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Consumer Preference Tests for Dehydrofreezing and Explosive – Puffing of Blueberries  
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Research Report

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# RESEARCH REPORT

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## *Consumer Preference Tests for Dehydrofreezing and Explosive-Puffing of Blueberries<sup>1</sup>*

By DENNIS S. ISIDRO, W. S. GREIG, C. L. BEDFORD  
and HENRY LARZELERE<sup>2</sup>

### Introduction

MICHIGAN IS ONE of the principal producers of cultivated blueberries in the U.S. The production of blueberries, in Michigan and nationally, has increased significantly over the past three decades. Projections indicate a continued increase in Michigan's production over the next several years. Total per capita consumption of both fresh and processed blueberries is increasing and consumption is concentrated relatively near to areas of production.

Over half of the total blueberry crop is processed, and the principal uses of the processed products are in pies and blueberry muffins. Blueberries are relatively higher priced than most fruits used in pie form, and limited data would suggest a relatively high elasticity of demand for fruit pies. There is no doubt that improved, cost-reducing technology could increase the sales of blueberry products.

### Objective

This is a progress report on the feasibility of using products from two new cost reducing processing methods for blueberries—the dehydrofreezing process and the explosive-puffing process. The feasibility of using products from these new processes was tested by quality comparisons to standard product forms through a consumer preference panel.

<sup>1</sup> This project was partially financed by the Michigan Blueberry Growers Association.

<sup>2</sup> Authors are, respectively: Graduate student and Associate Professor, Department of Agricultural Economics; Professor, Department of Food Science; and Associate Professor, Department of Agricultural Economics.

### The Technologies of Dehydrofreezing and Explosive-Puffing

Dehydrofreezing is a method of food preservation which involves drying the commodity to approximately 50 percent of fresh weight and volume before freezing (11, 12). The main objective of this processing method is the reduction of weight and bulk of the product while maintaining product quality (2, 13). As a result of the reduced weight and bulk; packaging, storage, and shipping costs are also reduced (14). In addition, reduction of drip upon thawing and the ease of controlling the moisture content are advantages of dehydrofrozen products over items frozen by the regular method.

Though plant investment for dehydrofreezing technology is higher than for freezing, the difference in cost is more than offset by the reduction in packaging, storage, and transportation costs of the processed products. In effect, the objective of dehydrofreezing is to obtain some of the economies of dehydration while maintaining the quality of the frozen product. Dehydrofreezing has been applied to peas (22), apples (23), and apricots (18).

Explosive-puffing is a new process developed at the Department of Agriculture's Eastern Utilization Research and Development Division near Philadelphia (3). It produces relatively larger dehydrated fruit and vegetable pieces that can be dehydrated and rehydrated more rapidly than those from conventional de-

hydration processes. Eisenhardt describes this new process:

"The vegetable or fruit pieces are partially dehydrated in a conventional manner and heated in a closed vessel having a quick-opening lid. When the water contained within the pieces is heated above its atmospheric boiling point and pressure has thereby developed within the chamber, the pieces are instantly discharged. The flashing of water vapor from within each piece creates a porous structure that permits much faster dehydration and much more rapid rehydration of the dried product (5)."

Explosion-puffing has been successfully applied on a pilot plant scale to white potatoes, sweet potatoes (21), carrots and beets (4), as well as to apple slices and blueberries (6). The quick-cooking dehydrated products, depending on the commodity, can be rehydrated for use in from 2-5 minutes in contrast to 30 minutes to an hour frequently required for vegetable pieces of the same size.

Quick-cooking dehydrated fruits and vegetables have certain advantages over canned and frozen products.<sup>3</sup> a) The dehydrated products have less weight and bulk and therefore storage, shipping, and packaging costs are reduced. b) Larger fruits and vegetable pieces are rehydrated? More easily, better, and faster.

Each of these two new processing techniques (dehydrofreezing and the explosive-puffing process) yield products which might be adaptable for use in many types of blueberry products: i.e., for use in pies, muffins, muffin and pancake mixes, tarts, jellies and jams, etc. However, each of the test products were produced under laboratory conditions and only limited quantities of products were available. Therefore, each new product type was primarily tested against standard products in only one final-use form. The quick-cooking dehydrated blueberries from the explosive-puffing process were tested against canned ones in blueberry muffin form and the dehydrofrozen ones were tested against normally frozen blueberries in pie form.

