FORTIFIED 2% MILK EXPOSED TO FLUORESCENT LIGHT: A COMPARISON OF CONSUMER ACCEPTABILITY AND RATE OF VITAMIN A LOSS

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FORTIFIED 2% MILK EXPOSED TO FLUORESCENT LIGHT: A COMPARISON OF COMSUMER ACCEPTABILITY AND RATE OF VITAMIN A LOSS

Key Words:
Vitamin A, Retinol, Light, Oxidation, 2% Milk

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ABSTRACT

Fortified 2% milk packaged in one-gallon polyethylene bottles was obtained from a local dairy and exposed to fluorescent light (1200 foot-candles) for times ranging from 0 to 64 hours. The flavor and acceptability of the milk was judged using a 100-member consumer panel. The amount of oxidative flavor was quantified in a descriptive panel using eight trained panelists. The concentration of saponified vitamin A from each sample was determined using HPLC. There

was a significant drop in flavor acceptability after 5.3 hours of exposure which was accompanied by an average loss of 11.5% vitamin A. When the flavor acceptability score of the milk fell below the acceptable range the concentration of the original vitamin A was still above the minimum level of 1.5 IU per ml (1418 IU per quart).

It appears that milk stored under fluorescent light in retail stores is more susceptible to sensory deterioration than vitamin A loss.

INTRODUCTION

In 1989 65% of all milk within the U.S. was sold through supermarkets or convenience/dairy stores. In that same year low fat milk sales exceeded sales of whole milk for the first time, and plastic gallon bottles were, by far, the most popular containers (7). Several studies over the last few years have shown that vitamin A is readily destroyed by the same type of fluorescent lighting that is common to many dairy cases and that this destruction is accompanied by other reactions in the milk that cause oxidative flavors to develop (1, 2, 4, 6, 8, 9, 10, 11, 12). Because milk is considered to be a good source of vitamin A, light-induced destruction of this nutrient continues to be a problem.

The most probable cause of vitamin A destruction is light-induced isomerization (2, 5, 8, 10). The cause of the oxidative flavor is still not fully understood, but it does require the presence of riboflavin, light, protein and oxygen (3).

The objective of this research was to compare the rate of vitamin A destruction to the oxidative flavor development in milk. The hypothesis was that the flavor of the milk would become less than acceptable before the concentration of vitamin A fell below the accepted minimum standard (1.5 IU per ml) for pasteurized fluid milk.

MATERIALS AND METHODS

Sample Preparation and Light Exposure

For each experiment ten gallons of homogenized, pasteurized 2% milk, packaged in one-gallon polyethylene bottles, were obtained from the university-owned dairy directly off the packaging line to ensure that the samples were as uniform as possible. This milk and packaging were used because of their popularity. The milk had been fortified with 5cc of Gen Sol 10 Vitamin A and D blend (Grinstead Industrial Products Inc., Industrial Airport, Kansas 66031) per 100 gallons of milk (equivalent to 2000 IU per quart).

The milk was immediately placed in brown paper bags to protect it from light. The milk was held at 4°C before, during and after exposure to fluorescent light at 1200 foot-candles. The lights used were Sylvania model 24618-0 Workshop F40 40 watt fluorescent tubes. The bottles were placed approximately 12 inches away from the tubes and about 3 inches from each other. Spacing was adjusted so all bottles received the same amount of exposure. The light intensity was measured with a light meter. Samples of milk were exposed for 0, 20, 40, 80, 160, 320, 640, 1280 and 2560 minutes for the preliminary experiment. Both the oxidative flavor development and vitamin A loss were insignificant for the 20 and 40 minute exposure times compared to the control so they were replaced with 1920 and 3840 minute exposures for consequent experiments.

Sensory Evaluation

The flavor of the milk was judged by 100 consumers who had positive or neutral attitudes towards milk. Each panelist received all nine samples in random order, served three at a time. The panelists were asked to judge the flavor of the milk using a nine-point hedonic scale, with one being "Dislike Extremely" and nine being "Like Extremely". They also judged the acceptability of the flavor on a three-point scale with one being "Unacceptable", two being "Marginal" and three being "Acceptable" (see Appendix A).

The milk was also evaluated by eight trained panelists who were found to be sensitive to oxidative flavor. They quantified the oxidative flavor on a 150 mm horizontal line scale that was marked "No Oxidized Flavor" on the extreme left and "Oxidized Flavor Very Strong" 8 mm from the extreme right (see Appendix B). They placed a mark on the line in the appropriate place indicating their opinion of the strength of the oxidized flavor. Each panelist tasted duplicates of all nine samples in different orders. The location of the mark was measured in millimeters from the left end of the scale. All panelists received a $3.00 stipend.

Quantification of Vitamin A

A sample from each bottle of milk was taken immediately after all samples were exposed to light. The vitamin A was saponified and quantified using a rapid method outlined by M.

