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Correlation of Loaf Volume with Peptizing Action of Salts on Wheat Flour Proteins.*

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We have recently completed in this laboratory an extensive study of the peptizing action of certain salt solutions on a series of wheat flours.† The 12 wheat flours used were selected with the object of including flours from the various types of wheat grown extensively in the United States and Canada. The experimental procedure was to weigh out 6 grams of flour into a 100 cc. centrifuge tube, and to add 50 cc. of a salt solution of given concentration. This mixture was then shaken for 30 minutes in a mechanical shaker, and the flour residue tightly packed in the bottom of the tube by an electric centrifuge. The clear supernatant liquid was decanted into a Kjeldahl flask and the extraction repeated on the flour residue with 50 cc. of fresh salt solution, repeating the shaking, centrifuging and decanting, and following this with a third extraction of the residue, with a fresh portion of 50 cc. of the salt solution. Sulfuric acid was then added to these combined extracts, and the nitrogen dissolved by the salt solution determined by the usual Kjeldahl-Gunning procedure. From the values thus obtained, the percentage of the wheat flour proteins soluble in the salt solution was calculated.

In all, 21 different inorganic salts were used, nearly all in four different concentrations, so that we have data as to the percentage of protein dissolved by the different salts, and the effect of concentration of the salt on protein peptization. Obviously such data are too extensive for summarization here. Great variations in the peptizing action of the various salts were observed. For example, normal solutions of KF dispersed an average of 13.07 per cent of the total protein, whereas a similar concentration of KCl extracted an average of 22.77 per cent. KBr extracted an average of 37.22 per cent and KI extracted an average of 63.89 per cent. All of these solutions had approximately the same hydrogen ion concentration, about pH = 5.87 to 6.05.

The different salts showed extreme ranges in the percentage of

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protein extracted from a single flour (*e. g.*, with flour No. 1, N/1 KF extracted 18.0 per cent of the total protein, whereas N/1 KI extracted 73.9 per cent.) There was an equally surprising variability in the percentage of total protein extracted by a single salt solution from the various flours (*e. g.*, the N/1 KF values ranged from 10.5 per cent to 18.0 per cent, the N/1 KCl values ranged from 18.7 per cent to 30.4 per cent, the KBr values ranged from 30.1 per cent to 48.6 per cent, and the KI values ranged from 55.4 per cent to 73.9 per cent). When the percentages of protein extracted by all the 21 salts (N/1) were averaged, the range between the flours was from 23.45 per cent to 37.71 per cent.

These characteristic variations in the behavior of the various flours toward salt solutions suggested that perhaps the peptizing action of the salt solutions on the wheat flour protein might be correlated with loaf volume. Accordingly the correlation coefficient between loaf volume and the percentage of protein extracted by a salt solution was calculated, using the correlation formula suggested by Harris.[1]

Thirteen correlation coefficients have been computed. The lowest correlation so far obtained (the N/1 KI series) is $r = -0.672 \pm 0.107$, and the highest (the N/1 $MgSO_4$ series) is $r = -0.925 \pm 0.028$.

These high negative correlations indicate that the larger the loaf volume, the smaller will be the percentage of protein peptized by a given salt solution. This is in exact agreement with a statement which I made[2] in 1918, to the effect that flours characterized by a small loaf volume yielded glutens which were more easily peptized than were the glutens from flours yielding large loaf volumes.

All of our studies[3] have indicated that the weak glutens were charterized by greater ease of peptization than were the strong glutens, but the present series of experiments is the only series where we have used statistical methods. There are sufficient data in one previous paper,[4] however, to justify the application of the correlation formula. Accordingly I have calculated the correlation coefficient between loaf volume and per cent of total protein soluble in 5 per cent K_2SO_4 solution for that series of flours, and find $r = -0.824 \pm 0.065$, so that the high negative correlation which we find in the present series of flours is substantiated by the data of this earlier series.

We are now preparing to begin an extensive experiment to test out the validity of the correlations on a much larger series of commercial wheat flours.

The implications involved, should our present high negative correlations be confirmed by the more extensive experiment, include (a) the possibility of calculating by means of a formula the volume of the loaf of bread which can be secured from a given sample of wheat flour; (b) the possibility of supplementing the milling and baking tests for the determination of wheat quality with a much simpler test involving the use of much smaller samples of wheat, this would be of extreme importance in plant breeding studies; and (c) the possibility of radically changing present systems of wheat grading.

Nothing can be said with certainty in regard to the above possibilities until we have completed more extensive experiments. Our present data, however, indicate that all of the flours included in the present or the previous[4] studies contained sufficient good protein to make a desirable loaf volume, but that associated with this good protein there was a certain amount of inferior, easily peptized, protein which prevented the good protein from exerting its maximum influence. Likewise the possibility of applying this method to the problems of frosted, rusted, sprouted, or otherwise damaged wheat must be obvious. (The complete data of these experiments will be published in *Cereal Chemistry*.)

We are at present engaged in another series of experiments in which we are studying the behavior of various pure proteins, some from wheat endosperm, others from other plant or from animal sources, toward the peptizing action of certain neutral salt solutions, and have already secured very striking results. Certain proteins which have hitherto been regarded as distinct entities have already been separated into fractions which show widely different properties. These data, however, are not sufficiently complete for a detailed report at the present time. This is a preliminary report.

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[1] Harris, J. A., *Am. Nat.*, 1910, xliv, 693.

[2] Gortner, R. A., and Doherty, E. H., *J. Agr. Res.*, 1918, xiii, 389.

[3] Gortner, R. A., and Sharp, P. F., *J. Phys. Chem.*, 1923, xxvii, 481; 1923, xviii, 567; Sharp, P. F., and Gortner, R. A., *ibid.*, 1922, xxvi, 101; 1923, xxvii, 674; 1923, xxvii, 771; 1923, xxvii, 942; *Tech. Bull. xix*, Minn. Agr. Exp. Sta., 1923, p. 119.

[4] Sharp, P. F., and Gortner, R. A., *Tech. Bull. xix*, Minn. Agr. Exp. Sta., 1923, p. 119.