THE INFLUENCE OF GAMMA RADIATION ON TEXTURAL CHANGES IN PEACHES

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ABSTRACT

Peaches of the Maygold, Southland, Loring and Dixiland varieties were used to measure textural changes resulting from gamma radiations.

The Maygold peaches were irradiated at levels of 0, 100, 200 and 300 kilorad (krad) and then stored at 67 F and 92% relative humidity (R. H.) for 1, 4 and 6 days. Irradiation induced softening of the fruit; however, the rate of softening was greatest for peaches measured after 1 day's storage. Results showed a significant irradiation x storage interaction, with the percent change in maximum shear force increasing with higher levels of irradiation.

Texture measurements were made on the Southland, Loring and Dixiland varieties immediately following irradiation in order to eliminate the storage effect. The percent change in maximum shear force was linearly proportional to the log of the irradiation dose.

INTRODUCTION

It has been observed that irradiation causes physical changes in most fruit. Texture changes in peaches have been detected and some attempts are being made to evaluate the nature of these changes. Merkley, et al. (2) using taste panel techniques, found that irradiated peaches of the Loring and Southland varieties, stored for one week at 50 F and 85% R. H. showed a decrease in firmness between levels of 0 and 300 krad. Peaches held at 50 F for 11 days also showed a decrease in firmness with increasing levels of irradiation. The flesh of the irradiated peaches was described as dry and mealy.

Shewfelt (3) studied the relationship of pectinesterase activity and three pectic fractions, i.e., water-soluble, versene soluble and versene-insoluble, with the firmness and maturity of fresh peaches. In a freestone variety there were significant statistical differences in the proportions of versene-soluble pectin retained with advancing ripeness. The differences in pectin constitution were related to the firmness of the product, while the level of pectinesterase was not in itself directly related to firmness retention.

Somogyi and Romani (4) found that the decrease in firmness of pears and peaches exposed to gamma radiation of 300, 600 and 900 krad corresponded to a decrease in protopectin content and an increase in pectin and pectate fractions of the fruits.

This study was made to determine the influence of irradiation on the nature of the textural behavior in peaches as indicated by shear press measurements.

EXPERIMENTAL METHODS AND PROCEDURE

A preliminary investigation was conducted to determine the best method for sample presentation to the Allo-Kramer Shear Press for texture measurements. The following results were obtained:

1. Slices approximately ½ inch wide, and taken from opposite cheeks of a peach, gave the best representation of texture for the whole fruit.

2. There was no significant variation in the slope or shape of the shear-force vs. distance curve for either peeled or unpeeled slices. The unpeeled slices yielded slightly greater maximum force values.

3. No differences were found in the maximum shear force per gram of sample when 5, 10 or 20 slices were used in the cell.

4. No differences were found in the maximum shear force readings or the shape of the curves with different arrangements of slices in the cell, i.e., concave side up, down or randomly placed.

The procedure selected for this study was 10 unpeeled slices obtained from 5 fruit arranged in the cell with the concave side up and perpendicular to the blades of the cell. The shear press was calibrated using the 2500 lb. ring at range settings from 5% to 50% of the

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maximum force, depending on the firmness of the sample. The time of descent of the blades was approximately 12 seconds for all measurements. Peak heights on the shear press recorder trace were used as the measure of maximum shear force in pounds, while the areas under the curve, measured with a planimeter, were used to express the work in inch-pounds.

Peaches of the Maygold variety were harvested and graded at Madison, Florida, and brought to Gainesville. Prior to irradiation, the fruit was randomly sorted into batches of 15 to provide for three replications. The fruit was at the firm-ripe stage of maturity when irradiated the day after harvest. Maygold peaches were irradiated at levels of 0, 100, 200 and 300 krad and stored at 68 F and 92% R. H. for periods of one, four and six days after irradiation. Shear press measurements were made after each storage period.

Peaches of the Southland variety were obtained from Barney, Georgia, while the Loring and Dixiland varieties were obtained from Fort Valley, Georgia. These peaches were also at the firm-ripe stage of maturity. The peaches were divided randomly into groups of five peaches each for irradiation after two days storage at 35 F. The Southland peaches were irradiated at increasing intervals of 50 krad, starting at 0 and ending at 400 krad, while the dose for the Loring and Dixiland was extended to 450 krad. Shear press measurements were made immediately after irradiation to provide information on the effects of irradiation independent of storage effects.

A split-plot experiment was conducted to measure the effects of 4 levels of irradiation and 3 storage periods on the texture of the Maygold peaches. The design was randomized blocks with replications as blocks. The main plot treatments were days of storage with levels of irradiation as sub-plot treatments. The Method of Least Squares was used to analyze the results from the experiments with the Loring, Southland and Dixiland varieties.

Results and Discussion

The results of the experiment with Maygold peaches are summarized in Tables 1 and 2. Several trends are of interest in Table 1. Generally, for each storage period the maximum shear force and the work decreased as the irradiation dose increased. The overall decrease is greater for the peaches measured after one day's storage than for the peaches which were stored for 4 or 6 days. It is also apparent that for each irradiation dose the greatest difference in maximum shear force and total work occurred between 1 and 4 days storage, with a much smaller decrease between 4 and 6 days storage.

A statistical analysis of the shear force data yields the following information which is presented in Table 2:

1. Error terms were obtained which indicated a coefficient of variation of 6.1% for reproducibility of measurements with the shear press.

2. There was a significant irradiation x storage interaction at the 0.05 level of probability

Table 1. Maximum shear force and work for levels of irradiation and storage time.

