may be easily worked to a kind of cheese, in which a large part of the wheat albumins are made available for human food.

The process is in no wise restricted to the use of wheat bran. Maize, peanuts, almonds and many other albumin-bearing seeds and oil cakes await their testing as to the production of palatable food. In fact there is a variety which could never be attained by the dairying industry working with cows' milk only.

SNEEK, HOLLAND

THE DETERMINATION AND DISTRIBUTION OF MOISTURE IN BREAD

By H. L. WESSLING

Received July 13, 1916

During the past few years the subject of the moisture content of bread has been receiving more and more attention. Excess of moisture is considered much in the nature of adulteration and in certain quarters the advisability of fixing a definite standard for the water content of bread is being considered. It will be necessary in that event, however, to arrive at some understanding as to the method of determining moisture in bread, since this is still a mooted question.

According to Jago,¹ a thin slice should be taken from the center of the loaf, the crust cut off and the interior portion crumbled, these crumbs thoroughly mixed and used for analysis.

Neumann² calls attention to the fact that the proportion of crust to crumb, which varies with the size and form of the loaf, must be taken into consideration. He states that the total water content of bread may be known only by determining that of crust and of crumb and finding the relation of crust to crumb. Berman³ asserts that the results are practically the same whether the moisture is determined on the crust and crumb together (direct method), or on these separately and then calculated for the entire loaf (indirect method). He uses a wedge-shaped slice and takes into consideration the proportion of crust to crumb. Boutroux,⁴ like Jago, cuts a slice from the center of the loaf, trims off the crust, crumbles the interior and mixes these crumbs thoroughly. He goes farther, however, in that he determines the moisture on crust and crumb separately. Boutroux also refers to work done along this line by Balland in which he gives the water content of crust, of crumb and of the whole bread.

Wiley⁵ uses the entire loaf, which he chops into bits, weighs at once and dries until the bread is reduced to a small bulk. The dried bread is weighed and the loss of moisture determined up to this point. This bread is then ground fine and a further moisture determination made upon a sample thereof.

A very rapid method for the determination of moisture in bread is that described by Wilh. Thörner⁶ and recently modified by F. Schaffer.⁷

¹ Wm. Jago and W. C. Jago, "The Technology of Bread-Making," 1911 Edition, p. 834.

² M. P. Neumann, "Brotgetreide und Brot," 1914, pp. 436-7.

³ "Watergehalte van Wittebrood," *Pharm. Weekblad*, **48**, 675.

⁴ L. Boutroux, "Le Pain et la Panification," 1897, p. 308.

⁵ Bureau of Chemistry, *Bull.* **13**, Part 9 (1898), 1321.

⁶ *Z. angew. Chem.*, **21** (1908), 148.

⁷ *Mitt. Lebensm. Hyg.*, **6** (1915), 6.

These are really modifications of Hoffmann's method for the determination of moisture in hops,¹ and the principle underlying them is similar to that used in the well-known Brown-Duvel moisture tester.²

According to Schaffer the loaf of bread is cut in two lengthwise and again in two crosswise; from every one of these four portions is cut a slice, from 0.5 to 1 cm. in thickness, which is crumbled fine and these crumbs thoroughly mixed. Of this well-mixed material a 25-g. sample is weighed off and distilled with 200 cc. of heavy petroleum. The water which distills over is collected in a graduated cylinder and the amount calculated to 100 g. of bread. Schaffer refers to the difficulty of getting a fair proportion of crust and crumb but suggests that since the time required for the entire operation is comparatively short, two moisture determinations may easily be made and their average taken.

For the purposes of the work described in this paper, Schaffer's method of taking his sample, from the center of the loaf alone, does not meet our requirements. There is also much opportunity for loss of moisture by evaporation during the operation of sampling and weighing. Finally, the difficulty of obtaining in a 25-g. sample the correct proportion of crust and crumb seems a decided objection.

It is planned later to make use of the Brown-Duvel moisture tester in determining the moisture in bread according to the suggestion of Schaffer, modifying his method of sampling to meet the objections above stated.

For the purpose of studying the variations in the moisture content in different parts of the same loaf this work was undertaken.

The method used for the determination of moisture consists in weighing as quickly as possible in a tared dish, on a torsion balance, the portion of bread selected. This bread is carefully heated at a temperature not exceeding 60° until practically dry. The dried bread is then allowed to stand exposed at room temperature for a few hours, in order to let it come into equilibrium with the air. The loss in moisture up to this point is then determined. The air-dried bread is then immediately ground to a fine meal and the moisture on a 2-g. sub-sample thereof determined in the vacuum oven at the temperature of boiling water. From the per cent of additional moisture lost by this sub-sample, that of the entire sample is calculated and added to the amount lost on heating at 60°. The combined loss gives the total percentage of moisture in the bread.

This method is practically the same as that described in *Arbeiten aus dem Kaiserlichen Gesundheitsamte*, **48** (1915), 605.

Three loaves of different types, and differing in shape as well, were bought on the open market, all being approximately 10 hrs. old and unwrapped. Sub-samples from a slice 2 in. thick, cut from the center of each loaf, were taken in the following order (see Fig. I):

¹ *Wochschr. Brau.*, **18** (1903).

² U. S. Dept. Agr., B. P. I., *Circ.* **72** (1910).

- A—The crust proper trimmed off the entire slice.
 B—A section about $\frac{1}{2}$ in. thick, next to the crust.
 C—A second section $\frac{1}{2}$ in. thick.
 D—The innermost portion, in form of a cube.

