

A Research Note

TEXTURAL QUALITY PREDICTION OF REHEATED FROZEN FRENCH
FRIED POTATOES BY OBJECTIVE TESTING OF RAW STOCK

ABSTRACT

Research is described which evaluates and relates a simple Durometer test of raw potato lots with instrumental texture measurements and sensory panel evaluation of oven-reheated frozen French fried potatoes. Statistical evaluation of the mean data shows no difference between the Idaho and Maine Russet Burbank samples for any of the measurements. Durometer means were significantly correlated with shear press measurements and all shear press values were significantly intercorrelated. The large correlation coefficients between Durometer readings and

other measurements indicate that Durometer evaluations can be used to predict from the raw tubers the shear press measurements and overall moistness, crust crispness and internal mealiness of oven-reheated frozen French fried potatoes. Further work is necessary with other source and variety combinations before a general prediction statement can be made.

INTRODUCTION

A RESEARCH PROGRAM at this laboratory has for some years been directed to examine by instrumental means the

¹ Retired

Table 1—Instrument means for Durometer readings on raw tubers and shear press values for oven-reheated frozen French fried potatoes^a

	Durometer reading ^c	Shear press ^b					
		AUC hot ^d	AUC cold	Peak 3 hot	Peak 3 cold	Peak 2 hot	Peak 2 cold
Idaho Russet Burbank	36.85a ^e	405a	337a	560ab	503ab	287a	340ab
Maine Russet Burbank	36.18a	443a	415a	610a	603a	307a	417a
Red River Valley Kennebec	32.21b	317b	235b	527b	417bc	233b	270bc
Maine Katahdin	25.32d	170c	160b	453c	370bc	127c	153d
Maine Kennebec, high specific gravity ^e	29.03c	293b	225b	457c	390bc	220b	213cd
Maine Kennebec, low specific gravity	27.37cd	225c	182b	450d	320c	163c	200cd

^a Values followed by the same letter are not significantly different from each other at the 5% level by Duncan's Multiple Range Test (Duncan, 1955).

^b Reported values are means of three results, each obtained by shearing seven sampled slices in a single layer in a standard shear test cell. The mean range for all the shear measurements is 74.

^c Each value is a mean of 10 observations on 15 tubers.

^d AUC is area under the shear press curve (work).

^e High sp. gr. ≥ 1.090 and low sp. gr. ≤ 1.080 .

Table 2—Treatment means for sensory scores and hedonic ratings for oven-reheated frozen French fried potatoes^a

	Treatment minus standard			
	Overall moistness	Crust crispness	Internal mealiness	Hedonic rating
Idaho Russet Burbank	-0.21a	0.06a	-0.11a	0.07b
Maine Russet Burbank	-0.34a	-0.10a	-0.13a	-0.16b
Red River Valley Kennebec	-0.29a	-0.04a	-0.31a	0.37a
Maine Katahdin	-1.57c	-1.17c	-1.51c	-2.16d
Maine Kennebec, high specific gravity ^b	-0.89b	-0.60b	-0.80b	-0.49c
Maine Kennebec, low specific gravity	-1.03b	-0.83bc	-0.90b	-0.19b

^a Panel of 14 judges, balanced incomplete block design. Values followed by the same letter are not significantly different from each other at the 5% level by Duncan's Multiple Range Test (Duncan, 1955). Each value is based on 70 observations.

^b High sp. gr. ≥ 1.090 and low sp. gr. ≤ 1.080 .

textural characteristics of frozen and reheated French fried potatoes. During this research a modified shear press, equipped with special electronic equipment, was developed for the precise and accurate evaluation of the various textural components of raw and French fried potatoes (Porter and Ross, 1966; Ross and Porter, 1966, 1968, 1969, 1971).

Since the vast frozen French fried potato industry makes huge purchases of raw tubers, a method of predicting the quality, from the raw tubers in the field, of the frozen and reheated French fried potatoes was sought. In this study we examined the relationships among data from laboratory shear testing of reheated French fries, sensory evaluation, and a simple instrumental test applied to the raw tubers.

MATERIALS & METHODS

RUSSET BURBANK potatoes grown in Idaho and in Maine, Kennebec potatoes grown in the Red River Valley and in Maine and Katahdin potatoes grown in Maine were used for this work. The Maine Kennebecs were brine graded into three specific gravity groups. The highest 25% (above s.g. 1.090) and the lowest 25% (below s.g. 1.080) were used for this work.

The Durometer used for this work was made by the Shore Instrument Co., Jamaica, N.Y. It is a pocket-sized, relatively inexpensive, dial penetrometer. The instrument selected is a type A-2 with a 1/2 in. round foot for irregular surfaces, a maximum reading needle for convenience, and a truncated cone-shaped indenter. Bourne and Mondy, 1967, used a hemispherical Durometer indenter which yielded raw potato readings in the 75–85 range. With the truncated cone-shaped indenter used in these studies, readings were in the 25–35 range. The Durometer reading vs. force per unit area curve is a straight line in this range and, therefore, yields a valid evaluation. For use, the potato is peeled at the point where the reading is to be taken, the Durometer is pressed firmly against the tuber, and the reading is noted. Durometer tests were made on representative samples of each of the six variety lots. Ten evenly spaced tests were made in a line from the bud end to the stem end of 15 tubers from each of the samples.

