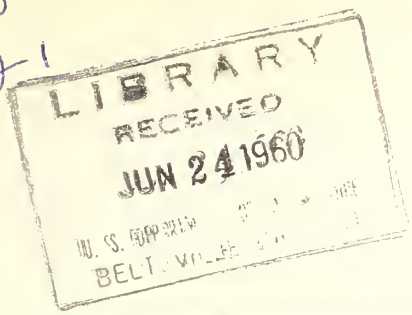

CONSUMER PREFERENCES AMONG

PULP-FORTIFIED and UNFORTIFIED GRAPEFRUIT JUICES

FROM RED AND WHITE FRUIT

MARKETING RESEARCH REPORT NO. 398

P R E F A C E

The study on which this report is based is one of a series of consumer preference studies made to determine the qualities and characteristics of agricultural products which appeal most to consumers, so as to expand markets for such products.

Difficulties have been encountered with the appearance of juice from red grapefruit processed in the usual manner. A way to eliminate the discoloration was developed, and it became necessary to learn whether consumers would like the new kind of juice. This survey was made to provide an answer to that question.

The study was conducted under the general supervision of Trienah Meyers of the Market Development Research Division, Agricultural Marketing Service.

F. P. Griffiths, of the Fruit and Vegetable Products Laboratory of the Southern Utilization Research and Development Division, Agricultural Research Service, provided technical advice and assistance in planning and research.

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Washington, D. C. May 1960

SUMMARY

Under certain conditions of storage, a discoloration of canned red grapefruit juice occurs. A solution to this problem has been developed by the Agricultural Research Service; the appearance of the juice is preserved by fortifying it with pulp during the canning process. Production of red grapefruit juice is increasing, and information is needed on consumers' acceptance of fortified juices. If consumers react favorably, market outlets for red grapefruit might be broadened, more juice could be obtained from a given quantity of fruit, and consumers would receive a product which may be slightly more nutritious.

This report presents the results of a study to measure the preferences of consumers among four juices: Pulp-fortified and unfortified juices, from red and white varieties of Texas grapefruit.

The juices were delivered, one juice a week for 4 weeks, to a panel of consumer households in a midwestern market. Panel members expressed their evaluation of each juice on a nine-point preference scale. Information on the reasons for the expressed preferences was obtained by personal interviews with the homemakers, after the ratings were made.

The study indicated a slight preference by consumers for juice from the white rather than the red variety of grapefruit. There is no indication that fortification with pulp enhances or detracts from the appeal of either juice when discoloration resulting from storage is not a problem.

Replies to the questions asked during the interview indicate that the juice from red grapefruit is at no serious disadvantage in competition with that from other grapefruit. All the juices used in the experiment were relatively tart. About one-fourth of the homemakers liked the tartness of each juice, but about half felt that all were too tart.

The study showed that the red fortified juice is reasonably acceptable to consumers. Prolonging the shelf life by fortification seems to be commercially feasible. However, it appears that a naturally sweeter or a sweetened juice might be more popular than the juices used in this test.

CONSUMER PREFERENCES AMONG PULP-FORTIFIED AND UNFORTIFIED GRAPEFRUIT JUICES FROM RED AND WHITE FRUIT

By J. Scott Hunter, project director,
Market Development Research Division

I N T R O D U C T I O N

Red varieties of grapefruit, when processed by conventional methods, yield a canned juice which has a gray tinge; also, under certain conditions of storage, a discoloration occurs, producing a dull or "muddy" appearance. This problem was solved by the Southern Utilization Research and Development Division, Agricultural Research Service, which developed a process that preserves the appearance of the fresh juice by fortification of juice with pulp during the canning process.

For producers of red grapefruit, a successful canning process would provide a new sales outlet. For processors, fortification with pulp reduces waste and increases the amount of juice obtained from a ton of fruit by as much as 7 percent. For consumers, fortification may provide a slightly more nutritious drink because of increased content of solids and provitamin A (B-carotene). Furthermore, some feel that fortification enhances the appeal of the juice because it deepens the color slightly.

This report presents the results of a study undertaken to measure consumers' relative satisfaction with fortified red grapefruit juice, unfortified red grapefruit juice, and fortified and unfortified juices from white grapefruit. All the fruit was produced in Texas.

