marily for this method of distillation. It could undoubtedly be diminished very materially in size with equally satisfactory results.

Obviously the principle is capable of application to numerous forms of condensers. It is only necessary to observe that the flasks are vigorously boiling for at least nineteen or twenty minutes. In a local laboratory the principle has been easily applied to a two-tube condenser constructed out of an old ether can. This apparatus has also given excellent satisfaction for over a year.

MIDDLETOWN, CONNECTICUT.

THE GLUTEN CONSTITUENTS OF WHEAT AND FLOUR AND THEIR RELATION TO BREAD-MAKING QUALITIES.

BY H. A. GUESS.

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DURING the last eighteen months the writer has been pursuing some investigations in the chemical factors which determine bread-making qualities of wheats and flours, and the notes here submitted, representing some results of the work, are offered as contributions to the chemical literature of an as yet rather neglected subject.

As aids in the work advantage was taken of published notes by other investigators, acknowledgments being more particularly due to the papers of M. E. Fleurent,[1] and of Mr. G. L. Teller.[2]

The result of considerable preliminary work in the estimation of the proteids of both wheats and flours, and subsequent comparisons with results of milling and baking tests, led the writer to confine his attention more particularly to the determination of the gluten constituents gliadin and glutenin, as being apparently the chief determining factors in bread-making qualities.

In the estimation of the gliadin and glutenin, five nitrogenous bodies were considered as being present in the samples,—gliadin,

1 "Sur la composition immédiate du gluten des cereals."—*Compt. rend.*, 123, 327. "Determination of Gluten in Wheat Flour."—Third Congress of Applied Chemistry. Vienna, August, 1898.

2 "Concerning Wheat and its Mill Products: A report of progress of investigations in the chemistry of wheat."—Arkansas Expt. Station, 1898.

glutenin, edestin, leucosin, and the amides. For the separation of the gliadin, alcohol of 0.90 sp. gr. was used, and after deducting the nitrogen of the amides present, the balance of the nitrogen in the alcohol extract, was calculated as gliadin.[1]

The nitrogen of the amides was determined on a separate sample, by extraction with one per cent. salt solution, precipitating all proteids with phosphotungstic acid, and determination of the amide nitrogen in the filtrate.

The edestin and leucosin were separated from the residue from the alcohol extraction, by extraction with one per cent. salt solution, and the nitrogen remaining in the final residue, calculated as glutenin. By making the 1 per cent. salt solution extraction on the residue from the alcohol extract, any uncertainty from partial solubility of gliadin, or allied proteid bodies, in salt solution, was avoided.[2]

The *modus operandi* of the analysis, was as follows:

a. Five grams of the finely ground wheat meal or flour, placed in a 250 cc. flask, 1 per cent. salt solution added from a pipette, at sufficient pressure to prevent any tendency to clot; flask filled to the mark, shaken at intervals for one hour, and let settle for two hours; decanted through a filter, duplicate portions of 100 cc. each of the clear supernatant liquid withdrawn, the proteids precipitated with a few cubic centimeters of 10 per cent. solution of phosphotungstic acid, the precipitate allowed to settle, 50 cc. of the clear filtrate evaporated with sulphuric acid, and the amide nitrogen determined.

b. One gram of sample put in a 500 cc. Kjeldahl flask with 100 cc. alcohol of 0.90 sp. gr., shaken to thoroughly mix, placed on a water-bath, and maintained at a temperature slightly below the boiling-point of the alcohol mixture; agitated every ten minutes for one hour, allowed to settle for one hour and decanted into a similar flask, being careful to not carry decantation close enough to cause any turbidity to appear in the decanted filtrate; 25 cc. fresh hot alcohol added, allowed to settle twenty minutes, decanted, and the operation repeated three times. In the extract, the alcohol is distilled off, and the nitro-

[1] *Am. Chem. J.*, 15, 441.
[2] *Ibid.*, 392 *et seq.*

gen in the residue determined, the amide nitrogen (*a*) subtracted, and the balance calculated as gliadin (N × 5.7).

c. To the residue from the alcohol extraction, after cooling, 250 cc. of 1 per cent. salt solution are added; it is allowed to settle for one hour, and decanted through a filter; 250 cc. fresh salt solution are added, shaken at intervals for one hour and allowed to settle for two hours, decanting through the same filter; the filter and contents are added to the residue in the flask, and nitrogen determined and calculated to glutenin.

Following are results of some determinations made in this way on wheats from different elevator points, throughout the Canadian Northwest, giving the locality, the buyer's regular grading mark, the percentages of gliadin and glutenin respectively; the ratio of same, and a composite factor representing this ratio × the total percentage of gluten (gliadin and glutenin) present. Also of the same determinations made at regular intervals on the flours produced from these wheats, by one of the largest milling companies in Canada. Analyses of the different 'break' products of the mill were also similarly made, but are not here included.