Dehydrofrozen blueberry samples were prepared by Dr. Clifford Bedford, Department of Food Science, Michigan State University, and quick-cooking dehydrated blueberry samples by Eastern Utilization Research and Development Division, USDA, Philadelphia, Pennsylvania. The blueberry muffins were baked by the Department of Home Economics, Michigan State University and the pies by a commercial bakery in Detroit.

<sup>3</sup> The process is referred to as "explosive-puffing process" while the processed product as "quick-cooking."

## The Consumer Panel

The consumer preference tests were conducted through the Michigan State University consumer preference panel in Detroit. Both the selection and composition of the consumer panel members and the methodologies employed in consumer preference and triangle tests have been described in previous reports (16, 10, 9). The consumers were chosen at random from the Detroit telephone directory. The members of the panel were consumers with annual income ranging from \$4,000 to \$10,000, of ages 30 to 45, and with 12 to 13 years of formal education. A subsample of 120 to 180 consumers from the above selected consumers composed the Michigan State University consumer panels for the tests of blueberry products.

### Experimental Procedure and Results

#### Test I. Dehydrofrozen Blueberry Pies — A Rank Test

Consumer preference tests were conducted among samples of blueberry pies made from normally frozen and dehydrofrozen blueberries.

The pie fillings were prepared by simmering dehydrofrozen blueberries in water and adding a commercial recipe of sugar, cornstarch, salt, lemon juice, and butter. Pie fillings, about 20 ounces each, were placed in 9-inch aluminum pans and covered with pie crust. The pies were wrapped in aluminum foil, frozen, stored and subsequently baked before each consumer preference panel test was to be conducted.

The four types of blueberries which were used in the preparation of the pie fillings were processed and treated as follows:

1) for control, the blueberries were frozen in a normal fashion.

2) for dehydrofrozen control, the blueberries were dried at 160°F to 50 percent of their original weight and volume and then were frozen at -5°F.

3) for dehydrofrozen nicked,<sup>4</sup> the blueberries were rolled over a plate, under slight pressure with razor sharp triangular blades protruding sufficiently high to cut through the skin. After this treatment, the berries were dried to 50 percent of their original weight and volume and then frozen at -5°F.

4) for the dehydrofrozen pricked, the blueberries were rolled over a needle board so that the pin size holes were made in the skin. After this treatment, the berries were dried to 50 percent of their original weight and volume and then frozen at -5°F.

In the first test, consumers ranked coded samples of each type of blueberry pie according to preference from 1, highest, to 4, lowest. The consumers were not asked the reasons for their preference. Panel members were served 1/8 of a 9-inch pie from each type.

<sup>4</sup> The "nicking" and "pricking" treatments were designed to alleviate "skin toughness" problems sometimes associated with frozen blueberries.

Of the 146 consumers, 64 percent gave first preference to the pie made of normally frozen blueberries; dehydrofrozen control, 8 percent; dehydrofrozen nicked, 14 percent; and dehydrofrozen pricked, 14 percent (Table 1).

A statistical analysis of results of the ranking test indicated a highly significant agreement among consumers that there was a difference in preference for pies. Pies made from normally frozen blueberries were significantly preferred over pies made from dehydrofrozen control blueberries, dehydrofrozen nicked, and dehydrofrozen pricked blueberries. There were no significant preferences among any other comparisons.

### Test II. Dehydrofrozen Blueberry Pies — A Triangle Test

A blueberry pie triangle test was conducted on Feb. 19, 1963 to confirm that there was no significant difference in the preference between the dehydrofrozen control and dehydrofrozen pricked blueberry pies. With the triangle test method, each panel member was given three samples, two of which were identical and one "different." The consumers were asked to pick out the "different" samples.

TABLE 1 — CONSUMER PANEL PREFERENCE RANKING OF PIES MADE FROM NORMALLY FROZEN, UNTREATED DEHYDROFROZEN, AND PRETREATED DEHYDROFROZEN BLUEBERRY PIE FILLINGS, 145 CONSUMERS, DETROIT, MICHIGAN, NOV. 14, 1962<sup>a</sup>

Type of Pie	Number of times ranked				Total
	First	Second	Third	Fourth	
Control (normally frozen) <sup>b</sup>	94	25	13	13	145
Dehydrofrozen control	12	53	39	41	145
Dehydrofrozen nicked	20	39	51	35	145
Dehydrofrozen pricked	20	37	40	48	145
Totals	146	154	143	137	

<sup>a</sup> Source: (15).