TEST PROCEDURES

This study was conducted with a panel of 192 households in Des Moines, Iowa, during June 1959. The research was designed to show whether consumers preferred juice from red or white grapefruit, 1/ whether they preferred fortified or unfortified juice, and whether the preferences were the same in households which normally use grapefruit juice as in households which do not.

The four juices were delivered to the participating households, one at a time, for 4 successive weeks. To provide members of the panel households with a means of expressing their opinions of the products, a nine-point "hedonic" rating scale was used. Each point on the scale was labeled to indicate a degree of liking or disliking for the juice being rated (fig. 1). Ratings were made by all members of the panel households 16 years old and over.

In the analysis of results, the points on the scale were assigned values of 1 at the bottom up to 9 at the top, and average scores were computed from the ratings of the participants in each household.

Information on the homemakers' reasons for liking or disliking each juice was obtained each week at the time the scales were collected. Homemakers were asked also whether the younger members of the family who did not actually participate in the study seemed to like or dislike the juice the family was testing.

Of the 192 households originally recruited to take part in the study, 183 cooperated throughout the 4 weeks, and the other 9 cooperated for part of the study. Since the 4 test juices were rated by all adult members of the participating households, the report is based on a total of 1,540 ratings.

1/ The juice from grapefruit with white pulp was a pale yellow, while juice from grapefruit with red pulp was a pale orange.

RESULTS

The Preference Scores

As the mean preference scores in the following tabulation show, there was a slight tendency for consumers to prefer the juice of the more familiar white variety of grapefruit to the juice of the less commonplace red variety:

Juice	Mean score
Red unfortified	6.01
White unfortified	6.38
Red fortified	6.03
White fortified	6.32
Both red	6.02
Both white	6.35
Both fortified	6.18
Both unfortified	6.19

Whether the juice was fortified or unfortified, the mean scores for juice from white grapefruit were slightly higher than those for juice from red grapefruit. These differences are significant at the 5 percent level (table 1). These data also show that fortification with pulp does not appear to affect consumer satisfaction with grapefruit juice.

Similar results are obtained when the preference scores of those who ordinarily use and those who ordinarily do not use grapefruit juice are examined separately:

Juice	USERS	NONUSERS
	Mean score	Mean score
Red unfortified	6.27	5.75
White unfortified	6.71	6.06
Red fortified	6.27	5.79
White fortified	6.60	6.05
Both red	6.27	5.77
Both white	6.65	6.05
Both fortified	6.44	5.92
Both unfortified	6.49	5.90

Users of grapefruit juice tended to rate all the juices a little higher than did nonusers, but in both groups the expressed preference favored the white grapefruit juice, and in neither group was the preference rating increased by the addition of pulp.

The difference between the mean preference scores of users and nonusers of grapefruit juice is significant at the 1 percent level (table 1).

Reasons for Preferences

When the ratings were collected, homemakers were interviewed about their satisfactions or dissatisfactions with the juice they had just scored. The first question was, "What did you think of the juice I left last week?" The replies to this question have been analyzed two ways: (1) By color of the juice, regardless of fortification or nonfortification, and (2) by fortification or nonfortification of the juice, regardless of color.

The answers of respondents indicate that, despite the slightly higher preference score given the juice of white grapefruit, juice from the red variety is not seriously handicapped in competition with the white. The reasons for liking or disliking the four juices merely reflect the wide variation in consumer tastes. Nearly equal proportions expressed a liking for the flavor and consistency of red, white, fortified, and unfortified juice; and similarly, nearly equal proportions expressed a dislike for these characteristics of each type of juice. For example, about one-fourth of the homemakers expressed approval of the tartness of each type of juice, and about half felt that all were too tart. Color was the one characteristic about which larger proportions of homemakers expressed approval of the red and fortified juices than of the white and unfortified juices. Nevertheless, a few liked the color of the white and unfortified juices, and some complained that the red and fortified juices were not clear (tables 2 and 3).