Six of the Durometer tested sample tubers were cut into 3/8 in. × 3/8 in. × 2-5/8 in. slices and 400g (0.88 lb) lots of slices were taken through the procedure until sufficient sample resulted for both shear and organoleptic evaluations. The slices were blanched in 79.4°C water for 6 min with occasional agitation. After a 1-min drain, the blanched slices were fried for 3 min in a 15 lb (6.8 kg), 4500 watt fryer set at 185°C and filled with hydrogenated vegetable oil type shortening. Occasional agitation was also employed at this point. After frying, the excess fat was shaken off the slices. Next, the French fried slices were quick-frozen for 20 min on a screen over liquid nitrogen inside a covered draft shield. The frozen fries were then stored in double polyethylene bags in a -17.8°C laboratory freezer. Two inches were maintained from all freezing surfaces in the unit by the use of raised shelves of wood and screen. For the evaluations, the frozen French fries were reheated at 218°C in a 14 in. × 14 in. × 14 in., 1500 watt gravity convection oven for 20 min.

Organoleptic evaluations were carried out by a trained 14-member panel in a special taste panel room. A balanced incomplete block design with three treatments (samples) and a hidden standard per block (serving tray) was used. The hidden standard—Idaho Russet Burbank—was included in each block to compare each treatment with the standard. Each panelist evaluated 10 blocks (on 10 different days), each treatment appeared eventually five times and each combination of two treatments appeared twice. The treatments were assigned at random to the treatment numbers (the order in which the 10 organoleptic evaluation series was conducted). Each block was presented to only two judges at a time. Overall moistness was judged with a 5-point scale with 1, soggy and 5, dry. Crust crispness was also judged on a 5-point scale with 1, limp and 5, crisp. Mealiness was judged on a 4-point scale with 1, not mealy and 4, mealy. A 9-point hedonic scale of 1, dislike extremely and 9, like extremely, was used for overall acceptability. Balanced incomplete block analyses of variances were calculated on the actual values and on the differences between the treatments minus the internal standard in that block.

Shear press evaluations were carried out on oven-reheated frozen French fried potatoes to obtain the area under the shear force curve and the heights of peaks 2 and 3 (Ross and Porter, 1968, 1969). Determinations were carried out on hot samples and on samples cooled for

Table 3—Correlation coefficients for all instrumental values, sensory scores and hedonic ratings

	Treatment minus standard			Shear press						
	Crust crispness	Internal mealiness	Hedonic rating	Durometer reading	AUC hot ^a	AUC cold	Peak 3 hot	Peak 3 cold	Peak 2 hot	Peak 2 cold
Overall moistness, treatment minus standard			0.879*	0.926**	0.897*	0.769	0.813*	0.685	0.912*	0.842*
Crust crispness, treatment minus standard	0.994**b	0.989**	0.826*	0.941**	0.905*	0.783	0.835*	0.719	0.921*	0.847*
Internal mealiness, treatment minus standard		0.979**	0.864*	0.953**	0.940**	0.839*	0.853*	0.746	0.947**	0.899*
Hedonic rating, treatment minus standard				0.677	0.669	0.493	0.506	0.331	0.693	0.599
Durometer reading					0.975**	0.927**	0.933**	0.875*	0.970**	0.951**
Shear press area under the shear force curve, hot					0.964**	0.907*	0.923**	0.907*	0.997**	0.971**
Shear press area under the shear force curve, cooled 30 min										
Shear press peak 3, hot							0.950**	0.972**	0.944**	0.984**
Shear press peak 3, cooled 30 min								0.957**	0.901*	0.975**
Shear press peak 2, hot									0.885*	0.946**
Shear press peak 2, cold										0.952**

^a AUC is area under the shear force curve (work).

^b Correlation coefficient significance: *5%, **1% levels. Correlations are based on six observations of lot means.

30 min. The entire procedure from slicing the potatoes to the shear testing was repeated three times.

RESULTS & DISCUSSION

STATISTICAL CALCULATIONS of the Durometer data indicate that better reproducibility could have been obtained with less effort as the mean of one equatorial Durometer reading for each of 23 representative potatoes rather than the 10 observations of 15 tubers used in this work.

Values for all the variables shown in Tables 1 and 2 rate Maine's one-time standard potato, the Katahdin, significantly inferior to the Russet Burbank. However, for all variables, Maine Russet Burbanks do not differ significantly from the long-accepted Idaho Russet Burbanks. Although the means for the Maine Kennebec high specific gravity samples were greater than those of the low specific gravity tubers (Table 1), the Durometer values and three of the six shear press values show no significant differences.

Table 2 shows the means of the organoleptic evaluations. Using the difference between a treatment minus the hidden standard within the block of the organoleptic data does not improve the evaluations. The Maine Katahdin tubers, as with the instrumental evaluations, yield the lowest organoleptic scores of all 6 treatments.

Table 3 contains all the correlation coefficients between the eight organoleptic and seven objective evaluations. All correlations between the shear press variables exceed 0.885 and are significant with only four degrees of freedom. Durometer and shear press values have significant correlation coefficients.

Organoleptic scores are highly correlated except for the hedonic rating. Durometer readings are highly correlated with overall moistness, crust crispness and internal mealiness scores.

However, correlation between the Durometer readings and the hedonic rating scores is 0.638 and not significant. The objectivity of the taste panel in evaluating the hedonic score was probably influenced by taste, color and appearance despite careful instructions to rate only for texture attributes. This problem was not evident when evaluations were made on only one facet of texture at a time.

CONCLUSIONS

IT MAY BE CONCLUDED from Table 3 that for the tubers used in these tests that the Durometer evaluation can readily be used to predict from the raw tubers the texture parameters overall moistness, crust crispness, and internal mealiness in the oven-reheated frozen French fried potatoes. If, for example, the Durometer mean for a lot of tubers is found to be 25, it may be concluded that this lot of potatoes will make French fries with poor textural characteristics. However, tubers with a Durometer mean of 35 will make French fried potatoes with excellent textural quality.

Further work is necessary with potato samples of other source and variety combinations before a general statement can be made about prediction of final textural quality of the reheated product from Durometer values of any raw stock.

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