<sup>b</sup> Significant differences in ranking at the 1 per cent level. The odds are 99 to 1 that the differences in ranking were not due to chance.

Of the 139 consumers testing dehydrofrozen control and dehydrofrozen pricked blueberry pie fillings in the triangle test, 70 consumers or about 50 percent were able to differentiate between the two products (Table 2). This indicated that there were distinguishable differences between pies made from the two pie fillings.

Of the 68 consumers who were able to differentiate pies made from the two mixes, 52 percent preferred the pies made from dehydrofrozen pricked pie fillings. This difference in preference was not significant.

The blueberry pie triangle test confirmed that there was no significant difference in the preference.

### Test III. Quick-Cooking Blueberries in Muffins

Cultivated blueberries were processed by the explosive-puffing process by the Eastern Regional Re-

TABLE 2 — TRIANGLE TEST OF BLUEBERRY PIES MADE FROM DEHYDROFROZEN CONTROL AND DEHYDROFROZEN PRICKED BLUEBERRY PIE FILLINGS, 139 CONSUMERS, DETROIT, MICHIGAN, FEBRUARY 19, 1963<sup>a, b</sup>

Total consumers participating	139
could not differentiate products	69
correctly differentiated between products	70 <sup>(c)</sup>
preference for dehydrofrozen pricked	36 <sup>N.S.</sup>
preference for dehydrofrozen control	32 <sup>N.S.</sup>
total correctly differentiating	68 <sup>(d)</sup>

<sup>a</sup> Source: (19).

<sup>b</sup> Source: (20).

<sup>N.S.</sup> Non-significant at the 1 per cent level.

<sup>c</sup> Consumer discernment of differences significant at the 1 per cent level.

<sup>d</sup> Of the 70 consumers who were able to differentiate correctly between the two pies, two consumers did not answer the second question.

search and Development Division of the U.S.D.A. at Philadelphia, and the dehydrated quick-cooking blueberries were packaged in sealed cans. Blueberry muffins using quick-cooking blueberries and normally canned blueberries were subsequently prepared by the Home Economics Department of Michigan State University using comparable quantities of blueberries in each muffin. The dehydrated quick-cooking blueberries were simmered, i.e. gently boiled, one to two minutes in water, then drained and rinsed and added to the batter. The muffins were baked, sealed in aluminum foil and frozen. The frozen muffins were subsequently thawed before being served to the consumer preference panel.

On Nov. 14, 1962, a triangle test of the muffins made from quick-cooking blueberries and canned blueberries was conducted with the consumer preference panel. In general, the same methods were used as in the previously reported triangle test with the dehydrofrozen pies. Each consumer was served 3 halves of blueberry muffins, two of which were identical and one which was "different." The consumer was asked to identify the different sample and to indicate which was preferred.

Of the 156 consumers testing (both visually and by tasting) quick-cooking blueberry muffins and canned blueberry muffins in the triangle test, 99 consumers or 63 percent were able to differentiate correctly the two products (Table 3). This indicates that there were distinguishable differences between muffins made by the two methods.

TABLE 3 — TRIANGLE TEST OF MUFFINS MADE FROM QUICK-COOKING DEHYDRATED AND ORDINARY CANNED BLUEBERRIES, 156 CONSUMERS, DETROIT, MICHIGAN, NOV. 14, 1962<sup>a</sup>

Total consumers participating	156
could not differentiate products	57
correctly differentiated between products	99 <sup>b</sup>
preference for quick-cooking blueberry muffins	40 <sup>N.S.</sup>
preference for canned blueberry muffins	59 <sup>N.S.</sup>
Total correctly differentiating	99

<sup>a</sup> Source: (20).

<sup>b</sup> Consumer discernment of differences significant at the 1 per cent level.

<sup>N.S.</sup> Differences in preference were not significant at the 1 per cent level.

Of the 99 consumers who were able to differentiate muffins made from the two mixes, 59 preferred the muffin made from canned blueberries and 40 the quick-cooking blueberries. This difference in preference was not quite significant and could have been due to chance alone.

#### Test IV. Quick-Cooking Blueberry Muffins

The muffin triangle test was repeated on Feb. 19, 1963. The same methods were employed as those in the previous tests. The results were nearly identical to the first test. A significant number of consumers, 101 out of 147, were able to differentiate between the two types of muffins (Table 4). Of the 101 consumers who were able to differentiate muffins made from the two mixes about 55 percent preferred the muffins made from canned blueberries. This difference in preference was not significant.

