NOTE ON THE IRRADIATION OF FLOURS FROM THIRTEEN VARIETIES OF WHEAT[1]

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In a previous paper (2), it was reported that the irradiation of flour with Co^{60} gamma rays caused a decrease in the recovery of crude gluten and an increase in the maltose value, the latter attributable to enhanced susceptibility of the starch, after irradiation, to autolytic hydrolysis. In the present work, a study was made on possible varietal differences in the changes brought about by irradiation. Samples of flour from 13 varieties of wheat with widely different breadmaking quality were each irradiated with 700,000 r. of Co^{60} gamma rays. These varieties, together with arbitrary rankings of their baking quality are listed in Table I. The irradiation was carried out by placing the flour in covered 50-ml. beakers and setting these beakers in fixed positions near a 90-curie Co^{60} source. The dose rates were measured by determining the ferric ions formed upon irradiating solutions of ferrous ammonium sulfate (5). Under the conditions of the experiments, exposures of the order of 17 hours were required to give the 700,000-r. dosage.

Recoveries of crude gluten and maltose values were determined on all samples of flour before and after irradiation, as outlined in *Cereal Laboratory Methods* (1). The results are also given in Table I. As expected, flours from all 13 varieties, after irradiation, showed decreased gluten recoveries and increased maltose values. There are considerable similarities in the magnitudes of these changes, as shown in columns 5 and 8 of Table I. After irradiation with a dose of 700,000 r., the loss

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in gluten recovery was within 2.4–3.0% for nine of the 13 varieties, while increases in maltose value were within the range of 31–40 mg. maltose per 10 g. flour for seven varieties and within the range of 46–52 mg. maltose per 10 g. flour for four others. Such similarities suggest that the gamma rays very probably caused random fragmentations of the protein and starch. The extent of breakdown of such molecules will be dependent on total radiation dosage and will not be very discriminating among flours of different breadmaking quality. Recently, Maes (4) reported that radiation had an improving effect on flours from certain weak European wheats, and hinted that radiation treatment has a special virtue for such wheats which it might not have for other types of stronger wheat. The present data, however, appear to indicate a similarity in the response to radiation for flours from widely varying types of wheat.

The breakdown of flour proteins by the gamma rays was also studied in another way. Samples of flour before and after irradiation were fractionated according to a procedure similar to that reported by McConnell and Ramachandran (3). Briefly, this consisted of extracting a 5-g. sample of flour first with a 5% solution of potassium sulfate. This extract was separated into two fractions by treatment with 10% trichloroacetic acid (TCA). The precipitated protein was designated "albumin" and the supernatant liquid termed "water-soluble nonprotein

TABLE I

GLUTEN RECOVERIES AND MALTOSE VALUES FOR FLOURS BEFORE AND AFTER IRRADIATION WITH 700,000 ROENTGENS OF Co^{60} GAMMA RAYS

RANK [a] AND VARIETY	GLUTEN RECOVERY [b]			MALTOSE VALUE [b]		
	Before Irradiation	After Irradiation	Difference	Before Irradiation	After Irradiation	Difference
	%	%	%	*mg/10g flour*	*mg/10g flour*	*mg/10g flour*
1 — Pacific Club	6.2	3.2	3.0	89	116	27
2 — Rio Negro	18.4	16.0	2.4	115	134	19
3 — McMurachy × Exchange	14.2	11.2	3.0	231	282	51
4 — Centana	12.3	9.7	2.6	161	213	52
5 — Kenya 321	11.7	9.3	2.4	188	235	47
6 — Redman	14.3	11.5	2.8	152	188	36
7 — Apex	13.3	11.9	1.4	161	207	46
8 — Mida	12.8	10.0	2.8	164	204	40
9 — Lake	12.8	10.3	2.5	198	234	36
10 — Rescue	13.0	10.5	2.5	170	201	31
11 — Rescue × Chinook	11.0	9.1	1.9	226	264	38
12 — Chinook	14.7	13.3	1.4	156	190	34
13 — Thatcher	12.7	10.9	1.8	149	188	39

[a] Arbitrary ranking of breadmaking quality for the 13 varieties, higher ranks being given for better quality.

[b] Mean values of two to four determinations.

nitrogen." The flour remaining after the extraction with the potassium sulfate solution was next extracted with 0.02*N* sodium hydroxide. This alkaline extract was also treated with 10% TCA. The precipitated protein was designated "gluten" and the aqueous residue called "alkali-soluble nonprotein nitrogen." The material remaining after the two extractions was termed the "residue." Kjeldahl nitrogen determinations were carried out on all the fractions as well as on the original flour. As an illustration, a typical set of results, that for the flour from the variety Rescue (rank No. 10), is given in Table II. For all 13 varieties,

TABLE II

CRUDE PROTEIN CONTENTS (N × 5.7) OF FRACTIONS FROM FLOUR OF RESCUE WHEAT

	Protein Content						
	Original Flour	Albumin	Water-Soluble Nonprotein Nitrogen (N × 5.7)	Gluten	Alkali-Soluble Nonprotein Nitrogen (N × 5.7)	Residue	Total Recovery
	%	%	%	%	%	%	%
Before irradiation	13.8	1.2	1.0	10.9	0.4	0.4	13.9
After irradiation	13.7	0.4	1.8	9.6	1.4	0.4	13.6

irradiation caused decreases in the albumin and gluten fractions and increases in the fractions containing the water-soluble and alkali-soluble nonprotein nitrogen, thus strongly indicating breakdown of the proteins by gamma rays.

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Literature Cited

1. AMERICAN ASSOCIATION OF CEREAL CHEMISTS. Cereal laboratory methods (6th ed.). The Association: St. Paul, Minnesota (1957).
2. LEE, C. C. The baking quality and maltose value of flour irradiated with Co^{60} gamma rays. Cereal Chem. **36:** 70–77 (1959).
3. MCCONNELL, W. B., and RAMACHANDRAN, L. K. Acetate metabolism of maturing wheat plants. Can. J. Biochem. Physiol. **34:** 180–190 (1956).
4. MAES, E. Influence des radiations ionisantes (rayons gamma) sur la valeur boulangère de la farine. Bull. ecole meunerie belge **20** (5): 60–65 (1958).
5. WEISS, J., ALLEN, A. O., and SCHWARZ, H. A. Use of the Fricke ferrous sulfate dosimeter for gamma-ray doses in the range 4 to 40 kr. Proc. Intern. Conf. Peaceful Uses Atomic Energy, Geneva, 1955, vol. 14, pp. 179–181 (1956).