	Force (lbs.)			Work (inch-lbs.)		
Krad	1	4	6	1	4	6
0	19.3	5.3	4.7	.88	.26	.21
100	14.7	3.8	2.7	.63	.17	.20
200	13.5	3.0	2.4	.57	.17	.18
300	9.5	2.6	2.2	.49	.17	.16

Table 2. Analysis of variance of storage and irradiation effects on texture of peaches. Split-plot experiment with storage time as main plots and irradiation as sub-plots, run as randomized block design with replications as blocks. Effects of storage and irradiation are fixed.

Source	d.f.	Sum of Sqs.	Mean Sq.	Expected Mean Sq.
main plots	8	112.74	14.09	
replications	2	2.29	1.15	
storage (S)	2	106.69	53.34	$\sigma_a^2 + 12\,K_s^2$
$S_{(linear)}$	1		93.75	
$S_{(quadratic)}$	1		12.94	
$error_a$	4	3.76	0.94	σ_a^2
sub-plots/main plots	27	22.41	0.83	
irradiation (I)	3	13.12	4.37	$\sigma_b^2 + 9\,K_I^2$
I_l	1		12.41	
I_q	1		0.32	
I_{cubic}	1		0.39	
I x S	6	6.09	1.02	$\sigma_b^2 + 3\,K_{I \times S}^2$
$I_l\ S_l$	1		4.97	
$I_l\ S_q$	1		0.76	
$I_q\ S_l$	1		0.05	
$I_q\ S_q$	1		0.00	
$I_c\ S_l$	1		0.21	
$I_c\ S_q$	1		0.11	
$error_b$	18	3.19	0.18	σ_b^2
total	35	135.15		

Table 3. Maximum shear force and percent change in shear force for levels of irradiation.

Level (krad)	Shear force (lbs.)			% Change		
	Loring	Southland	Dixiland	Loring	Southland	Dixiland
0	10.52	10.10	9.44			
50	10.90	9.07	9.42	3.61	10.2	0.20
100	10.43	7.64	9.15	0.85	24.4	3.10
150	8.70	6.30	7.93	17.3	37.6	15.9
200	6.63	4.00	7.13	36.9	60.4	24.5
250	6.09	4.17	5.58	42.1	58.7	40.9
300	4.63	3.82	5.27	55.9	62.2	44.2
350	4.22	3.99	4.31	59.9	60.5	54.3
400	3.53	3.36	3.94	66.4	66.7	58.3
450	2.61	--	3.79	75.2		59.8

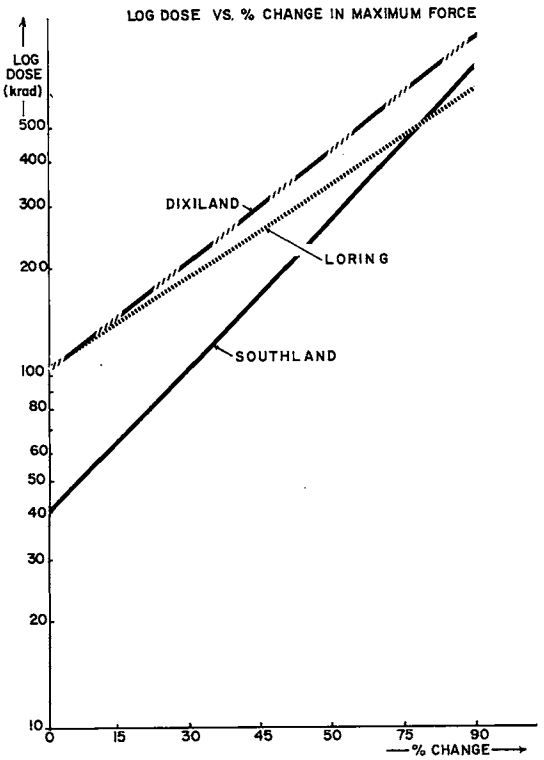

Fig. 1.—Log Dose vs. % Change in Maximum Shear Force.

which indicates that the effects of irradiation which cause softening in the peaches are not the same for each storage period. The term $I_1 S_1$ describes most of the relationship between irradiation and storage time in the interaction, since the remaining five terms, when included as a whole, are not significant.

The results of the experiment with the Loring, Southland and Dixiland peaches that describe the effects of irradiation without the influence of storage are presented in Figure 1 and Table 3. A notable softening of texture did not occur in the Loring and Dixiland peaches until approximately 100 krad dose of radiation, then the rate of softening was rather constant up to 450 krad, the maximum dose received. The Southland variety softened considerably at 50 krad dose and continued to soften uniformly up to the maximum dose received, 400 krad.

Least square procedures were used to obtain the straight lines which best fit the points obtained by plotting the logarithm of the dose vs. the percent change in maximum shear force. This relationship was found by Boyle et al. (1957) when cylinders of irradiated apples and carrots were crushed (1).

Correlation coefficients were calculated for the relationship between the percent change in maximum shear force and the log of the dose for the Loring, Southland and Dixiland peaches and were found to be 0.98, 0.96 and 0.98, respectively. No rate of change was apparent for the Loring and Dixiland varieties until 100 krad; hence, the correlation coefficients and the regression lines do not reflect the values for 0 and 50 krad in these two varieties. The rate of percent change was not as great for the Loring peaches as for the Southland and Dixiland varieties; this can be seen by examination of the slopes of the three lines. However, there are no criteria which indicate that the slopes should be the same, since the nature of the texture and the maturity at the time of irradiation have a strong influence on the changes within the peaches for different varieties.

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