#### Summary and Conclusions

The feasibility of two new processing methods for blueberries (dehydrofreezing and the explosive-puffing process) were tested by determining consumer preference panel acceptability of two new product forms. Dehydrofrozen blueberries were compared to normally frozen blueberries in pie form and quick-cooking blueberries produced by the explosive-puffing process were compared to canned blueberries in blueberry muffin form.

The tests reported here are to be considered as preliminary tests only. The test products were produced under laboratory or pilot-plant type conditions. Only a limited number of test runs of each process were conducted, and it was the first season on which either of the new processing technologies was tried on blueberries.

Normally frozen blueberries were compared to dehydrofrozen control (no pretreatment), dehydrofrozen pricked, and dehydrofrozen nicked blueberries in pie form. The consumer preference tests indicated a highly significant preference for normally frozen blueberry pies over both the dehydrofrozen control and the pretreated dehydrofrozen blueberries, but no significant differences between the control dehydrofrozen and pretreated dehydrofrozen blueberries in pie form.

In a triangle test comparing pies from the dehydrofrozen control to dehydrofrozen pricked blueberries, the discernment of differences was significant but the preferences between the two forms were not significant.

The dehydrofrozen blueberry pies were not as acceptable as normally frozen blueberries. It is not known whether this was due to the technology or to the recipe of the pies. However, the success of dehydrofrozen apples<sup>5</sup> and the savings in packaging,

TABLE 4 — TRIANGLE TEST OF MUFFINS MADE FROM QUICK-COOKING AND ORDINARY CANNED BLUEBERRY MUFFINS, 147 CONSUMERS, DETROIT, MICHIGAN, FEB. 19, 1963<sup>a</sup>

Total consumers participating	147
could not differentiate products	44
correctly differentiated between products	103 <sup>b</sup>
preference for quick-cooking blueberry mix	44 <sup>N.S.</sup>
preference for canned blueberry mix	57 <sup>N.S.</sup>
	<hr/> 101 <sup>c</sup>

<sup>a</sup> Source: (20).

<sup>b</sup> Highly significant differentiation.

<sup>N.S.</sup> Non-significant differences at the 1 per cent level.

<sup>c</sup> Of 103 consumers who were able to differentiate correctly between the two muffin mixes two (2) consumers did not answer the second question.

storage and distribution costs would suggest that work on the dehydrofreezing process be continued.

In the two triangle tests, comparing muffins made from quick-cooking and ordinary canned blueberries, there was a significant discernment of differences but a nonsignificant preference. Thus under the conditions of the test, the quick-cooking blueberries prepared by the explosive-puffing process were as acceptable as the normally canned blueberries in muffin form. These tests are only initial steps in determining the feasibility of using blueberry products from these two new processing technologies. The dehydrofrozen blueberries should be retested in pies after more exacting reconstitution procedures and recipes are developed. Similarly, both products should be tested in many use forms. Further, costs of alternative processing and distribution methods should be developed as well as more exhaustive market tests before either new processing method could be recommended for blueberries.

#### Supplemental Statistics: Trends in Production, Consumption, and Utilization

Utilization and per capita consumption of blueberries have changed substantially in the last 12 years.

The total volume of blueberries processed increased from about 27 million pounds in 1950 to 48.5 million pounds in 1962, a per capita increase from .25 to .32 pounds per year. In the same period, canned blueberries declined 18 percent, and frozen blueberries increased 142 percent. Large scale canning of blueberries in pie filling form began in 1955. The volume of canned pie fillings increased from about 5.2 million pounds in 1955 to about 8.8 million pounds in 1962, a 70 percent increase.<sup>6</sup>

Consumption of blueberries is proportionately much higher in regions close to production areas. Between 1952 and 1956, the average per capita consumption of fresh blueberries in Michigan amounted to .82

<sup>5</sup> At least 8 processing plants in New York State are dehydrofreezing apples. See (9). See also, "Market Potentials for Dehydrofrozen and Dehydrocanned Apple Slices," Ag. Econ. mimeo 801, Sept. 1960, by W. S. Greig and Noel W. Stuckman.

<sup>6</sup> Computed from blueberry processing data furnished by the National Association of Frozen Food Packers and National Cannery Association.