This ratio of gliadin to glutenin has been used tentatively, as an index of the gluten quality. So far as the writer has been enabled to have this index checked by actual baking tests on the flour produced, it was found that the elastic quality of the gluten was improved in proportion as the ratio of gliadin to glutenin increased, and as yet no limit has been found beyond which further increase of gliadin ratio rendered the gluten inelastic or sticky.

Manifestly, if this ratio of gliadin to glutenin be a true index of the quality of the gluten, the factor of quantity must also be taken account of in estimating the true gluten value of a wheat or flour, the value being the total number of units of gluten present × the value per unit. Need was felt, in the work, for a factor to indicate this gluten value, so as to be of use commercially, in grading wheats and flours, and in the lists following this gluten value is in each case calculated out as a composite factor made up of the percentage of gluten × ratio of gliadin to glutenin (quality index).

CANADIAN NORTHWEST WHEATS.

Locality.	Buyer's grade.[1]	Gliadin. Per cent.	Glutenin. Per cent.	Ratio of Gliadin to Glutenin.	Composite factor. Gluten ratio. Per cent.
Reston	2 H	7.32	4.43	1.65	19.38
Plum Coulee ..	1 N	5.4	3.61	1.49	13.42
Carman	1 H	7.77	3.30	2.34	25.90
Holland.....	2 H	5.73	4.0	1.43	13.91
Lauder.....	2 H	7.18	4.67	1.53	18.13
Virden (damp)	1 H	5.19	4.93	1.05	10.62
Lauder '97	1 H	8.39	4.61	1.8	23.4
Franklin	1 N	6.14	4.53	1.35	14.40
Hartney.....	1 H	5.43	4.24	1.2	11.6
Dom. City.....	2 N	5.15	3.71	1.38	12.22
McDonald.....	1 N	5.51	5.08	1.08	11.43
Manitou	2 N	4.57	5.91	0.7	7.33
Altonia.....	1 H	6.53	4.25	1.54	16.60
Reston.....	1 H	7.7	4.88	1.57	19.75
Treesbank.....	1 H	7.36	5.0	1.47	18.16
Douglass.....	1 H	7.7	4.4	1.77	21.41
Qu'appelle	1 H	7.86	4.16	1.9	22.84
Souris	1 H	7.01	5.10	1.37	16.59
Indian Head ..	1 H	7.98	4.92	1.62	20.89
Sintaluta.....	1 H	8.14	5.2	1.56	20.81
Whitewater ...	1 H	6.12	5.44	1.12	12.95
Boissevain	1 H	6.46	4.84	1.33	15.02
Stocton	1 H	6.62	4.40	1.5	16.53
Rosenfeldt	1 H	5.14	5.04	1.0	10.18
Ninga.....	2 H	5.59	5.0	1.11	11.97
McGregor.....	1 N	6.02	4.88	1.23	13.40
Neepawa	1 N	4.76	4.64	1.0	9.4
Portage.....	..	6.7	4.92	1.36	15.66
Portage (damp)	..	6.4	6.08	1.05	13.10
Elkhorn	1 H	7.06	5.2	1.35	16.55
Thornhill	1 N	6.5	4.4	1.47	16.02
Fleming	1 H	7.50	5.09	1.47	18.52
Griswald	1 H	7.50	5.64	1.33	17.48
Mileta	1 H	8.18	5.04	1.6	21.15
Bagat	2 H	7.34	5.0	1.47	18.13
Alemeda	1 H	8.29	4.45	1.86	23.69
Stocton	L White Fife	6.6	4.7	1.4	15.82
Sintaluta	1 H	9.21	4.60	2.1	27.62
Methven	1 H	8.52	5.0	1.7	22.98
Elkhorn(damp)	..	8.13	4.64	1.75	22.34
Carroll	..	7.58	5.30	1.43	18.42
Indian Head...	1 H	7.88	4.77	1.65	20.87

[1] Grades in descending. 1 Hard ; 2 Hard ; 1 Northern ; 2 Northern.

