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Consumers' Reaction to

**VARIOUS PEEL OIL LEVELS IN
FROZEN CONCENTRATED
ORANGE JUICE**

STATISTICAL REPORTING SERVICE
U.S. DEPARTMENT OF AGRICULTURE

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PREFACE

Frozen concentrated orange juice products are usually packed with relatively low peel oil levels on the assumption that they are preferred. Little research, however, has been conducted on how the amount of peel oil affects consumer taste preference. The present study was undertaken to provide information about consumer reaction to frozen concentrated orange juice containing various levels of peel oil.

The Special Surveys Branch, Standards and Research Division, Statistical Reporting Service (SRS), U.S. Department of Agriculture (USDA), was responsible for the conduct of the study, which is part of a research program to determine consumer reaction to agricultural products. The Fruit and Vegetable Products Laboratory, Southern Utilization Research and Development Division, Agricultural Research Service, provided the test products and contributed a portion of the research costs. Subject matter specialists in USDA assisted in the planning stage.

The project was conducted under the general direction of Margaret Weidenhamer, Chief, Special Surveys Branch, SRS. Larry Pope provided consultation on some aspects of the planning stage and on the statistical analysis of some results. The Field Research Corporation, San Francisco, Calif., under contract with USDA, conducted a segment of the study and prepared a draft report.

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SUMMARY

Both adults and children prefer frozen concentrated orange juice containing lower levels of peel oil, according to a consumer survey conducted by the U.S. Department of Agriculture.

The survey was conducted in two stages. The first stage consisted of taste testing under controlled laboratory conditions in Chicago, Ill., and Washington, D.C., in 1968. A supplemental laboratory taste test was also made in Washington, D.C., in 1969. In the second stage, conducted in Chicago in 1969, consumer reaction to selected peel oil levels was tested under more normal orange juice drinking conditions in the home.

The in-home preference test also permitted the generalization that preference ratings do not change noticeably with repeated usage of the same juice over a 2-week period. There was an indication, however, that when families tested a pair of different samples--one sample the first week and another the second--the order of testing seemed to affect preference ratings; that is, the second juice of a pair tested gained an advantage in preference.

CONSUMERS' REACTION TO VARIOUS PEEL OIL LEVELS
IN FROZEN CONCENTRATED ORANGE JUICE

by

Jon P. Weimer
Standards and Research Division
Statistical Reporting Service

INTRODUCTION

This study was conducted to determine the most preferred peel oil level(s) in frozen concentrated orange juice for adult and children markets. To achieve its goal, the investigation was divided into two stages. The purpose of the first stage was to obtain consumer preferences for frozen concentrated orange juice containing various peel oil levels under controlled laboratory conditions. To accomplish this, laboratory preference tests were conducted in Chicago, Ill., and Washington, D.C., in the summer of 1968. A supplementary laboratory taste test was made in Washington, D.C., in the summer of 1969. The second stage, conducted in the summer of 1969, was designed to test consumer reactions to selected peel oil levels in frozen concentrated orange juice under more normal conditions in the home.

STAGE I--LABORATORY TASTE TESTING

Chicago, Ill.

Two mobile laboratory vans were set up in two large shopping centers--one on the north side and another on the south side of the city.

Test Products.--Twelve different juice samples were tested, reflecting the use of four peel oil levels within each of three sweetness levels. The sweetness and peel oil levels of the juice samples are shown in table 1.

The lowest peel oil level (approximately 0.015 volume percent) is somewhat below the usual commercial pack; the next level (approximately 0.027-0.030) is fairly typical of current industry practice; and the remaining two levels exceed this level. An important note is that these orange juice products had no off-flavors and had not been in storage very long prior to testing.

Table 1.--Sweetness and peel oil levels of frozen concentrated orange juice samples, summer 1968 1/

| Sweetness (Brix/acid) level | Peel oil level | | | |
|-----------------------------|-------------------|-------|-------|-------|
| | A | B | C | D |
| | g./100 m.l. juice | | | |
| Low (13.5) | : 0.014 | 0.027 | 0.040 | 0.055 |
| Medium (14.8) | : .015 | .029 | .045 | .060 |
| High (18.1) | : .014 | .029 | .042 | .053 |

1/ Data supplied by U.S. Fruit and Vegetable Products Laboratory, Winter Haven, Fla.

Experimental Design and Composition of Panel Members.--The experimental pattern for this test was essentially a 3 x 4 design (three sweetness levels and four peel oil levels) with two population subgroups--adults and children (8-12 years of age).

Subjects in each of the two age groups were randomly assigned to one of three sweetness panel levels as they entered a van. Each person tasted and rated all four peel oil samples within his assigned sweetness level. The order of presentation of peel oil samples was systematically rotated to represent all samples in all positions an equal number of times. The test was confined to adults and children who acknowledged that they drank orange juice of any type. A total of 336 adults (112 for each of three sweetness levels) and 432 children (144 respondents for each sweetness level) participated in the experiment.

Measuring Instrument.--A nine-point hedonic scale was used for determining taste preferences. Subjects recorded their ratings after tasting each sample on this scale, ranging from "dislike extremely" to "like extremely." For analysis, preference judgments for the samples were converted to numerical scores by assigning successive integers from one (dislike extremely) to nine (like extremely) to each scale category (see rating scale in appendix).

Results.--As noted previously, the primary variable of interest in this investigation was the effect of various peel oil levels on consumer preferences for frozen concentrated orange juice. Less importance was attached to measuring the main effect of sweetness levels on consumers' preference ratings.

An analysis of variance on the mean preference ratings can be used to determine if the main factors, levels of peel oil or sweetness levels, or their interaction effects, are too great to be attributed to chance (that is, are they significantly different). In addition to the analysis of variance, it is useful to describe the general form (trend) of the relationship between two variables, for example, between increasing levels of peel oil and mean preference ratings. A trend analysis is typically used to approximate the shapes of data functions. A trend can occur as a result of random variation.

The important question, of course, is whether the upward or downward trend is a random occurrence or meets the requirements of statistical significance. Similarly, the trend of the means, in addition to being downward or upward, may also show a bend or degree of curvature. Again, if there is a bend or curvature in the trend, it is important to determine whether the curvature meets the requirements of statistical significance. A significant deviation from linearity can be described by a quadratic and/or cubic mathematical function.

Figure 1 depicts both the adults' and children's hedonic scale mean preference ratings for the four peel oil levels. The ratings were obtained by combining ratings across all three sweetness levels for each peel oil level. In figure 1, for both the adults' and children's ratings, the notable linear downward trend for frozen concentrated orange juice containing successively higher levels of peel oil is significant. An analysis of variance, employing the mean scores obtained for each peel oil level, indicates that the peel oil level variable was a significant factor in affecting preference ratings.

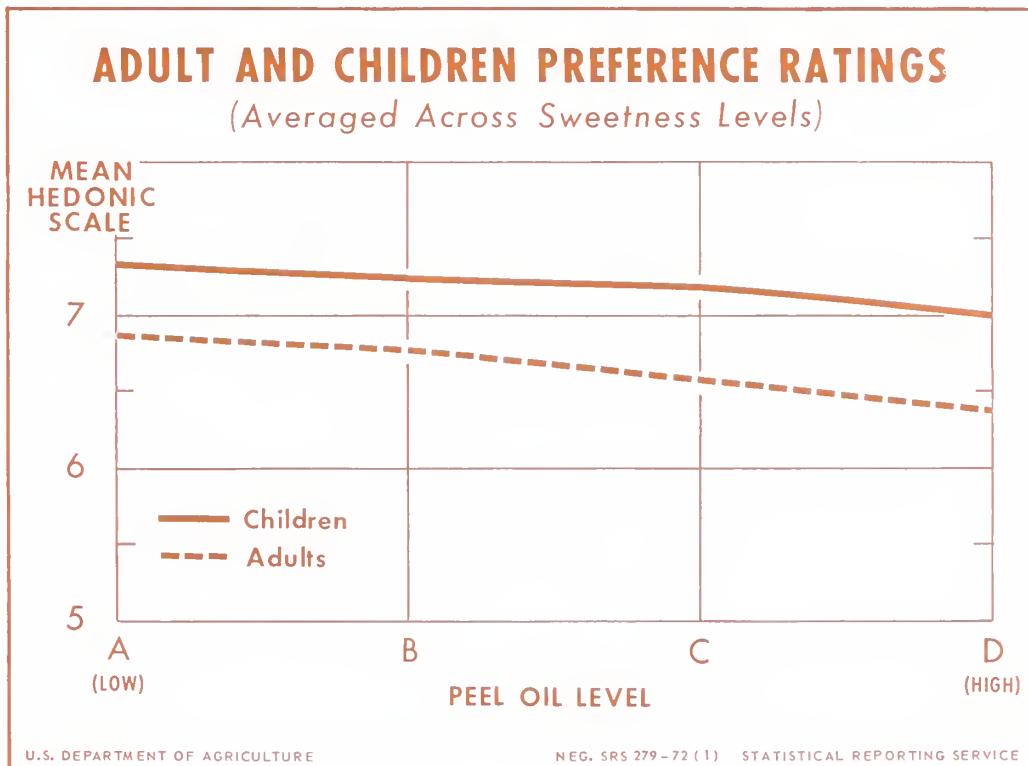


Figure 1

Mean hedonic scale preference ratings for figure 1 (all sweetness levels)

| | Peel oil level | | | |
|----------|----------------|------|------|----------|
| | A (Low) | B | C | D (High) |
| Adults | 6.88 | 6.77 | 6.56 | 6.38 |
| Children | 7.35 | 7.24 | 7.19 | 7.00 |

Figures 2 and 3 depict the mean scores obtained for the successive levels of peel oil, within each of the three sweetness levels, for adults and children, respectively. Figure 2 shows that, for both high and low sweetness levels, there is a general linear drop in preference ratings with successively higher levels in peel oil. This linear trend is significant for both sweetness levels. However, for the medium sweetness level, a more complex curvature is evident. Preference ratings decline for the first three peel oil levels, and then rise sharply at the higher peel oil level. This curvature is better defined by a quadratic function. An analysis of variance on the mean scores depicted in figure 2 indicates that, within each sweetness level, the peel oil factor was significant. The analysis also shows a highly significant interaction of sweetness level with peel oil level, reflecting the anomalous curvature for the medium sweetness level.