Another question used to obtain an estimate of consumer satisfaction with the test juices was, "If grapefruit juice like this were sold in stores where you shop, do you think you would serve it to your family from time to time?" In reply, majorities of the homemakers who were already users of grapefruit juice said they would be willing to buy each juice, and substantial proportions of the nonusers of grapefruit juice were equally well satisfied (table 4). A majority of the homemakers who said they would not care to purchase the juice cited "too sour" as the reason; 19 users out of 26, and 23 nonusers out of 40, gave this response.

Furthermore, most of the homemakers who were willing to buy each juice felt that they would be willing to pay a little more for that juice than for other kinds of grapefruit juice. They were asked, "Would you buy it even if it cost a little more than other grapefruit juice?" Approximately four-fifths of the homemakers who were willing to buy the juice they were rating (about half of those who participated in the study) said they would be willing to pay a little more (table 5).

All of the juices also appeared to be about equally acceptable to younger children. In households where there were children under 16 years old, homemakers were asked, "Did the younger members of the family who didn't use the rating scale seem to like it (the juice I left last week)?" In from 4 to 5 households out of 10, the homemakers said that the children seemed to like each juice (table 6). Although not to a statistically significant degree, children seemed to favor the white juice, as did the adults.

These results indicate that all four of the juices tested satisfy the preferences of some segment of the consumer market. However, about 4 in 10 of the users of grapefruit juice interviewed said they preferred sweetened rather than unsweetened grapefruit juice. As noted above, about half of the participants in the preference study reported that they considered all of the juices too tart; and previous research conducted by the Department suggests that grapefruit juice with a Brix-acid ratio of 9 or higher, and at 10 degrees Brix, is more acceptable to consumers than the juices used in this study, which had a Brix-acid ratio of about 7.8 with about 9 degrees Brix. 2/ It seems likely, therefore, that a naturally sweeter or a sweetened juice would be more popular with many consumers than the juices used in this test, and that one possibility for expanding consumption of red grapefruit juice lies in marketing a sweeter juice in addition to the tart juice.

2/ Bell, Hugh P., Preferences for Canned Grapefruit Juices. Mkt. Res. Rpt. No. 108, U. S. Dept. Agr., Dec. 1955.

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APPENDIX

The Sample Design

The study was conducted with a panel of consumer households in Des Moines, Iowa, during June 1959. A sample of 24 clusters was selected by area probability sampling techniques, and within each cluster, 8 households were recruited to participate in the study. All households were eligible for selection except those in which (1) there were no facilities for refrigerating foods, (2) a language difficulty or educational handicap prevented the homemaker from understanding the rating procedure, or (3) the homemaker was unwilling to agree to participate throughout the 4 weeks of the study.

Although only eight households in each cluster were needed for the study, homemakers in four nonparticipating households also were interviewed to obtain a sample on which to base estimates of the characteristics of the population studied. Interviews were completed in approximately two-thirds of the sample households.

The 192 households whose members participated in the study were representative of a wide range of social and economic characteristics. The sample included consumers from the young, middle, and older age groups, and from upper and lower income groups, and consumers with differing educational backgrounds. These characteristics of the participants, moreover, were not very different in any important respects from the characteristics of the 71 households in the sample which did not participate (table 10).

The reasons for not cooperating, given by the nonparticipants who were interviewed, were such as to suggest that their loss from the sample had no important effect on the outcome of the study. About one-third did not expect to be at home continuously during the 4 weeks of the study; another third would not or, for health reasons, could not drink grapefruit juice. The only other important reason for nonparticipation, involving about 2 households in 10, was the exclusion of households because the quotas of users or nonusers of grapefruit juice in the preceding year were already filled for some clusters.

Household Use of Selected Citrus Juices

The interviews conducted with the sample of homemakers (both participants and nonparticipants) included a few questions regarding use of grapefruit and competing citrus juices during the preceding year.

Grapefruit juice, either canned or frozen, was served in about half the households. Use appears to be related to the age and education of the homemaker. Slightly higher proportions of homemakers in the older age groups and at the lower educational levels reported that they had served grapefruit juice in their homes in the year preceding the survey (table 7).

Generally speaking, adults drank more grapefruit juice than children, and in nearly all households the homemakers' own preference or the wishes of another adult were the primary influence on the decision whether to buy grapefruit juice.