Locality.	Buyer's grade.[1]	Gliadin. Per cent.	Glutenin. Per cent.	Ratio of Gliadin to Glutenin.	Composite factor. Gluten ratio. Per cent.
Arden	1 N	5.07	5.49	0.92	9.71
Treesbank.....	1 H	8.76	4.82	1.81	24.57
Alemeda	1 White Fife	8.85	4.6	1.92	25.82
McGregor	2 H	6.44	4.36	1.47	15.87
Dauphin	1 N	4.25	4.25	1.0	8.5
Morden	1 N	3.65	3.65	1.0	7.3
Gretna	1 N	3.8	3.7	1.0	7.5
McDonald.....	2 H	5.8	4.0	1.45	13.21
Carberry	1 N	5.7	3.7	1.53	14.38
Moosomin.....	1 H	7.65	4.0	1.9	22.13
Treesbank	1 H	7.87	4.3	1.83	22.47
Neepawa	1 N	6.65	4.2	1.57	17.03
Indian Head ..	1 H	6.35	4.1	1.51	16.48
Carroll.....	1 H	6.7	4.1	1.63	17.60
Elva	2 H	7.6	3.95	1.92	22.17
Winkler	1 N	6.0	3.5	1.71	16.24
Altonia.....	1 N	7.5	4.1	1.82	21.11
Dom. City.....	2 N	5.4	3.7	1.46	13.28
Elkhorn(damp) ..	..	6.5	4.0	1.65	18.00
Elva	2 H	8.37	4.3	1.94	24.58
Reston	2 H	8.0	4.5	1.78	22.25
Douglass(damp) ..	..	6.65	4.2	1.58	17.13
Sintaluta.....	1 H	7.77	4.5	1.73	21.2
Boissevain	1 H	7.3	4.4	1.65	19.3
Qu'appelle	1 H	8.58	4.2	2.904	26.0
Manitou.....	2 Spring	4.0	4.2	0.95	7.78
Bagat	1 N	3.7	4.0	0.93	7.20
McGregor	1 N	4.65	4.10	1.1	9.62
Thornhill	1 N	5.4	4.2	1.3	12.48
Hamiota	1 H	7.15	4.6	1.54	18.10
Hartney	1 H	7.8	4.0	1.95	23.0
Treesbank	..	8.37	4.0	2.09	25.85
Indian head ...	..	7.51	4.1	1.83	21.24
Carman	..	7.77	3.6	2.14	24.18
Douglass	..	7.8	3.8	2.0	23.2
Bagat.....	..	7.0	4.2	1.66	18.59
Holland.....	..	6.1	4.4	1.4	14.7
Methven	..	8.1	4.0	2.02	24.44

[1] Grades, in descending order : 1 Hard ; 2 Hard ; 1 Northern ; 2 Northern.

CANADIAN NORTHWEST AND OTHER FLOURS.

Name of flour.	Grade.[1]	Gliadin. Per cent.	Glutenin. Per cent.	Ratio of gliadin to glutenin.	Composite factor. Per cent. gluten × ratio.
Keewatin	Patent	8.13	2.24	3.62	37.54
"	Baker's	8.47	3.90	2.17	26.84
"	Algoma	7.98	4.55	1.75	21.92
"	Glenwood	7.2	5.53	1.3	16.54
Portage	Patent	8.4	2.1	4.0	42.00
"	Baker's	8.65	2.6	3.32	37.25
"	Algoma	8.2	3.2	2.59	29.78
"	Glenwood	8.0	4.7	1.7	21.69
Keewatin	Patent	8.9	1.60	5.56	58.38
"	Baker's	8.14	3.52	2.3	26.81
"	Algoma	7.46	4.80	1.6	19.61
"	Glenwood	6.90	5.90	1.2	15.38
Austria-Hungary (best)		9.38	2.80	3.35	40.80
Keewatin	Patent	8.25	2.0	4.12	42.23
"	Baker's	9.06	2.25	4.02	45.46
"	Algoma	8.63	3.24	2.66	31.57
"	Patent	9.0	1.9	4.73	51.55
"	Baker's	8.65	3.2	2.7	32.0
"	Algoma	8.5	3.8	2.23	27.42
"	Glenwood	8.1	4.9	1.65	21.45
"	Patent	7.95	2.85	2.78	30.02
"	Baker's	8.1	3.1	2.61	29.23
Ogilvie	Patent	8.04	2.92	2.76	30.24
"	Baker's	7.4	3.6	2.05	22.55

At the present stage of progress in these investigations, it cannot be stated that these ratios, or the calculated factors, are true indices of the bread-making qualities and values of the different wheats and flours, but it is certain that there is a direct and very intimate connection between the same.

The subject is one worthy of attention by industrial chemists, and it is quite possible that in time the buying, mixing, and milling of wheats may come under as definite chemical control as are, at present, similar operations, with respect to the smelting of ores.

LABORATORY OF THE OTTAWA GOLD MILLING AND MINING CO., KEEWATIN, ONTARIO, March 6, 1900.

[1] Grades in descending scale: Patent, Baker's, Algoma, Glenwood.