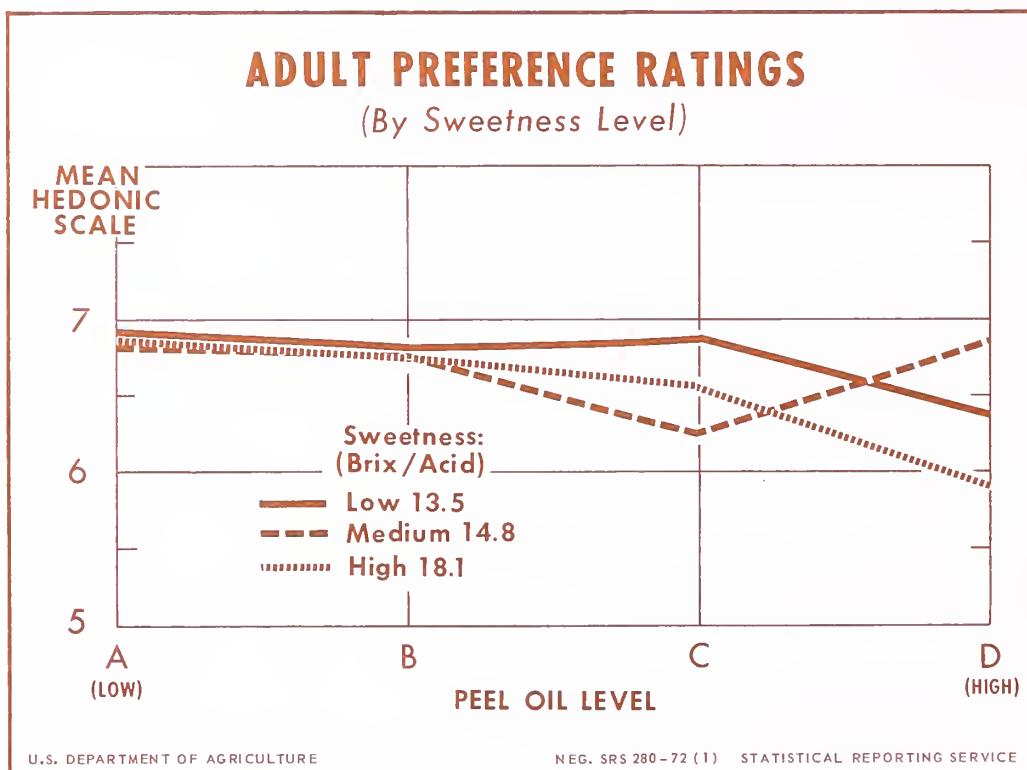


Figure 2

Mean hedonic scale preference ratings for figure 2

| | Peel oil level | | | |
|------------------------|----------------|------|------|----------|
| | A (Low) | B | C | D (High) |
| Low sweetness level | 6.91 | 6.81 | 6.87 | 6.38 |
| Medium sweetness level | 6.87 | 6.75 | 6.25 | 6.86 |
| High sweetness level | 6.86 | 6.73 | 6.55 | 5.90 |

In figure 3, a general linear downward trend in preference ratings is again evident with successively higher peel oil levels for the high and low sweetness levels. This linear trend for both high and low peel oil levels is significant. The medium sweetness sample tested by the children panel members, however, displayed no significant trend up or down across the peel oil levels, as it did with the adult group. Also, no discernible main effect of sweetness level on the preference ratings was obtained for either the children or adults.

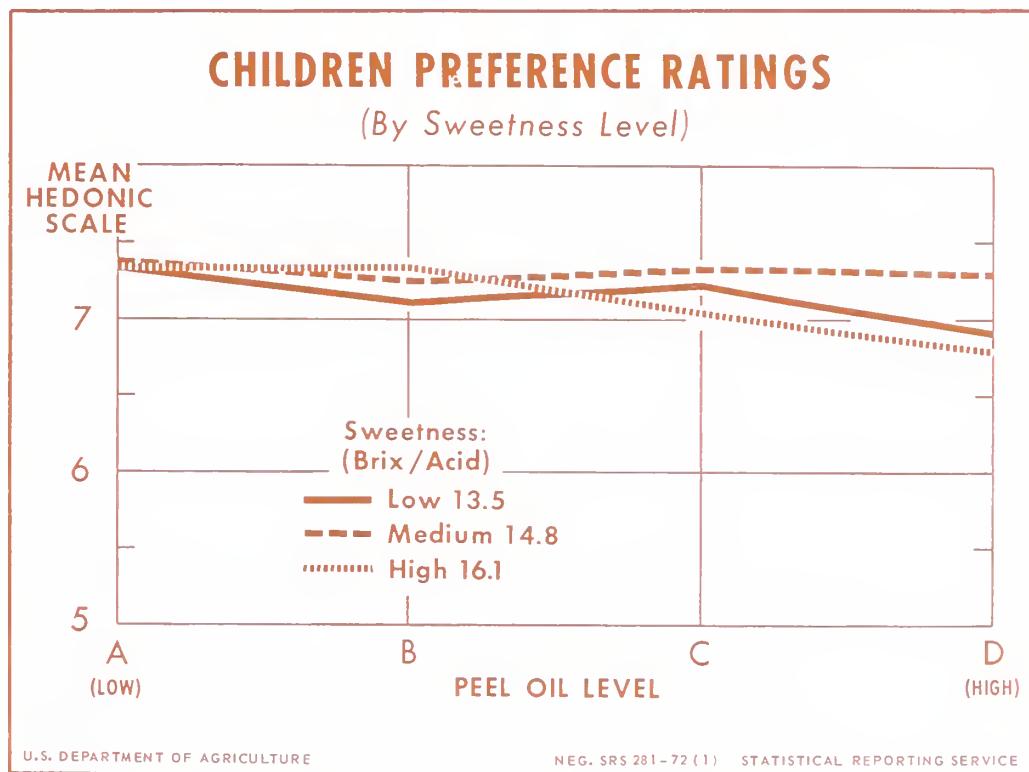


Figure 3

Mean hedonic scale preference ratings for figure 3

| | Peel oil level | | | |
|------------------------|----------------|------|------|----------|
| | A (Low) | B | C | D (High) |
| Low sweetness level | 7.34 | 7.12 | 7.21 | 6.90 |
| Medium sweetness level | 7.38 | 7.25 | 7.31 | 7.29 |
| High sweetness level | 7.31 | 7.33 | 7.04 | 6.79 |

Washington, D.C.

While the mobile laboratory experiment was being performed in Chicago, the Special Surveys Branch conducted a parallel study in its laboratory in Washington, D.C. The purpose of this study was to provide a basis for comparison with the data obtained in Chicago.

Test Products.--The products sampled in this experiment were prepared in identical fashion to those tested in Chicago.

Experimental Design and Composition of Panel Members.--The Washington study was performed in a manner similar to that conducted in the mobile vans in Chicago. The laboratory of the Special Surveys Branch, however, is a stationary site, and the respondents in the Washington experiment (216, a total of 72 for each of three sweetness levels) were USDA employees who were selected by a systematic sampling procedure from the Special Surveys Branch's master list of about 500 volunteers. Many of these USDA employees had served as taste-test panel members for previous laboratory experiments of the Branch. No children served as panel members in this experiment.

Measuring Instrument.--The nine-point hedonic scale also was used in the Washington experiment.

Results.--Despite the disparity between the Chicago and Washington studies with respect to geographic location, laboratory conditions, and respondent composition, results obtained from both studies were remarkably similar. For example, as seen in figure 4, the Washington data also demonstrate a linear downward trend in preference ratings with successively higher peel oil levels, when preference ratings were averaged across the three sweetness levels. A trend analysis confirmed that this linear trend was significant, and an analysis of variance on these preference ratings indicated that the peel oil level factor was highly significant. The Washington data also show a parallel significant interaction of sweetness levels with peel oil levels, as depicted in figure 5. Figure 5 illustrates that there is a general linear drop in preference for both the high and low sweetness levels, similar to the Chicago study results. For the medium sweetness level, the complex curvature is again observed; that is, the mean preference ratings decline with the first three successive increments of peel oil, then

rise sharply at the high level of peel oil. Trend analyses indicate that the linear downward trends for the low and high sweetness levels were significant, and that the nonlinear sweetness level curvature could be adequately defined by a quadratic function. Lastly, again similar to the Chicago study, there was no significant main effect of sweetness level on preference.