About two-thirds of the nonusers indicated they had not served grapefruit juice to their families in recent years. Among the remaining third, who had served grapefruit juice in recent years, the predominant reasons for no longer serving it were objections to the taste or a preference for the fresh juice or for another juice (table 8).

Only frozen orange juice, served in 7 households in 10, and canned orange juice, served in 5 households in 10, were more widely used than canned grapefruit juice, served in 4 households in 10, among the group studied. Canned grapefruit juice blended with orange juice was served in about 2 households in 10, and frozen grapefruit juice and frozen blends of it with orange and with pineapple were served in about 1 household in 10 (table 9).

The Juices Used

The test juices were delivered to participating households in cans of No. 2 size, with labels that were identical except for a coded serial number indicating which of the four juices was being rated. The juices were provided by the Fruit and Vegetable Products Laboratory of the Southern Utilization Research and Development Division, Agricultural Research Service. They were prepared on a semi-commercial scale in March 1959 in the plant of a Texas canning company. For details on methods of fortifying juice with pulp, see "Production of Canned Pulp-Fortified Red Grapefruit Juice," ARS 72-12, by Lime, Stephens, and Griffiths, issued by the U. S. Department of Agriculture.

The chemical characteristics of the juices used in this study were as follows:

Type of juice	Percent acid	Degrees Brix	Brix-acid ratio	Percent suspended solids
White fortified	1.14	8.8	7.7	14.5
White unfortified	1.15	9.0	7.8	7.5
Red fortified	1.18	9.2	7.8	10.0
Red unfortified	1.15	9.0	7.8	8.0

The Experimental Design

This study was designed to provide tests of the three following hypotheses: (1) The juices of the red and white varieties of grapefruit are equally acceptable to consumers, (2) the fortified and the unfortified juices are equally acceptable, and (3) the opinions about the test juices of both users and nonusers of grapefruit juice are equally favorable.

Since two variables (juice from the red and from the white varieties of grapefruit) were varied in two ways (fortification and nonfortification), the study was factorial in design. This design was combined with a systematic Latin square to minimize the effects of order of presentation. To provide a test of the third hypothesis, a replication of the study was conducted with a panel of households in which grapefruit juice is normally served and another with a panel of households in which grapefruit juice is not normally served.

To determine the order in which the juices were to be presented to the individual households during the 4 weeks of the study, each household was randomly assigned to one of the four groups shown below. This procedure was followed for users and nonusers separately. "A" represents the red pulp fortified juice, "B" the red unfortified, "C" the white fortified, and "D" the white unfortified.

Order of presentation

	Group number —			
	I	II	III	IV
First week	A	B	C	D
Second week	B	D	A	C
Third week	C	A	D	B
Fourth week	D	C	B	A

All the juices were thus rated in all households and each juice followed every other juice an equal number of items. For example, from inspection of the diagram it can be seen that juice A was presented first in one-fourth of the households (group I); it followed juice B in one-fourth of the households (group IV), juice C in one-fourth of the households (group III), and juice D in one-fourth of the households (group II). Since ratings were made by all members of the panel households who were 16 years old and over, the report is based on a total of 1,540 ratings of the test juices.

Reliability and Validity of the Preference Ratings

The preference rating scale used was selected on the basis of the results of a pretest conducted to determine the reproducibility of the ratings when juices of similar quality are judged, and the sensitivity of the scale when juices of dissimilar quality are judged. In this test, the results obtained

from the use of two different scales were compared. The first (scale I, shown in fig. 1) was a nine-point scale with each point labeled to represent a degree of liking or disliking. The second scale (scale II) had 10 points and was labeled only with the terms "Like extremely" at the top and "Dislike extremely" at the bottom.

The materials used in the pretest of the scales were a high-quality frozen and a low-quality canned orange juice. A panel of 100 employees of the U. S. Department of Agriculture was enlisted to taste and rate the juices on two afternoons, a week apart. Each employee was randomly assigned to one of the experimental conditions shown in the following diagram. This procedure was followed for Scale I and Scale II separately. The letter A represents the frozen juice and B the canned:

First week	A B A B
Second week	A B B A

In analyzing the results, the points on the scale were labeled from 1 at the bottom to 9 at the top (10 in scale II) and mean scores were computed for each juice.

