat produces flours of a creamy tinge, while some of the soft winter wheats produce white flours. Dark-colored flours invariably possess poor bread-making qualities. The fact that color is such an important factor in determining the commercial value of a flour has resulted in the use of artificial means of bleaching. Various bleaching agents, as oxides of nitrogen and ozone, are used. A favorite way of producing the oxidizing gases is by electrical action, the flour being brought into contact with the gases thus produced. Some of the claims made for the bleaching of flour are, from a chemical point of view, most interesting, one being that by means of electrical action the amount of proteid material in flour can be largely increased by changing the starch to proteids, thereby improving the bread-making and nutritive value of the flour! This alleged method of converting starch into gluten by electrical action, although covered by United States patents, results in producing flour with practically the same nitrogen and gluten content as prior to bleaching. The main effect of bleaching is a slight change in color. In the case of flours of high color, this has been found to be a commercial advantage, as the treated flours have a color, more like the best commercial grades. The bleaching of flour has been found to have but little influence upon the bread-making value. If, however, the bleaching is carried to excess, the proteids are slightly oxidized and the size of the loaf is decreased. It is not possible to improve the lower grades of flour, as first and second clear and red dog, so that they have the same bread-making value as patent flours. The bleaching of the lower grades and then blending them with the patents can readily be detected by the high ash percentage. The extent to which flour bleaching will be adopted remains to be determined.

Much reliance has been placed heretofore upon color in the commercial grading of flour, but the advent of bleaching renders the factor of color of minor importance in determining the grade to which a flour belongs. By the application of chemical tests, it is possible to ascertain accurately whether a flour is patent, straight or clear, but as yet chemical tests are not capable of accurately determining the bread-making value of a flour. They often indicate, however, why a flour is deficient in desirable bread-making characteristics, and from the chemical tests ways are suggested for improving the flour, but the actual bread-making value can be determined only by comparative bread-making tests. Such tests necessitate the making of the flour into bread under definite and uniform conditions, the various ingredients, as flour, yeast, salt, sugar, shortening, etc., being exactly proportioned and the fermentation and mechanical manipulations being carried on under standard and uniform conditions. For purposes of comparison, a flour of known bread-making value is used. Comparisons are made as to size of loaf, texture and other physical properties. From these comparative tests, the bread-making value of a flour can be accurately determined, including such data as the number of loaves per barrel.

In the testing of flour the best results are secured by the joint application of chemical and baking tests. When only baking tests are employed, the blending of grades cannot be readily detected, as they afford no absolute data upon which definite conclusions as to grade can be drawn, and, on the other hand, the chemical data alone are not always a safe index as to the bread-making value of the flour. In the interpretation of the results of both chemical and baking tests, no hard and fast rules can be formulated. The various factors must be separately considered and then carefully balanced in order to secure results that are of value. It is important to note that the same factors which impart commercial value to flour are in a general way in harmony with those which impart nutritive value. The flours which make the best bread are those which are well milled and are free from fibrous offals, and these are the flours which give the low ash content. They are also mediumly rich in proteids, which impart desirable physical properties and insure a loaf of the highest value. The best commercial grades of flour are of mediumly fine granulation in contradistinction to graham and whole wheat flours. Fine granulation insures more complete digestion and absorption of the nutrients of the flour by the body.[1]

[FROM THE DEPARTMENT OF EXPERIMENTAL MEDICINE, PARKE, DAVIS & CO., DETROIT, MICH.]

ADRENALIN, THE ACTIVE PRINCIPLE OF THE SUPRARENAL GLANDS.*

BY T. B. ALDRICH.

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THE OBJECT of this paper is to take up the chemical side of adrenalin, the active principle of the suprarenal glands, but, before doing so, I will review very briefly this subject up until the time when adrenalin was discovered.

Addison[1]† (1855) was the first to recognize the great importance of the suprarenal glands in the animal economy, particularly in their relation to the disease since called "Addison's Disease."

Vulpian[2] (1856) observed that the expressed juice of these glands, obtained from various animals, gave certain characteristic color reactions, not given by any other glands in the body; for example, ferric chloride gave a green color, while iodine gave a pink or rose-red color.

Virchow[3] (1857) substantiated Vulpian's observations, but added nothing new of importance.

Vulpian and Cloez[4] (1857), Arnold[5] (1866), and Holm[6] (1867), attempted the isolation of the active principle, but were unsuccessful.

[1] Office of Experiment Stations, U. S. Dept. of Agriculture, Bulls. 101 and 126.

* Read before the Section of Physiology, at the Buffalo Meeting of the American Chemical Society, June 23, 1905.

† The numbers refer to the literature at the end of the article.