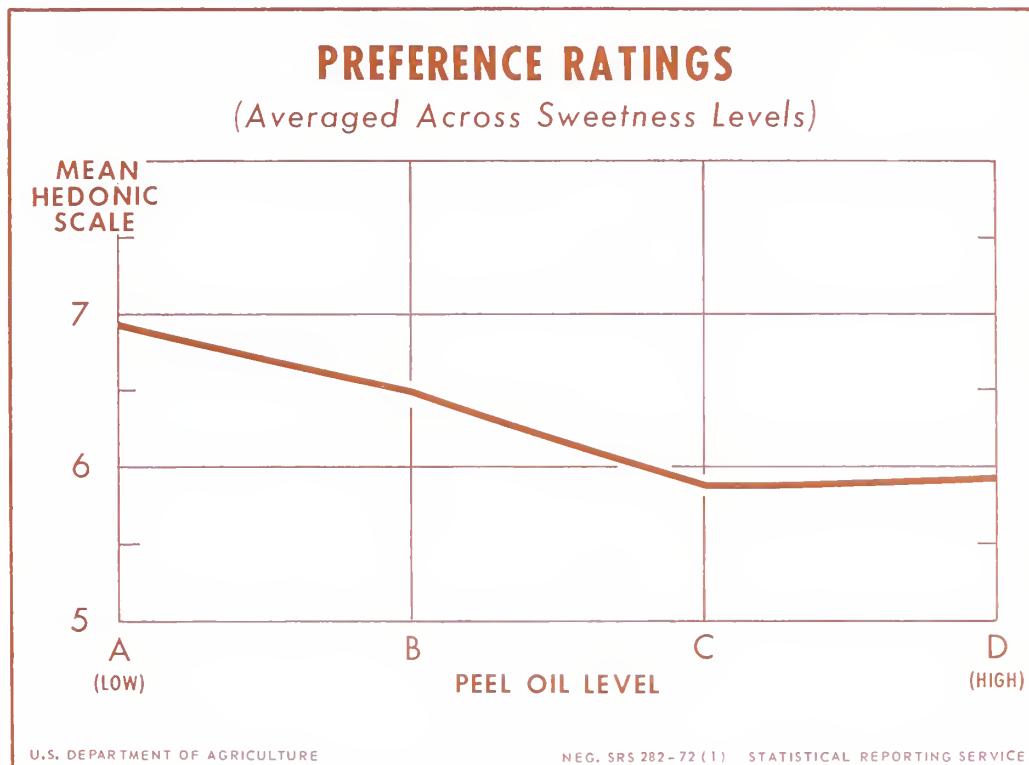


Figure 4

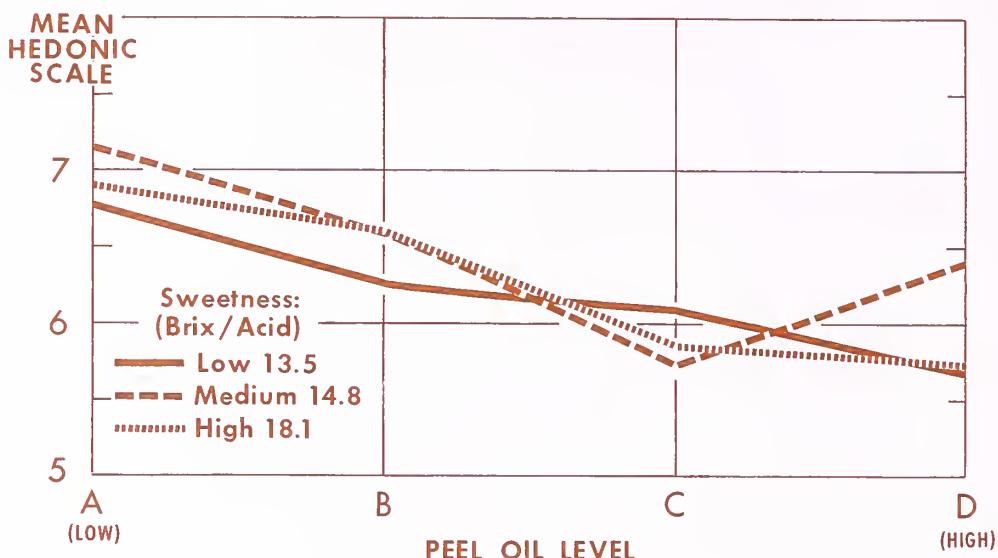
Mean hedonic scale preference ratings for figure 4 (all sweetness levels)

| Peel oil level | | | |
|----------------|------|------|----------|
| A (Low) | B | C | D (High) |
| 6.94 | 6.48 | 5.88 | 5.93 |

The findings of this first stage of research (controlled laboratory taste testing) showed a pronounced general downward trend in preference for frozen concentrated orange juice containing successively higher levels of peel oil. There was, however, a definite interaction between peel oil level and sweetness level among adults. Preference for both the high and low sweetness levels declined as peel oil increased; for the medium sweetness level, however, preference declined for the low and medium peel oil levels and then sharply rose at the highest peel oil level.

PREFERENCE RATINGS

(By Sweetness Level)



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Figure 5

Mean hedonic scale preference ratings for figure 5

| | Peel oil level | | | |
|------------------------|----------------|------|------|----------|
| | A (Low) | B | C | D (High) |
| Low sweetness level | 6.78 | 6.26 | 6.07 | 5.67 |
| Medium sweetness level | 7.15 | 6.58 | 5.72 | 6.40 |
| High sweetness level | 6.89 | 6.58 | 5.85 | 5.72 |

The deviation in the pattern of reaction to peel oil within the medium sweetness level was so marked for both the Chicago and Washington, D.C., experiments that it suggests the possibility of systematic error. Such error might be found in one or more of the following sources: (1) Testing operations, including reconstituting the frozen concentrated orange juice products at the testing sites and administering the samples to the respondents; (2) interaction with respondent characteristics; or (3) processing and preparing the frozen concentrated orange juice products that were sent to the taste-testing sites.

In both Chicago and Washington, D.C., the reconstitution and mixing of the juice samples were done by at least two individuals each time, and checks were specifically made to guard against mislabeling. In addition, precautions were taken to ensure that servers would present the right juices in the proper rotated order. Note that representatives of the Fruit and Vegetable Products Laboratory and Special Surveys Branch observed the taste testing in Chicago to ensure that these measures were taken and that similar procedures would be followed in the Washington experiment. The presence of operational errors cannot, of course, be ruled out entirely, but it is difficult to believe that they occurred in a way that would selectively affect only those sets of subjects assigned to the medium sweetness level panels.

The possibility also exists that a specific respondent characteristic, such as age, sex, or frequency of consumption of orange juice, might have been responsible for the discrepant pattern in the medium sweetness level. All the above mentioned respondent characteristics were assessed in the Chicago experiment by a questionnaire form accompanying the rating form, but only the sex of the respondent was obtained in the Washington test. However, as seen in table 2, these factors also show no significant deviation from the distinctive medium sweetness level preference curve. Rather, these characteristics reflect the deviant pattern, suggesting that no one factor and its interaction with the medium sweetness level was accountable for the observed preference ratings.

Table 2.--Mean hedonic scale ratings for adults, by medium sweetness level, sex, age, and frequency of orange juice consumption, Chicago and Washington, D.C., summer 1968

| Item | Peel oil level | | | | | (N) |
|--|----------------|------|------|------------|-------|-----|
| | : A (Low) | : B | : C | : D (High) | | |
| <u>Chicago, Ill.</u> | : | | | | | |
| Sex: | : | | | | | |
| Male | : 6.76 | 6.69 | 6.44 | 6.80 | (168) | |
| Female | : 6.98 | 6.82 | 6.05 | 6.92 | (168) | |
| Age: | : | | | | | |
| 18 - 25. | : 6.42 | 6.57 | 5.71 | 6.37 | (116) | |
| 26 - 45. | : 7.04 | 6.36 | 6.07 | 6.75 | (120) | |
| 46 and over. | : 7.11 | 7.38 | 6.97 | 7.47 | (100) | |
| Frequency of orange juice consumption: | : | | | | | |
| Heavy (20+ days/mo.) | : 7.28 | 6.77 | 6.66 | 7.31 | (119) | |
| Medium (10-19 days/mo.) | : 6.33 | 6.54 | 5.54 | 6.50 | (102) | |
| Light (under 10 days/mo.) | : 6.74 | 6.86 | 6.20 | 6.60 | (115) | |
| <u>Washington, D.C.</u> | : | | | | | |
| Sex: | : | | | | | |
| Male | : 7.08 | 6.55 | 5.94 | 6.25 | (36) | |
| Female | : 7.22 | 6.61 | 5.50 | 6.55 | (36) | |

This leaves open the question of possible error in the preparation of the orange juice concentrate. To each batch of juice (each batch representing a sweetness level), the appropriate volumes of peel oil had been added just prior to the day on which the products were forwarded to the Chicago and Washington testing sites. Checks were made by Fruit and Vegetable Products Laboratory personnel on those batches of juice which had been prepared in a fashion identical to those forwarded to the test sites, but which had remained at the Laboratory for the purpose of double-checking the ingredients of the juice samples. These checks indicated that the correct amounts of peel oil had been added to the medium sweetness level batch of juice. Thus, this unexpected finding for the medium sweetness level remains a mystery, despite the efforts of the Fruit and Vegetable Products Laboratory, the contractor, and the Special Surveys Branch to unravel it.

Supplementary Taste Test--Washington, D.C.