TABLE 5 — TOTAL PRODUCTION AND PROCESSING OF U. S. BLUEBERRIES (1959-1962)

Year	Total production (000) (lbs.)	Total processed		Frozen <sup>c</sup>		Canned <sup>d</sup>		Canned <sup>e</sup> Pie Filling		Fresh	
		(000) (lbs.)	% of Total Crops	(000) (lbs.)	% of Total Crops	(000) (lbs.)	% of Total Crops	(000) (lbs.)	% of Total Crops	(000) (lbs.)	% of Total Crops
1959	49,002 <sup>a</sup>	37,465	76.4	16,400	33.4	12,566	25.6	8,499	17.4	11,557	23.6
1960	75,573 <sup>b</sup>	44,528	58.9	25,230	33.4	10,999	14.5	8,299	11.0	31,045	41.1
1961	68,512 <sup>b</sup>	43,089	62.8	21,990	32.0	12,433	18.2	8,666	12.6	25,423	37.2
1962	75,437 <sup>b</sup>	48,551	64.3	26,452	35.0	13,233	17.6	8,866	11.7	26,886	35.7
4-Year Average	67,136	43,408	64.7	22,518	33.5	12,307	18.4	8,582	12.8	23,728	35.3

<sup>a</sup> 1959 production data from U. S. Bureau of the Census, U. S. Census of Agriculture.

<sup>b</sup> 1960-1962 production data from estimates of Michigan Blueberry Growers Association.

<sup>c</sup> Bureau of the Census.

<sup>d</sup> Source (1).

pounds; commercially processed pies, .6 pounds; canned, .35 pounds; and frozen, .04 pounds (7) a total of 1.81 pounds per capita compared to a national average of approximately 0.4 pounds.

During the period 1959 to 1962, approximately 35 percent of the U. S. blueberry crop (23.7 million pounds per year) was used in fresh form, while 65 percent (43.4 million pounds per year) was used in processed form. Of the 43.4 million pounds processed, about 52 percent was frozen, 28 percent canned, and 20 percent was used as canned pie fillings (see Table 5).

Over 90 percent of the U.S. blueberry crop is produced in 5 states; Maine, New Jersey, Michigan, North Carolina, and Washington (Table 6). Considerable quantities are also produced in Canada. Most of the blueberries grown in Maine and Canada are "wild" blueberries while those grown in Michigan and New Jersey are "cultivated" blueberries. Most of the wild berries, which are normally of smaller size, are processed, while a larger proportion of the tame or cultivated berries are marketed fresh. During 1960-1962, approximately 99 percent of the Maine crop was processed, while only 55 percent of the Michigan crop and 33 percent of the New Jersey crop was processed. Practically all of the U. S. imports of Canadian blueberries are processed forms of wild blueberries.

The proportion of the blueberry crop processed in Michigan has remained more or less stable at approximately 50 to 55 percent of the crop. In New Jersey the proportion processed decreased from 39 percent in 1960 to 28 percent in 1962.

Wild blueberries (Maine) as a proportion of the total U. S. crop has been decreasing, from 53 percent in 1949 to around 31 percent in 1959. Michigan production of cultivated berries increased from 6.7 percent of the total crop in 1949 to 24 percent in 1959.

Blueberries sold in fresh form are principally cultivated blueberries from Michigan, New Jersey, and North Carolina. These three states supply about 95 percent of the blueberries going to fresh market. Consumption of fresh blueberries is concentrated near the point of production. Over 80 percent of the unloads of fresh blueberries were reported, in or near these states, in the 5 cities, New York, Boston, Philadelphia, Detroit, and Chicago, and 95 percent in these and 5 additional cities (Table 7).

Large quantities of blueberries are consumed in bakery-produced pie form. During the period 1953 to 1957, about 37 percent of families in Michigan purchased commercially prepared apple and cherry pies, while only 22.4 percent of families bought commercially prepared blueberry pies (8). On the average, apple and cherry pies accounted for 65.6 percent of

TABLE 6 — BLUEBERRY PRODUCTION OF 5 STATES, SELECTED YEARS

State	1929 <sup>a</sup>		1939 <sup>a</sup>		1949 <sup>a</sup>		1954 <sup>a</sup>	
	Pounds	% of total	Pounds	% of total	Pounds	% of total	Pounds	% of total
United States	7,417,306	100.00	13,301,086	100.00	24,074,953	100.00	45,964,653	100.00
Maine	5,716,209	77.00	8,608,530	64.72	13,332,442	53.37	17,223,946	37.50
New Jersey	274,281	3.70	1,103,929	8.30	6,790,462	28.00	13,060,462	28.40
Michigan	300,705	4.00	1,047,667	7.80	1,629,781	6.70	10,106,265	22.00
North Carolina	165	.002	174,484	2.00	501,799	2.00	1,578,547	3.40
Washington	2,400	.03	63,142	.50	672,535	2.80	815,812	1.80
5 State total	6,294,460	84.732	10,997,752	83.32	22,927,019	92.87	42,785,032	92.70