The moisture was determined on every portion with the results shown in Table I:

TABLE I—PERCENTAGES OF MOISTURE IN PORTIONS OF A SLICE OF BREAD

Bread No.	A Crust	B Section next to crust	C Section next	D Inner cube
1.....	25.50	40.78	42.98	42.60
2.....	18.79	32.27	38.42	38.69
3.....	22.31	37.57	41.70	41.67

Loaves similar to the preceding were then used to determine how the moisture varies in slices taken from different portions of the loaf (see Fig. II).

These loaves were sampled as follows:

- A—The end crust, about $\frac{1}{4}$ in. thick.
 B—A slice immediately adjoining A and about $\frac{1}{2}$ in. thick.
 C—A slice $\frac{1}{2}$ in. thick cut about half-way toward the center.
 D—A slice $\frac{1}{2}$ in. thick directly from the center of the loaf.

The moisture content of every slice (crumb and crust together) was determined with the results shown in Table II:

TABLE II—PERCENTAGES OF MOISTURE IN DIFFERENT PARTS OF COMMERCIAL BREADS

Bread No.	A Crust	B Slice next to crust	C Slice half-way to center	D Slice from center
1.....	22.63	35.12	35.41	36.01
2.....	27.77	35.74	36.26	36.23
3.....	17.11	30.68	37.38	37.77

Having shown in this experiment that the water content varies depending upon the section of the loaf from which a slice is cut, the next step was to determine the moisture of the loaf as a whole compared with that of these slices. Loaves of bread similar to

FIG. 1

FIG. 2

the preceding were used. These were cut in half and the moisture determined on slices cut from one half in a manner similar to that indicated in Fig. II. The other half, E, was used entire, crust and crumb together, for a total moisture determination. These results are shown in Table III:

TABLE III—PERCENTAGES OF MOISTURE IN DIFFERENT PARTS OF A LOAF OF BREAD COMPARED WITH THAT OF THE ENTIRE LOAF

Bread No.	A Crust	B Slice next to crust way to center	C Slice half-way to center	D Slice from center	E Half loaf or total
1.....	26.85	36.59	37.70	37.45	35.14
2.....	20.03	32.75	35.65	35.93	33.09
3.....	23.50	35.32	38.18	38.00	34.99

As a final experiment the moisture of the entire loaf as well as of different portions thereof was determined as follows: The loaf (which was a crust-covered one) was cut in half, and one half divided into two quarters. The total moisture was determined on one quarter, and the moisture of the crust and of the crumb separately on the other quarter. From the remaining half loaf was cut a thick slice, as in our first experiment, and the different portions trimmed off as indi-

cated in Fig. I, moisture being determined on every portion. These results are shown in Table IV:

TABLE IV—PERCENTAGES OF MOISTURE IN PORTIONS OF A LOAF OF BREAD COMPARED WITH THAT OF THE ENTIRE LOAF

A Crust	B Section next to crust	C Section next	D Inner cube	E Crust of $\frac{1}{4}$ loaf	F Crumb of $\frac{1}{4}$ loaf	Total in $\frac{1}{4}$ loaf
26.84	39.72	43.10	43.08	29.18	41.44	37.17

DISCUSSION OF RESULTS

It is very evident that the moisture content of the crumb varies considerably, depending upon its proximity to the crust or to the center of the loaf. It might be supposed that there would be a more or less regular increase in moisture as the sample approaches the actual center, but this does not seem to be the case. In fact, the results indicate that there is no appreciable difference in moisture content in slices of bread taken a reasonable distance from the end of the loaf or in the crumb of any individual slice taken a reasonable distance from the crust. Therefore, after one gets fairly within the loaf, it seems to matter little whether the crumb be taken directly from the center of the loaf or not, since the variation is not great until rather near the end or crust of the loaf. There is a great difference, however, between the moisture in the whole bread (as determined on one-half or one-quarter of a loaf),¹ and that in either the crust or crumb taken separately or in one entire slice. This shows that in reporting the moisture content of bread it is necessary to state what portion of the bread was used, as well as how the moisture was determined.

Another point that seems to deserve attention is the age of the loaf. It is known to every one that bread loses moisture from the moment it leaves the oven. Consequently some idea of the freshness of the loaf should be given. When bread is baked in the laboratory it is usually weighed from 1 to 2 hrs. after leaving the oven. When loaves are bought on the open market it is not always possible to know how long the time since baking, but this will almost always be less than 24 hrs.

In conclusion, to determine the moisture in bread use one-half or one-quarter of a loaf, depending upon the character of the crust, and follow the method described on page 1021. This is a far more simple as well as more accurate method than to find the proportion of crust to crumb and to determine the water content of each separately.

LABORATORY OF PLANT CHEMISTRY
 BUREAU OF CHEMISTRY, WASHINGTON

A POLARISCOPIC DETERMINATION OF SUGAR IN "CONDENSED MILK"

By R. O. Brooks

Received September 20, 1916

In the legal analysis of "condensed milk," two items are of paramount importance, *viz.*, the percentage of fat and the percentage of milk-solids. For the estima-

¹ When the loaf is crust-covered, one quarter of it, obtained by cutting the loaf in half crosswise and this half in two lengthwise, is sufficient to represent the entire loaf. When the loaf lacks crust on one side, by reason of having been baked in contact with another loaf, one half of the loaf is required for analysis.