In the summer of 1969, when tentative plans were being made to conduct an in-home preference test with three of the juices, it was decided to further investigate, under laboratory conditions controlled by the Special Surveys Branch, consumers' reactions to various peel oil levels within the medium sweetness level.

Test Products.--Since the anomalous preference ratings of the medium sweetness level in the previous taste tests occurred with the higher peel oil levels, only the three highest peel oil volume samples were tested, that is, those samples containing 0.030, 0.045, or 0.060 volumes of peel oil.

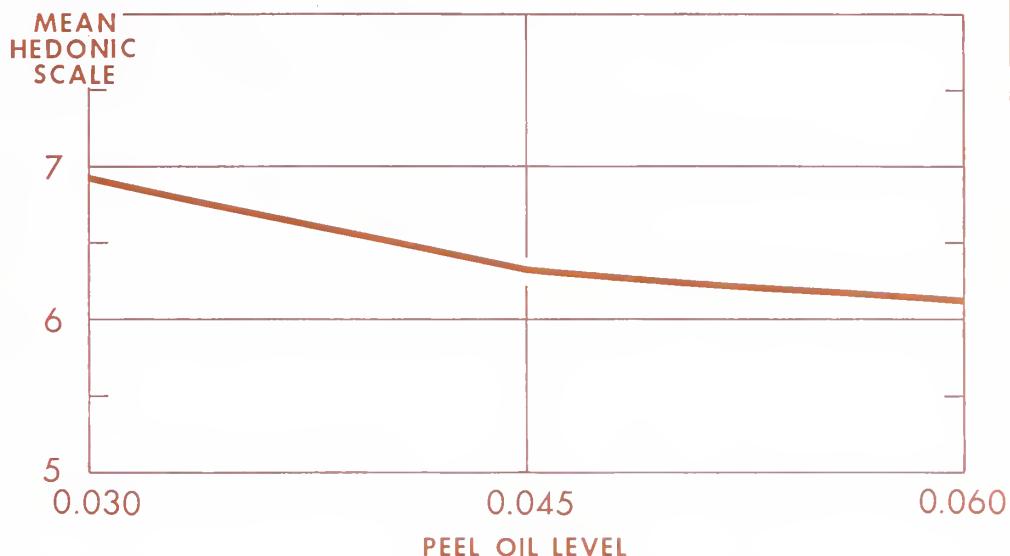
Experimental Design and Composition of Panel Members.--This experiment was conducted in a manner similar to the taste test conducted a year earlier in Washington, D.C. Ninety-six respondents (48 women and 48 men) were selected from the master list of about 500 USDA employees. None of these 96 subjects had participated in the prior Special Surveys experiment on these products.

Measuring Instrument.--As before, the nine-point hedonic scale was used.

Results.--As seen in figure 6, preference ratings display a linear downward trend with successively higher peel oil levels. A trend analysis confirmed that this linear trend was significant. Thus, the results for the medium sweetness level are consistent with those obtained for the low and high sweetness levels in the previous taste tests conducted earlier in Chicago and Washington, D.C. These latter results also give credence to the aforementioned hypothesis that the deviant preference rating pattern found for the medium sweetness level in the previous taste tests was affected by a systematic (although undetermined) error.

PREFERENCE RATINGS

(Medium Sweetness Level)



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Figure 6

Mean hedonic scale preference ratings for figure 6

| | Peel oil level | 0.030 | 0.045 | 0.060 |
|------------------------|----------------|-------|-------|-------|
| Medium sweetness level | | 6.94 | 6.32 | 6.11 |

STAGE II--IN-HOME TASTE PREFERENCE TEST

As stated in the introduction, the second stage of the investigation, conducted in the summer of 1969, was designed to test consumer reactions to selected peel oil levels of frozen concentrated orange juice under more normal orange juice drinking conditions in the home. In this stage, three samples of frozen concentrated juice, all at the medium sweetness level but at three different peel oil levels (approximately 0.030, 0.045, and 0.060), were tested.

Experimental Design.--The basic test design called for each selected family to taste a pair of juices from the three juice samples available--one juice during the first week and another juice during the second week. One-half of the panel families received the same juice both weeks (replicated juice experiment), thus actually making a relatively prolonged comparison of the same juice over time.

Families were recruited by personal visits to a random sampling of households within the survey area. Eligible families received a normal week's supply of the first juice and a set of nine-point hedonic scales for each member of the family 8 years of age or older to record his or her reaction to the test product. In the subsequent week, interviewers returned to interview the family spokesman about the first juice and to leave a week's supply of the second juice and another set of rating sheets. (See appendix for examples of questionnaire and rating sheets.) In another week, the interviewer telephoned the homemaker to get her own and her household members' ratings of the second juice. The homemaker was also asked which of the two products she would buy if it were on the market and her reason for preferring one or the other.

Survey Area and Sample Size.--The survey area was designated as those communities lying within a 10-mile radius of each of two shopping centers in the Chicago area that served as the locations for the controlled laboratory taste test conducted earlier in Chicago.

A total of 331 families with 1,123 members were recruited to take part in the test. These families were not a representative sample of Chicago residents. Five families participated only during the first week, leaving 326 families who completed the 2-week test. Of the family members, 1,090 tried and rated both products and 33 tasted and rated only one juice (either the first or second week, but not both).

Note on Presentation of Results.--A note should be made here on how the data are presented. The sampling units used in this survey were families, not individuals. Therefore, the statistical analyses for this stage of the research should appropriately employ family average (mean) scores, obtained by combining each individual family member's rating to get a grand family average preference rating. It was believed, however, that useful supplemental information could be provided if individual scores were also analyzed, disregarding an individual's respective family membership. Parallels could then be made between family and individual mean preference analyses. In addition, the analyses conducted on individual mean ratings could provide interesting information regarding the effect of such demographic variables as sex and age upon preference ratings.

Results.--Table 3 shows the family mean preference ratings accorded to each peel oil level by 163 families who received the same juice during the 2-week period of the test. Note that in the aggregate there was a difference of only 0.01 rating point between weeks 1 and 2, and that within peel oil levels, the differences between weekly ratings were also minor--the largest being 0.12 scale points in the medium peel oil test panel. A series of t

statistical tests (correlated observations), conducted to determine if any of these interweek differences within peel oil levels were significant, did not indicate that the aggregate preference levels for low, medium, and high peel oil changed significantly between the first and second week. Table 4 displays the mean preference ratings given to each peel oil level by 450 individuals in the families rating the same juice for both weeks. Again, no interweek differences within each peel oil level proved significant. Thus, it appears that preference ratings do not change appreciably with repeated use of the same juice over a 2-week period.

Table 3.--Family mean hedonic scale preference ratings for three peel oil levels over time--replicate sample, summer 1969

| Peel oil level | Preference rating | |
|--------------------------|-------------------|--------|
| | Week 1 | Week 2 |
| Low (0.030) | 7.03 | 6.98 |
| Medium (0.045) | 6.29 | 6.41 |
| High (0.060) | 6.47 | 6.40 |
| Total | 6.59 | 6.60 |
| | : | |

Table 4.--Individual 1/ mean hedonic scale preference ratings for three peel oil levels over time--replicate sample, summer 1969

| Peel oil level | Preference rating | |
|--------------------------|-------------------|--------|
| | Week 1 | Week 2 |
| Low (0.030) | 7.01 | 6.92 |
| Medium (0.045) | 6.12 | 6.39 |
| High (0.060) | 6.18 | 6.25 |
| Total | 6.43 | 6.52 |
| | : | |

1/ In total, 529 individuals tested these juices. Random selection was made of 25 individuals within each of the six age-sex cells at each peel oil level, resulting in 450 individuals for purposes of this analysis.

Table 5 gives both the family mean and individual mean preference ratings obtained by combining test data from weeks 1 and 2 for each juice to examine the effect of peel oil on overall preference ratings. Note that there is a considerable difference in preference between the lower peel oil level sample and the other two levels for both families (7.00 vs. 6.35 and 6.43) and individuals (6.97 vs. 6.25 and 6.23). Analyses of these differences for the family and individual mean scores revealed them to be highly significant.

Table 5.--Family and individual 1/ mean hedonic scale preference ratings for three peel oil levels--replicate sample, summer 1969

| Item | Preference rating for peel oil level of-- | | | Total |
|-----------------|---|------------------|----------------|-------|
| | : Low (0.030) | : Medium (0.045) | : High (0.060) | |
| | : | | | |
| Families . . . | : 7.00 | 6.35 | 6.43 | 6.59 |
| Individuals . . | : 6.97 | 6.25 | 6.23 | 6.48 |
| | : | | | |

1/ Based on 450 individuals; 150 for each peel oil level, balanced equally by age and sex.

In table 6, the combined test data from weeks 1 and 2 display the ratings given by the 450 respondents by sex and age, in addition to the specific peel oil levels tested. Women tended to rate all the peel oil samples somewhat higher than did men (6.65 vs. 6.32), a statistically significant difference. However, no age effect was detected, nor were the interactions involving any of the variables (that is, sex, age, and peel oil level) large enough to be significant.