  

State	1959 <sup>a</sup>		1960 <sup>b</sup>		1961 <sup>b</sup>		1962 <sup>b</sup>	
	Pounds	% of total	Pounds	% of total	Pounds	% of total	Pounds	% of total
United States	49,022,851	100.00	75,573,577	100.00	68,512,735	100.00	75,437,563	100.00
Maine	15,168,658	31.00	21,336,422	28.00	25,550,157	37.29	30,282,017	40.00
New Jersey	12,648,690	25.80	25,410,000	33.00	16,214,000	23.66	18,216,000	24.10
Michigan	11,839,407	24.00	21,426,155	28.00	18,583,578	27.12	18,294,446	24.25
North Carolina	3,244,665	6.60	4,895,000	6.00	5,170,000	7.54	5,995,000	8.00
Washington	2,828,022	5.80	2,875,000	3.00	2,995,000	4.37	2,650,000	3.00
5 State total	45,729,442	93.20	75,942,577	98.00	68,512,735	99.98	75,437,563	99.35

<sup>a</sup> Data from 1929 to 1959 were obtained from Census of Agriculture, Bureau of Census.

<sup>b</sup> Data from 1960 to 1962 were obtained from estimates of the Blueberry Growers Association of Michigan. It includes only 5 states listed above.

TABLE 7 — FRESH BLUEBERRY UNLOADS REPORTED IN 18 TERMINAL CITY AREAS, 1957 - 1962

City	CARLOT EQUIVALENT <sup>c</sup>					
	1957 <sup>a</sup>	1958 <sup>a</sup>	1959 <sup>a</sup>	1960 <sup>b</sup>	1961 <sup>b</sup>	1962 <sup>b</sup>
New York/Newark	472 <sup>d</sup>	529	445	703	559	609
Boston	145	156	151	178	184	115
Philadelphia	117	136	119	173	141	171
Detroit	126	110	81	109	98	109
Chicago	103	130	99	123	124	142
Total of 5 Cities	963	1,061	895	1,286	1,106	1,146
% of Total	89.41	87.18	85.4	86.83	84.17	82.03
Cleveland	31	36	34	48	41	45
St. Paul, Minn.	29	34	33	42	46	58
Baltimore	19	28	22	36	36	42
Washington, D. C.	2	22	27	27	31	29
Cincinnati	16	14	10	20	18	21
Total of 10 Cities	1,060	1,195	1,021	1,459	1,278	1,341
% of Total	98.42	98.19	97.42	98.57	97.26	95.99
8 Other Cities <sup>e</sup>	17	22	27	22	36	52
Total	1,077	1,217	1,048	1,481	1,314	1,397
	100.00	100.00	100.00	100.00	100.00	100.00

<sup>a</sup> Source: (17, p. 26).

<sup>b</sup> Source: (24).

<sup>c</sup> Carlot is considered equivalent to 1400 - 12 pint berry crates.

<sup>d</sup> Excludes Newark.

<sup>e</sup> Atlanta, Birmingham, Dallas, Los Angeles, New Orleans, Pittsburgh, Portland, Oregon, and San Francisco.

all fruit pies purchased by each person in Michigan, while blueberry pies accounted for a little over 10 percent (8, p. 494). In 1957, 82 percent of Michigan families bought no blueberry pies, 12 percent purchased blueberry pies once, and only 4 percent bought pies three or more times (8, p. 497).

The prices of all types of fruit pies averaged 38 cents per pound. The price of blueberry pies was consistently above the prices of other fruit pies, averaging 42 cents per pound between 1953 and 1957 (8, p. 496). Based on the average price and quantity purchased, a 10 percent change in the average price of fruit pies was associated with about a 21 percent change (in the opposite direction) in the quantity consumed (8, p. 497). Thus, if the prices of blueberry pies could be reduced to a price comparable to other fruit pies such as cherry and apple pies, it is likely that blueberry pie purchases would increase.

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