Reliability.--Results of the pretest show that both scales provide a means of obtaining stable, reproducible expressions of group opinions of the juices being rated. The reliability of the ratings of individual judges obtained with scale I, however, was greater than that obtained with scale II; there was a smaller standard error of estimate with scale I (1.1 scale points) than with scale II (2.1 scale points).

Validity.--Pretest results also show that the two scales are equally sensitive to the difference in quality of the juices; the mean preference scores obtained for each juice with the two scales were almost identical. However, the pooled variances of the scores obtained with scale I were less than half the magnitude of the pooled variances of the scores obtained with scale II.

Thus, although the mean scores obtained with the two scales were similar, scale I was superior in reproducibility of results and in the size of the estimate of experimental error.

Rating Scale

From the rating scale you will see that your opinion of this juice may be expressed anywhere from "Dislike extremely" up through "Like extremely." Put an "X" in the one block that best expresses your opinion of this juice.

☐	Like extremely
☐	Like very much
☐	Like moderately
☐	Like slightly
☐	Neither like nor dislike
☐	Dislike slightly
☐	Dislike moderately
☐	Dislike very much
☐	Dislike extremely

Figure 1. -- Scale I, used in the study

TABLES

Table 1.--Analysis of variance of preference scores for fortified and unfortified red and white grapefruit juice

Source of variation	Degrees of freedom	Sums of squares	Mean squares	F
Varieties ----------	1	20.74	20.74	5.65 *
Fortification ----------	1	.05	.05	--
Use - nonuse ----------	1	55.91	55.91	15.23**
Interaction of fortification	1	.94	.94	--
Experimental error ---------	734	2,697.27	3.67	--
Total ----------	741	2,774.91	--	--

* Significant at the 5 percent level.
** Significant at the 1 percent level.

Table 2.--Favorable comments by participating homemakers on fortified and unfortified white and red grapefruit juice 1/

Reasons	Juices			
	White 2/	Red 2/	Fortified 3/	Unfortified 3/
	Percent	Percent	Percent	Percent
Flavor--right tartness, not sour	26	26	25	27
Flavor--right sweetness, not too sweet	14	13	13	14
Flavor--general	17	21	18	20
Color--pleasant	11	21	36	13
Color--clear, not cloudy	8	5	4	9
Color--general	7	4	5	6
Consistency--not thin or watery	12	13	15	9
Consistency--not too thick	8	5	6	6
Consistency was just right	8	5	4	9
Just liked it	1	1	1	1
Nothing liked mentioned	27	31	31	28
Number of homemakers	186	187	187	186

1/ Percentages add to more than 100 because some respondents gave more than one reason.
2/ Fortified and unfortified combined.
3/ White and red combined.

Table 3.--Unfavorable comments by participating homemakers on white and red, fortified and unfortified grapefruit juice 1/

Reasons	Juices			
	White 2/	Red 2/	Fortified 3/	Unfortified 3/
	Percent	Percent	Percent	Percent
Flavor--too sour, too bitter	50	52	55	48
Flavor--after taste	4	4	3	5
Flavor--watery taste	2	3	2	4
Flavor--general	2	1	1	2
Color--not clear	4	9	7	5
Color--general	3	3	4	2
Consistency--too thick	5	8	8	5
Consistency--too thin or watery	4	2	2	3
Miscellaneous	--	1	4/	4/
Nothing disliked mentioned	42	41	40	43
Number of homemakers	186	187	187	186

1/ Percentages add to more than 100 because some homemakers gave more than one reason.
2/ Fortified and unfortified combined.
3/ White and red combined.
4/ Less than 1 percent.