Table 6.--Individual 1/ mean hedonic scale preference ratings for three peel oil levels by sex and age--replicate sample, summer 1969

| Item | Preference rating for peel oil level of-- | | | Total |
|-------------------|---|------------------|----------------|-------|
| | : Low (0.030) | : Medium (0.045) | : High (0.060) | |
| | : | | | |
| All individuals | : 6.97 | 6.25 | 6.23 | 6.48 |
| | : | | | |
| Sex: | : | | | |
| Men | : 6.81 | 6.04 | 6.11 | 6.32 |
| Women | : 7.12 | 6.47 | 6.36 | 6.65 |
| | : | | | |
| Age: | : | | | |
| Under 20. . . . | : 6.94 | 5.92 | 6.10 | 6.32 |
| 20 - 39 | : 7.00 | 6.28 | 6.58 | 6.62 |
| 40 or older . . . | : 6.96 | 6.56 | 6.02 | 6.51 |
| | : | | | |

1/ Based on 450 individuals; 150 for each peel oil level, balanced equally by age and sex.

Results (Paired Comparison Test Panel Findings).--The second panel of families (163) in this study tested different juices each week. Each family tested and rated one of three possible pairs, that is, low vs. medium peel oil, low vs. high peel oil, or medium vs. high peel oil. Testing order within pairs was alternated throughout the sample.

Table 7 reports the family mean preference scores for each peel oil level in total, by pairing, and by testing order within each pairing. This table shows that there is a general trend toward favoring low over medium (6.94 vs. 6.52) and medium over high (6.52 vs. 6.07) peel oil. This trend is consistent with the direction indicated by the controlled taste-test laboratory results reported in Stage I and by the replicated family juice taste panel findings.

Table 7 also shows that testing order does have a significant effect on preference. In the low vs. medium pairing, low is preferred overall (6.81 vs. 6.56); however, when low is tested first, medium is preferred (6.80 vs. 6.75). When medium is tested first, low is preferred by a wider margin (6.87 vs. 6.38). These results suggest that the second juice of a pair tested gains an advantage in preference.

The same pattern is apparent in the medium vs. high pairing. That is, although medium is the preferred juice of this pair in total, high is preferred over medium when high is tested second, but medium is strongly preferred over high when medium has the advantage of the second testing position.

In the low vs. high comparison, low is consistently preferred irrespective of testing order, although here, too, the mean difference advantage is somewhat greater for low when it is tested second.

An analysis of variance on the results displayed in table 7 indicated that both the main effects of pairing and testing order were significant as well as the interaction of these two.

Table 7.--Family mean hedonic scale preference ratings and mean differences for three peel oil levels, by pairing and testing order, summer 1969

| Testing order | : Number :Preference rating for peel oil level of-- | | | | |
|-------------------|---|-----|--------------|-----------------|---------------|
| | : of | | :Low (0.030) | :Medium (0.045) | :High (0.060) |
| | :families: | | A | B | C |
| : | | | | | |
| Total. | : | 163 | 6.94 | 6.52 | 6.07 |
| A vs. B | : | 54 | 6.81 | 6.56 | |
| A first | : | 26 | 6.75 | 6.80 | |
| B first | : | 28 | 6.87 | 6.38 | |
| A vs. C | : | 55 | 7.06 | | 5.97 |
| A first | : | 27 | 7.25 | | 6.36 |
| C first | : | 28 | 6.87 | | 5.60 |
| B vs. C | : | 54 | | 6.46 | 6.16 |
| B first | : | 28 | | 5.95 | 6.30 |
| C first | : | 26 | | 7.00 | 6.02 |

Table 8 is similar to table 7 except that the mean scores displayed are those obtained by individual rather than family mean scores. The same observations for table 7 can be stated for table 8. There is a general trend of favoring low over medium (6.88 vs. 6.57) and medium over high (6.57 vs. 6.17) peel oil, and the testing order significantly affects individual preference in the same manner as it did family preference (table 7). An analysis of variance on the individual mean scores shown in table 8 confirms that the main effects of peel oil and testing order, as well as the interaction between these two variables, were significant.

Table 8.--Individual mean hedonic scale preference ratings and mean differences for three peel oil levels, by pairing and testing order, summer 1969

| Testing order | : Number : of : individuals: | :Preference rating for peel oil level of-- | | |
|-------------------|------------------------------------|--|------|------|
| | | :Low (0.030):Medium (0.045):High (0.060) | | |
| | | A | B | C |
| Total. | : 561 | 6.88 | 6.57 | 6.17 |
| A vs. B | : 167 | 6.67 | 6.62 | |
| A first | : 91 | 6.76 | 6.91 | |
| B first | : 76 | 6.58 | 6.28 | |
| A vs. C | : 204 | 7.04 | | 6.23 |
| A first | : 105 | 7.23 | | 6.47 |
| C first | : 99 | 6.84 | | 5.98 |
| B vs. C | : 190 | | 6.53 | 6.11 |
| B first | : 101 | | 6.17 | 6.37 |
| C first | : 89 | | 6.94 | 5.82 |

At the conclusion of the second week of testing, the family spokesman was asked which juice of the pair she tested she felt she would be likely to buy if it were available. Homemakers' stated purchase preferences among the pairs of juices tested are shown in table 9, where the overall preference for low peel oil is again clearly evident. It also appears that the particular testing order that homemakers received had an effect on their purchase preferences in a manner similar to that described for their hedonic rating preference scores.

Conclusion.--In general, the findings of the second stage of this study confirm the findings of the first stage of the project, that is, that lower peel oil levels in frozen concentrated orange juice are preferred over higher. Although there is some ambiguity about the positioning of the medium peel oil level sample (that is, whether it is positioned higher or lower in the range between the least preferred and the most preferred), there was no question of the superior preference score for the lower peel oil sample in both tests.

Table 9.--Homemakers' stated preference 1/ for pairs of juices tested, summer 1969

| Testing order | Homemakers | Prefer A | Prefer B | Prefer C | No preference |
|-------------------------------|------------|----------|----------|----------|---------------|
| | | (Low) | (Medium) | (High) | |
| :--Number-- -----Percent----- | | | | | |
| A, B | : 26 | 35 | 46 | - | 19 |
| B, A | : 28 | 61 | 14 | - | 25 |
| A, C | : 27 | 62 | - | 27 | 11 |
| C, A | : 28 | 66 | - | 14 | 21 |
| B, C | : 28 | - | 36 | 39 | 25 |
| C, B | : 26 | - | 62 | 23 | 15 |
| : | | | | | |
| Average A (Low)- | : | | | | |
| 0.030. | : 109 | 56 | - | - | |
| Average B (Medium)- | : | | | | |
| 0.045. | : 108 | - | 39 | - | |
| Average C (High)- | : | | | | |
| 0.060. | : 109 | - | - | 26 | |
| : | | | | | |

1/ Question wording: "Now that you have tried both of the orange juice samples and have seen your family's reaction, which of the two products do you feel you would want to buy if it were on the market today--the first one you tried or the second one? Why is that?"

Note: Average preferences for A, B, and C add to well over 100 percent because each was tasted in various pairings.

The in-home preference study also permits the generalization that preference levels (at least those sampled in this study) do not change noticeably with repeated usage of the concentrates over a 2-week period.

The finding that order of tasting seems to affect preference levels is of some concern, but does not distort the main conclusions discussed above. Interpretation of this finding involves theoretical issues beyond the scope of this report; however, this question should be pursued since it has obvious implications for future research on taste preferences.

APPENDIX

INTRODUCTORY LETTER TO CHICAGO TASTE-TEST PARTICIPANTS

Thank You For Coming In!

You are about to take part in a consumer test of orange juice. This test is being conducted by Field Research Corporation, an independent national marketing research firm.

You will be asked to judge four samples of orange juice and to give us your personal reaction to them. By compiling the results of your ratings, and those of other people who are participating in the test, we will be able to determine how the various samples measure up to consumer preferences.

While you're waiting to begin the test, please do not smoke or chew gum. We want your taste buds to be in tip-top shape.

Incidentally, if you see later any friends or acquaintances who have not yet taken the test, please do not discuss it with them.

We hope you will enjoy the test and we sincerely appreciate your cooperation.

INSTRUCTIONS FOR CHICAGO TASTE-TEST PARTICIPANTS

You will be asked to taste four samples of orange juice. The samples will be served one at a time, with one minute between servings to give you time to fill out the questions for each sample.

First of all, please answer the questions on the green sheet. Then you will receive your first sample to taste.

When you get your first sample,

1. Rinse your mouth out with water from the small cup. Do not swallow the water--expectorate it in the larger paper cup.
2. Taste the orange juice--as much or as little as you wish.
3. Fill out the first white question sheet for that sample of orange juice.
4. Eat the salt-free wafer.
5. Rinse out your mouth in preparation for the second sample.

Now repeat this procedure for the next three samples of orange juice and fill out a separate white question sheet for each of the samples you receive.

IMPORTANT REMINDERS:

- * Always rinse with water before tasting each sample.
- * Taste each sample in the same way.
- * Leave your rating sheets with the interviewer as you leave.

QUESTIONNAIRE FOR CHICAGO TASTE-TEST
PARTICIPANTS (CHILDREN)

Please fill out the following information about yourself:

1. Your sex: Boy Girl

2. Your age: _____

3. About how often do you drink orange juice? (CHECK ONE BOX)

Every day

Quite often

Not very often

QUESTIONNAIRE FOR CHICAGO TASTE-TEST
PARTICIPANTS (ADULTS)

Please fill out the following information about yourself:

1. Your sex: Male Female

2. Your age: _____

3. In the past 30 days, on about how many days have you had orange juice?
(CHECK ONE BOX)

25 - 30 days

20 - 24 days

15 - 19 days

10 - 14 days

5 - 9 days

0 - 4 days

RATING FORM USED IN CHICAGO TASTE-TEST

This Is A Sample Of Orange Juice

Please taste the sample and fill out the ratings below:

How much did you LIKE or DISLIKE the sample, everything considered?