Table 4.--Replies to the question, "If grapefruit juice like this were sold in stores where you shop, do you think you would serve it to your family from time to time?" (Asked only for juice rated during last week of test)

Replies	Participating homemakers who --	
	Use grapefruit juice	Do not use grapefruit juice
	Percent	Percent
White unfortified		
Yes, would buy	16	12
No, would not buy	8	13
Red unfortified		
Yes, would buy	14	15
No, would not buy	12	9
Red fortified		
Yes, would buy	19	14
No, would not buy	6	11
White fortified		
Yes, would buy	22	16
No, would not buy	3	9
Not ascertained	--	1
Total	100	100
Number of homemakers --	91	94

Table 5.--Replies to the question, "Would you buy it even if it cost a little more than other grapefruit juice?" (Asked only of homemakers who thought they would purchase the juice)

Replies	Participating homemakers who --	
	Use grapefruit juice	Do not use grapefruit juice
	Percent	Percent
White unfortified		
Yes, would buy	17	17
No, would not buy	6	4
Red unfortified		
Yes, would buy	15	24
No, would not buy	5	2
Red fortified		
Yes, would buy	23	19
No, would not buy	3	5
White fortified		
Yes, would buy	29	20
No, would not buy	2	7
Not ascertained	--	2
Total	100	100
Number of homemakers	65	54

Table 6.--Replies to the question, "Did the younger members of the family who didn't use the rating scale seem to like it (grapefruit juice)?"(Asked only of participating homemakers in households with children under 16)

Replies	Juices			
	White[1]	Red[1]	Fortified[2]	Unfortified[2]
	Percent	Percent	Percent	Percent
Yes, all liked	49	42	44	48
Yes, some liked	2	1	[3]	2
No, none liked	40	44	45	40
Not ascertained	9	13	11	10
Total	100	100	100	100
Number of homemakers	106	106	106	105

1/ Fortified and unfortified combined.
2/ White and red combined.
3/ Less than 1 percent.

Table 7.--Relation between background characteristics of all homemakers interviewed and use of grapefruit juice (canned or frozen)

Characteristics	Homemakers who --			
	Use grapefruit juice	Do not use grapefruit juice	Total	Cases
	Percent	Percent	Percent	Number[1]
Total	47	53	100	263
Age				
Under 36	46	54	100	89
36 - 55	42	58	100	93
56 and over	55	45	100	77
Income				
Under $5,000	52	48	100	91
$5,000 and over	46	54	100	138
Education				
Elementary school	53	47	100	53
High school	49	51	100	151
College	36	64	100	58

1/ Number of cases add to different totals because some information was not obtained from all respondents.

Table 8.--Replies to the question (asked of nonusers of grapefruit juice): "Have you served grapefruit juice to your family in recent years" and (asked of those who had served it in past) "Why don't you serve grapefruit juice any longer?" 1/

Replies	Homemakers	
	Percent	
No, have not served grapefruit juice		61
Yes, have served grapefruit juice		35
Taste characteristics--too tart, etc.	11	
Some member of the family doesn't like	7	
Preference for other juice	7	
Preference for fresh	5	
Habit--just don't	2	
Health factors--doesn't agree with	1	
Can too large, can't use it all up	1	
Miscellaneous	3	
Not ascertained	6	
Not ascertained		4
Total	100	
Number of households	139	

1/ Percentages add to more than 100 because some homemakers gave more than one reason.

Table 9.--Replies to the question: "Will you read down this list (hand card to respondent) and tell me which of these canned or bottled juices you have used in your home in the past year?"

Juice	Homemakers who --			
	Use	Do not use	Total	Cases
	Percent	Percent	Percent	Number
Frozen orange juice ----	73	27	100	263
Canned orange juice ----	50	50	100	263
Canned grapefruit juice	42	58	100	263
Canned orange-grapefruit blend ----------	23	77	100	263
Frozen grapefruit juice	13	87	100	263
Frozen orange-pineapple blend ----------	13	87	100	263
Frozen orange-grapefruit blend ----------	13	87	100	263
Frozen grapefruit-pineapple blend -------	13	87	100	263

Table 10.--Range of background characteristics in the sample

Characteristics	Participants	Nonparticipants
	Percent	Percent
Age		
Under 36	36	28
36 to 55	36	33
55 and over	27	35
Not ascertained	1	4
Total	100	100
Number of households	192	71
Income		
Under $5,000	32	42
$5,000 and over	58	38
Not ascertained	10	20
Total	100	100
Number of households	192	71
Education		
Grammar school	19	24
High school	59	54
College	22	21
Not ascertained	--	1
Total	100	100
Number of households	192	71

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