(PLEASE CHECK ONE BOX)

Like extremely

Like very much

Like moderately.

Like slightly.

Neither like nor dislike

Dislike slightly

Dislike moderately

Dislike very much

Dislike extremely

INTRODUCTORY LETTER TO IN-HOME PREFERENCE
TEST PARTICIPANTS - FIRST WEEK

Dear Homemaker:

We would like to get your opinion and the opinions of all members of your household 8 years of age or older of some frozen orange juice.

We would like you and your family to use this juice during the next week or so.

At the end of this time, would you and all your family members please rate how much you liked or disliked the juice on the Blue Rating Sheets.

Then, your interviewer will come back in person to pick up these rating sheets and give you some more frozen orange juice to try. If you find that you will not be home at the time agreed on for our interviewer to return, please call her and make arrangements for her to drop back some other time.

We sincerely appreciate your cooperation and hope you'll enjoy your very important part in this survey.

Your interviewer's name is: _____

Her telephone number is: _____

Your interviewer will come to see you _____
(day) _____ (time) _____

INTRODUCTORY LETTER TO IN-HOME PREFERENCE
TEST PARTICIPANTS - SECOND WEEK

Dear Homemaker:

We would like to get your opinion and the opinions of all members of your household 8 years of age or older of another frozen orange juice.

Please use the orange juice during the next week or so. At the end of this time, have each family member--including yourself--rate how much he liked or disliked the juice on the Blue Rating Sheets.

Then, keep these rating sheets handy by your telephone, so you can give your scores to our interviewer when she telephones you. After you have given her your scores, would you please mail us your family member rating sheets in the attached, pre-paid envelope.

If you find that you will not be home at the time agreed on for our interviewer to telephone you for your scores, please call her to make arrangements for her to telephone you some other time.

Thank you very much for your cooperation in our test. We hope you enjoyed it.

Your interviewer's name is: _____

Her telephone number is: _____

Your interviewer will telephone you _____
(day) _____ (time) _____

QUESTIONNAIRE FOR IN-HOME PREFERENCE TEST

With the exception of check-box material, some instructions to interviewers, office record information, and free-answer space, the questionnaire used in the in-home preference test for this study is reproduced below in entirety. The card used is reproduced at the end of the questionnaire. Instructions to interviewers are in upper case letters enclosed in parentheses.

Budget Bureau No. 40-S 69030

Expiration Date: 10/31/69

INTRODUCTION: Hello, my name is _____ . We're doing a survey of consumers in this area for the U.S. Department of Agriculture, and I would like to speak to the lady of the house--

1. First, do you ever serve any of the following fruit juices in your home?

ORANGE JUICE
APPLE JUICE
GRAPE JUICE
PINEAPPLE JUICE
GRAPEFRUIT JUICE

YES NO

IF NEVER SERVE ORANGE JUICE
TERMINATE AND RECORD ON YOUR
CONTACT RECORD SHEET

2a. Which of the following kinds of orange juice do you ever serve in your home? (READ KINDS AND RECORD ALL THOSE EVER SERVED BELOW UNDER QUES. 2a)

2b. Which kinds of orange juice do you serve once a week or more often? (RECORD BELOW UNDER QUES. 2b)

(Ques. 2a)

(Ques. 2b)

EVER SERVE

ONCE A WEEK
OR MORE OFTEN

FRESH HOME-SQUEEZED.
FROZEN CONCENTRATE
CHILLED (BOTTLE OR WAX CARTON)
CANNED

3. (AT THIS POINT ACQUAINT RESPONDENT WITH THE TEST AND ASK HER COOPERATION AS FOLLOWS:)

We are conducting a test of some different kinds of frozen concentrate orange juice. If you and your family would be willing to take part in this test I will leave you with a week's supply, which you and other members of your family will use in your normal way.

After you have had a chance to use it for several days, each of you eight years or older will each fill out a rating sheet telling us how well you liked it.

I'll come back and pick up the rating sheets in a week and give you some more samples to test. The orange juice samples we are testing have been prepared under the supervision of the U.S. Department of Agriculture and are similar to the regular frozen concentrate that you buy in the stores.

This is a scientific research survey to determine how consumers react to different kinds of orange juice. There is nothing to buy. I will supply you with the orange juice and all you have to do is use it as you normally would.

My organization does not engage in selling any products, and you need have no worries about getting a "sales pitch" later on since your identity will be kept absolutely confidential.

Would you be willing to take part in this product test?

(IF RESPONDENT INDICATES ANY UNWILLINGNESS TO PARTICIPATE, DO NOT PRESS RECORD ON CONTACT RECORD SHEET.)

4. About how many six ounce cans of frozen orange juice concentrate would your family normally use in a week's time? (IF USE 12 OZ. OR OTHER SIZE, CONVERT TO EQUIVALENT NUMBER OF 6 OZ. CANS)

ONE
TWO
THREE
FOUR
FIVE
SIX
SEVEN OR MORE _____

(specify)

FIRST PLACEMENT

5. I'm going to give you _____ six ounce cans of our first test product to use during the coming week.

6. Now, so I will know how many rating forms to give you, will you list for me all the people (eight years or older) in your family, including yourself, who drink orange juice--start with the adults and just give me their first names so the rating forms won't get mixed up.

7. This letter describes the purpose of our test and it gives you some instructions on how to carry it out. Let's go over it to see if you have any questions. (REVIEW TEST PROCEDURES THOROUGHLY WITH RESPONDENT. EMPHASIZE THAT RATING SHEETS ARE TO BE FILLED OUT AT END OF WEEK--OR WHENEVER A PERSON STOPS TESTING, IF HE STOPS BEFORE END OF WEEK)

8. I believe you now have everything you need to conduct this test for us. I will be back in a week to pick up the rating sheets and leave you one more set of cans of juice to test. I'll call you ahead of time to make sure you're at home. That will be on--(SPECIFY DAY AND DATE, AND FIND OUT BEST TIME TO CALL. WRITE THIS ON BOTTOM OF HER LETTER AS A REMINDER TO HER THAT YOU WILL BE CALLING.)

CALLBACK ON: _____

(Day)

(Date)

(Time)

9. My name and phone number are on that letter. So that I can get in touch with you, please give me your phone number here, and your name--

NAME _____

PHONE _____

ADDRESS _____

Now, just a few final questions . . .

10. What is the occupation of the chief wage earner in your household? That is, what type of industry or service does (he) (she) work in, and what is (his) (her) particular job?

(Type of industry or service)

(Type of job)

11. What was the last grade of school you completed?

HIGH SCHOOL GRADUATE OR LESS
SOME COLLEGE, BUSINESS OR TECHNICAL
SCHOOL
COLLEGE GRADUATE OR BEYOND

12. Now, I need some rough idea of your total household income, before taxes, counting from all sources of household members living here. (HAND CARD A). Just tell me the letter of the group your household income falls into.

RECORD FROM OBSERVATION

WHITE 1
NEGRO 2
OTHER _____

DATE OF FIRST PLACEMENT: _____

TIME OF FIRST PLACEMENT: _____

SECOND PLACEMENT

1. (PICK UP FIRST PRODUCT RATING SHEETS. ENTER RATING SCORE NUMBERS OF EACH FAMILY MEMBER ON PAGE 4 LIST UNDER "FIRST PRODUCT." ATTACH SCALE SHEETS TO THIS QUESTIONNAIRE.)
2. (PREPARE RATING SHEETS FOR SECOND PRODUCT TEST AND GIVE TO HOMEMAKER.)
3. (GIVE HER A WEEK'S SUPPLY OF SECOND PRODUCT. CAREFULLY CHECK TO BE SURE CODE NUMBERS MATCH CONTROL NUMBER SHOWN ABOVE.)
4. (PICK UP ANY TEST PRODUCT FROM LAST WEEK WHICH FAMILY HAS NOT USED YET. YOU MUST TAKE THIS UNUSED PRODUCT AWAY WITH YOU.)
5. (MAKE AN APPOINTMENT TO TELEPHONE IN ONE WEEK TO GET FAMILY MEMBER RATINGS ON SECOND TEST PRODUCT.)

TELEPHONE APPOINTMENT: _____ (DAY) _____ (DATE) _____ (TIME)

6. (LEAVE POSTAGE-PAID ENVELOPE FOR RETURNING FINAL RATING SHEETS. TELL RESPONDENT NOT TO MAIL UNTIL AFTER YOU CALL, HOWEVER.)

DATE OF SECOND PLACEMENT: _____ TIME: _____

TELEPHONE CALLBACK INTERVIEW

1. (RECORD EACH FAMILY MEMBER'S RATING SCORE NUMBERS AND COMMENTS, IF ANY, IN SPACE PROVIDED ON FAMILY LIST ON PAGE 4 UNDER "SECOND PRODUCT.")
2. (ASK HOMEMAKER:) Now that you have tried both of the orange juice samples and have seen your family's reaction, which of the two products do you feel you would want to buy if it were on the market--the first one you tried, or the second one?

FIRST ONE
SECOND ONE
EITHER ONE, NO PREFERENCE
NEITHER, WOULD NOT BUY

3. Why is that? (PROBE)
4. (CONCLUDE INTERVIEW BY SAYING:) That's the end of our test. I want to thank you very much for your cooperation. Don't forget to mail back your family rating sheets for the second product in the envelope I left you. You have been of great help, and I hope that you and your family enjoyed taking part in our study.

DATE OF TELEPHONE INTERVIEW: _____ TIME: _____

CARD USED IN INTERVIEW

CARD A

A. Under \$5,000

B. \$5,000 - \$9,999

C. \$10,000 - \$14,999

D. \$15,000 or more

RATING SCALE USED IN IN-HOME PREFERENCE TEST

This rating scale is to be filled out by:

(name)

SEX: M F

AGE: _____

NOTE: PLEASE DO NOT RATE THIS JUICE UNTIL YOU HAVE TASTED
IT FOR SEVERAL DAYS, OR AT THE END OF A WEEK

(check one box)

| | | | |
|--------------------------|-------|---|---|
| Like extremely | | □ | 9 |
| Like very much | | □ | 8 |
| Like moderately | | □ | 7 |
| Like slightly | | □ | 6 |
| Neither like nor dislike | | □ | 5 |
| Dislike slightly | | □ | 4 |
| Dislike moderately | | □ | 3 |
| Dislike very much | | □ | 2 |
| Dislike extremely | | □ | 1 |

Comment:

How many different times did you
drink this juice?

(No. times)

THE SAMPLE AND BACKGROUND INFORMATION FOR THE IN-HOME PREFERENCE TEST

Selection of Clusters

In the sample selection procedure, two shopping centers were pinpointed and a 10-mile radius circle was drawn around them. Once the residential communities within these two areas were determined, "key address" starting points were drawn by a systematic random procedure from the local telephone directories covering each survey area. Each "key address" served as the starting point for a cluster of six household participants. Each interviewer was assigned four block cluster areas for a total of 24 households per interviewer.

Selection of Households

The interviewer was instructed to pick up her frozen juice for the cluster area, and go to her "key address" starting point. She listed this as her first household on a Contact Record Sheet (stapled to a Block Assignment Map for that cluster). She attempted her first placement there. Then, regardless of whether she completed a placement, as she left the house, she turned to her right and proceeded around the block in a clockwise direction, listing and calling on all occupied residential dwelling units in an effort to make six initial placements with orange juice users. She did not list or call on vacancies, inaccessible houses, businesses, boarding houses, motels, or other transient lodgings. If the block were irregularly shaped, she proceeded around it in the same fashion as though it were a standard rectangular block. If the street or road were not part of a block, she continued along the street or road until she made six placements.

The block with the key address became the Primary Block and the blocks directly to the north, east, south, and west of it became the first, second, third, and fourth respective Alternate Blocks. These Alternates were used as substitutes only when the Primary Block did not have enough households for the interviewer to carry out her assignment.

In an apartment building, each apartment was treated as a separate dwelling, but no more than one placement for every six apartments was allowed.

When the interviewer was successful in making a placement, she was instructed to skip the house or apartment next door to avoid nextdoor neighbors comparing notes about the test products.

No call-backs were made at addresses along the route where no one was at home for the initial placement attempt. Initial placements were made after

3:00 PM and before 9:00 PM on weekdays and all day on Saturday. Callbacks for the second placement could be made at any time convenient for participating families.

Results of Household Contacts

Below are shown the results of the contacts made to obtain the 331 families initially recruited for the study.

| | <u>Number</u> | <u>Percent</u> |
|---|---------------|----------------|
| Total households called on for initial placements | 1,261 | 100 |
| <u>No contact made</u> | <u>678</u> | <u>54</u> |
| No one home | 529 | 42 |
| Refused | 149 | 12 |
| <u>Contact made</u> | <u>583</u> | <u>46</u> |
| Eligible adult not home | 81 | 6 |
| Nonuser of orange juice | 94 | 7 |
| Refused initial product | 75 | 6 |
| Interview not complete enough for tabulation | 2 | * |
| Completed first week | 331 | 26 |
| Completed both weeks | 326 | 26 |

* Less than 1/2 of one percent.

Household Characteristics

| | <u>Number</u> | <u>Percent</u> |
|--------------------------------------|---------------|----------------|
| Total families recruited | 331 | 100 |
| <u>Survey area</u> | | |
| Northern | 164 | 50 |
| Southern | 167 | 50 |
| <u>Type orange juice ever served</u> | | |
| Frozen concentrate | 302 | 91 |
| Chilled (bottle or wax carton) | 144 | 44 |
| Fresh home-squeezed | 97 | 29 |
| Canned | 55 | 17 |

| | <u>Number</u> | <u>Percent</u> |
|--|---------------|----------------|
| Type orange juice served once a week or more often | | |
| Frozen concentrate | 279 | 84 |
| Chilled (bottle or wax carton) | 71 | 22 |
| Fresh home-squeezed | 33 | 10 |
| Canned | 23 | 7 |
| No. of 6-ounce cans frozen concentrate used per week | | |
| One | 11 | 3 |
| Two | 68 | 21 |
| Three | 63 | 19 |
| Four | 65 | 20 |
| Five | 23 | 7 |
| Six | 75 | 23 |
| Seven or more | 26 | 8 |
| Occupation of chief wage earner | | |
| Professional and technical | 75 | 23 |
| Managers, officials, proprietors | 74 | 22 |
| Clerical and sales | 59 | 18 |
| Craftsmen, foremen, skilled workers | 76 | 23 |
| Semiskilled, service, laborers | 23 | 7 |
| Retired, not employed | 21 | 6 |
| Not reported | 3 | 1 |
| Education of homemaker | | |
| High school or less | 138 | 42 |
| Some college, business, or technical school | 92 | 28 |
| College graduate or beyond | 78 | 24 |
| Not reported | 23 | 7 |
| Ethnic group | | |
| White | 331 | 100 |
| Negro/other | - | - |
| Household income | | |
| Under \$5,000 | 7 | 2 |
| \$5,000 - \$9,999 | 58 | 18 |
| \$10,000 - \$14,999 | 121 | 37 |
| \$15,000 or more | 109 | 33 |
| Refused | 36 | 11 |

| | <u>Number</u> | <u>Percent</u> |
|--|---------------|----------------|
| <u>Individual Characteristics</u> | | |
| Individuals who tested and rated both juices of a pair | 1,090 | 100 |
| <u>Sex</u> | | |
| Male | 519 | 48 |
| Female | 571 | 52 |
| <u>Age</u> | | |
| Under 20 | 402 | 37 |
| 20 - 39 | 334 | 31 |
| 40 or older | 338 | 31 |
| Not reported | 16 | 1 |
| <u>Size of Household</u> | | |
| One member | 14 | 1 |
| Two members | 212 | 19 |
| Three members | 146 | 13 |
| Four members | 327 | 30 |
| Five members | 250 | 23 |
| Six members or more | 141 | 13 |

Testing Order for Products

| <u>Product pairs in testing order</u> | <u>Families recruited for test</u> | <u>Individuals rating both products</u> | <u>Individuals rating only one of pair</u> |
|---------------------------------------|------------------------------------|---|--|
| A, B | 26 | 91 | - |
| B, A | 28 | 76 | 1 |
| A, C | 29 | 105 | 8 |
| C, A | 28 | 99 | 2 |
| B, C | 28 | 101 | 1 |
| C, B | 27 | 89 | 6 |
| A, A | 54 | 162 | 8 |
| B, B | 56 | 187 | 3 |
| C, C | 55 | 180 | 4 |
| Total: | 331 | 1,090 | 33 |

A - Low peel oil (0.030)
 B - Medium peel oil (0.045)
 C - High peel oil (0.060)

STATISTICAL ANALYSES

Analysis of variance of effects of peel oil variations and sweetness levels for adults,
Chicago taste-testing site, summer 1968

| Source | : Sum of : squares | : Degrees of : freedom | : Mean : squares | : F |
|--------------------------|-----------------------|---------------------------|---------------------|---------------|
| : | | | | |
| Sweetness level. | : 13.26 | 2 | 6.63 | 1.37 |
| Error. | : 1607.40 | 333 | 4.83 | |
| : | | | | |
| Peel oil 1/. | : 50.06 | 3 | 16.69 | <u>2/6.87</u> |
| : | | | | |
| Sweetness level | : | | | |
| X peel oil interaction | : 61.25 | 6 | 10.21 | <u>2/4.20</u> |
| Error. | : 2431.82 | 999 | 2.43 | |
| : | | | | |

1/ Four peel oil levels: 0.015, 0.030, 0.045, and 0.060.

2/ Significant at 0.0005 probability level.

Analysis of variance of effects of peel oil variation and sweetness levels for children, Chicago taste-testing site, summer 1968

| Source | : Sum of : squares | : Degrees of : freedom | : Mean : squares | : F |
|--------------------------|-----------------------|---------------------------|---------------------|---------------|
| : | | | | |
| Sweetness level. | : 11.87 | 2 | 5.94 | 1.03 |
| Error. | : 2484.75 | 429 | 5.79 | |
| : | | | | |
| Peel oil 1/. | : 28.05 | 3 | 9.35 | <u>2/3.64</u> |
| : | | | | |
| Sweetness level | : | | | |
| X peel oil interaction | : 16.89 | 6 | 2.82 | <u>1.10</u> |
| Error. | : 3304.87 | 1287 | 2.57 | |
| : | | | | |

1/ Four peel oil levels: 0.015, 0.030, 0.045, and 0.060.

2/ Significant at 0.01 probability level.

Trend analyses for peel oil preference trends by sweetness level, for adults, Chicago taste-testing site, summer 1968

| Sweetness level | Linear | | | | Quadratic | | | | Cubic | | | |
|-----------------|--------|-------|-------|----------|-----------|-------|------|---------|-------|-------|------|----------|
| | df | MS | F | p | df | MS | F | p | df | MS | F | p |
| Low | 1 | 13.12 | 5.39 | <0.025 | 1 | 4.26 | 1.75 | ns | 1 | 3.04 | 1.25 | ns |
| Medium | 1 | 1.57 | .65 | ns | 1 | 14.92 | 6.14 | <0.01 | 1 | 13.03 | 5.37 | <0.025 |
| High | 1 | 52.43 | 21.58 | $<.001$ | 1 | 7.57 | 3.11 | $<.10$ | 1 | 1.37 | .56 | ns |
| All levels | 1 | 49.12 | 20.21 | $<.001$ | 1 | .41 | 0.17 | ns | 1 | .53 | .22 | ns |

ns = Not significant.

Trend analyses for peel oil preference trend by sweetness level, for children, Chicago taste-testing site, summer 1968

| Sweetness level | Linear | | | | Quadratic | | | | Cubic | | | |
|-----------------|--------|-------|-------|---------|-----------|------|------|----|-------|------|------|----|
| | df | MS | F | p | df | MS | F | p | df | MS | F | p |
| Low | 1 | 10.89 | 4.23 | <0.05 | 1 | 0.29 | 0.11 | ns | 1 | 3.44 | 1.34 | ns |
| Medium | 1 | .32 | .12 | ns | 1 | .43 | .17 | ns | 1 | .45 | .18 | ns |
| High | 1 | 24.64 | 9.59 | $<.005$ | 1 | 2.62 | 1.02 | ns | 1 | 1.86 | .72 | ns |
| All levels | 1 | 26.13 | 10.17 | $<.001$ | 1 | .69 | .27 | ns | 1 | 1.23 | .48 | ns |

ns = Not significant.

Analysis of variance of effects of peel oil variations within the medium sweetness level, Washington, D.C., taste-testing site, summer 1969

| Source | : | Sum of squares | : | Degrees of freedom | : | Mean squares | : | F |
|---------------------------------|-----|----------------|---|--------------------|---|--------------|---|---------------|
| Peel oil 1/ | ... | 35.15 | | 2 | | 17.58 | | <u>2/8.79</u> |
| Subjects | ... | 466.17 | | 95 | | 4.91 | | <u>2/2.46</u> |
| Peel oil X subjects interaction | ... | 380.18 | | 190 | | 2.00 | | |
| Total | ... | 881.50 | | 287 | | | | |

1/ Three peel oil levels: 0.030, 0.045, and 0.060.

2/ Significant at 0.01 probability level.

Trend analysis for peel oil preference trend within the medium sweetness level, Washington, D.C., taste-testing site, summer 1969

| Sweetness: level | Linear | | | | Quadratic | | | |
|---------------------|--------|-------|-------|---------|-----------|------|------|-----|
| | : df | : MS | : F | : p | : df | : MS | : F | : p |
| Medium | : 1 | 32.50 | 16.25 | <0.01 | 1 | 6.92 | 3.46 | ns |
| | : | | | | | | | |

ns = Not significant.

Analysis of variance for effects of peel oil variations and sweetness levels for adults, Washington, D.C., taste-testing site, summer 1968

| Source | : Sum of : squares | : Degrees of : freedom | : Mean : squares | : F |
|------------------------------|-----------------------|---------------------------|---------------------|-----------------|
| Sweetness level. | : 11.49 | 2 | 5.75 | 0.81 |
| Error. | : 1513.98 | 213 | 7.10 | |
| Peel oil <u>1</u> /. | : 162.79 | 3 | 54.26 | <u>2</u> /28.86 |
| Sweetness level | : | | | |
| X peel oil interaction | : 27.40 | 6 | 4.57 | <u>3</u> / 2.43 |
| Error. | : 1202.06 | 639 | 1.88 | |
| | : | | | |

1/ Four peel oil levels: 0.015, 0.030, 0.045, and 0.060.

2/ Significant at 0.01 probability level.

3/ Significant at 0.05 probability level.

Trend analyses for peel oil preferences by sweetness level, Washington, D.C., taste-testing site, summer 1968

| Sweetness level | Linear | | | | Quadratic | | | | Cubic | | | |
|--------------------|--------|--------|-------|---------|-----------|-------|-------|---------|-------|-------|------|---------|
| | : df | : MS | : F | : p | : df | : MS | : F | : p | : df | : MS | : F | : p |
| Low (13.5) | : 1 | 44.80 | 23.83 | <0.01 | 1 | 0.22 | 0.18 | ns | 1 | 1.12 | 0.60 | ns |
| Medium (14.8) | : 1 | 34.84 | 18.53 | $<.01$ | 1 | 28.12 | 14.96 | <0.01 | 1 | 12.10 | 6.43 | <0.05 |
| High (18.1) | : 1 | 64.60 | 34.36 | $<.01$ | 1 | .59 | .31 | ns | 1 | 3.91 | 2.07 | ns |
| All levels | 1 | 141.92 | 75.49 | $<.01$ | 1 | 14.26 | 7.58 | $<.01$ | 1 | 6.61 | 3.52 | ns |

ns = Not significant.

Analysis of variance for effects of peel oil level variations, replicate sample--family mean scores, in-home preference test

| Source | : Sum of : squares | : Degrees of : freedom | : Mean : squares | : F |
|------------------------------|-----------------------|---------------------------|---------------------|----------------|
| Peel oil <u>1/</u> | : 13.53 | : 2 | : 6.77 | <u>2/</u> 4.31 |
| Error. | : 251.35 | : 160 | : 1.57 | |
| Total. | : 264.88 | : 162 | | |
| | : : | | | |

1/ Three peel oil levels: Low (0.030), Medium (0.045), and High (0.060).

2/ Significant at 0.05 probability level.

Analysis of variance for effects of peel oil level variation by sex and age, replicate sample--individual mean scores, in-home preference test

| Source | : Sum of : squares | : Degrees of : freedom | : Mean : squares | : F |
|------------------------------------|-----------------------|---------------------------|---------------------|----------------|
| Peel oil level <u>1/</u> | : 52.35 | : 2 | : 26.18 | <u>2/</u> 11.3 |
| Sex. | : 12.17 | : 1 | : 12.17 | <u>3/</u> 5.2 |
| Age <u>4/</u> | : 6.94 | : 2 | : 3.47 | 1.5 |
| Peel oil x sex | : .59 | : 2 | : .30 | - |
| Peel oil x age | : 12.62 | : 4 | : 3.16 | 1.4 |
| Sex x age. | : 1.39 | : 2 | : .70 | - |
| Peel oil x sex x age | : 3.45 | : 4 | : .86 | - |
| Error. | : 1001.88 | : 432 | : 2.32 | |
| Total. | : 1091.39 | : 449 | | |
| | : : | | | |

1/ Three peel oil levels: Low (0.030), Medium (0.045), and High (0.060).

2/ Significant at the 0.0005 probability level.

3/ Significant at the 0.025 probability level.

4/ Three age categories: Under 20, 20-39, and 40 and older.

Analysis of variance for effect of peel oil pairing by testing order--family mean hedonic scores, in-home preference test

| Source 1/ | : | Sum of squares | : | Degrees of freedom | : | Mean squares | : | F |
|---------------------------|---|----------------|---|--------------------|---|--------------|---|-----------------|
| Peel oil pairing 2/ . . . | : | 49.50 | | 2 | | 24.75 | | <u>3/</u> 6.62 |
| Testing order 4/ | : | 48.43 | | 1 | | 48.43 | | <u>3/</u> 12.95 |
| Pairing x testing order. | : | 29.30 | | 2 | | 14.65 | | <u>5/</u> 3.92 |
| Error. | : | 587.65 | | 157 | | 3.74 | | |
| Total. | : | 714.88 | | 162 | | | | |
| | : | | | | | | | |

1/ Measures analyzed are difference scores between families' mean ratings of juice pairs.

2/ Three peel oil pairings: Low (0.030) vs. Medium (0.045), Low vs. High (0.060), Medium vs. High.

3/ Significant at the 0.01 probability level.

4/ Within each pairing, two testing orders.

5/ Significant at the 0.05 probability level.

Analysis of variance for effect of peel oil pairing by testing order--individual mean hedonic scores, in-home preference test

| Source 1/ | : Sum of squares | : Degrees of freedom | : Mean squares | : F |
|---------------------------|------------------|----------------------|----------------|-----------------|
| Peel oil pairing 2/. | 52.62 | 2 | 26.31 | <u>3/</u> 5.71 |
| Testing order 4/. | 46.56 | 1 | 46.56 | <u>5/</u> 10.10 |
| Pairing x testing order. | 50.08 | 2 | 25.04 | <u>3/</u> 5.43 |
| Within cells (error term) | 2558.63 | 555 | 4.61 | |
| Total. | 2703.00 | 560 | 4.83 | |

1/ Measures analyzed are difference scores between individuals' mean ratings of juice pairs.

2/ Three peel oil pairings: Low (0.030), vs. Medium (0.045), Low vs. High (0.060), Medium vs. High.

3/ Significant at the 0.01 probability level.

4/ Within each pairing, two testing orders.

5/ Significant at the 0.002 probability level.

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