Zahar and D.E. Smith (13) with diethyl ether:petroleum ether 1:1 containing 0.01% (wt/vol) BHT as the solvent. The HPLC consisted of an Altex model 110a pump fitted with an Altex 210 vented injector and a 20 μl loop (Altex Scientific, Inc., Berkeley, Ca). The column was an Alltech Econosphere C18 5U Column, 150 mm X 4.6 mm ID (Cat. No. 70065, Alltech Assoc., Inc., Deerfield, IL). The detector was a Beckman Model 165 Variable Wavelength UV Detector set at 325 nm (Beckman Instruments, Fullerton, CA).

Statistical Analysis

Linear regression was used to predict the concentrations of vitamin A in the milk samples by comparing their peak heights with those of the standards. The data from the sensory evaluation panels was analyzed using a SAS General Linear Model (see appendix D). The Duncan Multiple Range Test was used to determine significant differences between sample means (see Appendix E).

RESULTS

Results are shown in Table 1. The data that were of most concern in this research were the consumer acceptance scores and the vitamin A concentrations. In trials 1 and 2 the acceptance scores were significantly lower at 640 minutes of exposure which also resulted in a vitamin A loss of 14.3% and 12.5% respectively. When the mean acceptance scores fell

below 2.33 there was a loss in vitamin A of 31.0% and 30.0% respectively.

In both trials there was a significant drop in the hedonic scores at 320 minutes of exposure and a significant increase in oxidative flavor for trials 1 and 2 at 640, and 320 minutes respectively.

DISCUSSION

It was decided that the flavor of the milk would be less than acceptable when the acceptability score fell into the marginal range (see Figure 1) since consumers and milk producers would not want to buy or sell a marginal product. The hypothesis held true; in both trials the concentration of vitamin A was still above the minimum level of 1.5 IU per ml (1418 IU per quart) after the flavor of the milk became less than acceptable.

It was interesting to compare the consumer's reactions to the oxidative flavor with those of the trained panelists. The presence of oxidized flavor as detected by the descriptive panelists did not greatly depress the acceptability as judged by the consumers. Some consumers even preferred the sample with the highest amount of light exposure over the control. It is possible that consumers are accustomed to the presence of oxidative flavor and accept it as a normal characteristic of the milk.

It is obvious that the level of vitamin A remaining would

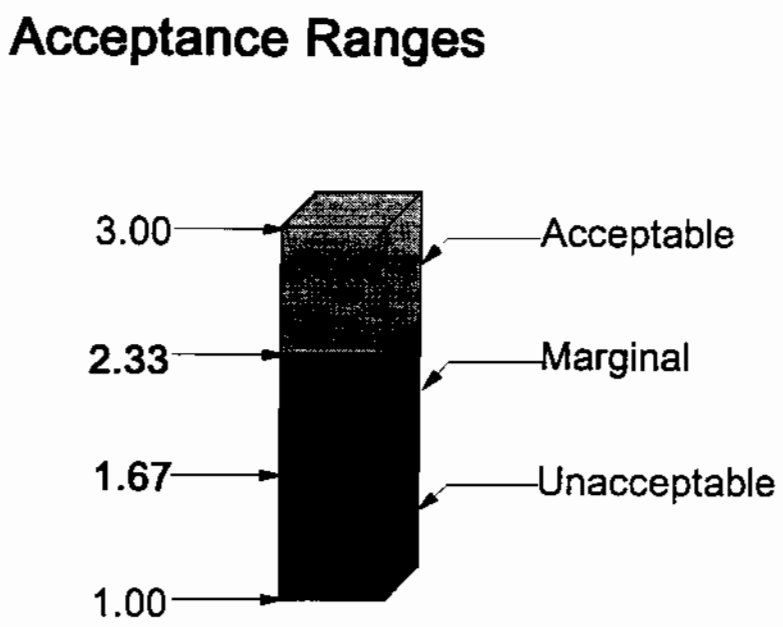
depend on the original level of fortification. Because fat and other solids help to protect milk from light-induced reactions, the fat content of the milk would likewise influence the results.

Table 1

Exposure Time (minutes)	Consumer Hedonic Score	Consumer Acceptance Score	Descriptive Off-flavor Score	Vitamin A Concentration (I.U./quart)
		Trial 1		
0	7.11^{a}	2.79^{a}	8.4^{a}	2573^{a}
80	6.91^{ab}	2.76^{a}	10.4^{a}	2428^{b}
160	7.16^{a}	2.78^{a}	13.0^{a}	2414^{b}
320	6.65^{b}	2.69^{ab}	19.1^{a}	2296^{bc}
640	6.21^{c}	2.54^{b}	61.3^{b}	2206^{c}
1280	5.70^{d}	2.36^{c}	67.9^{b}	2033^{d}
1920	5.83^{cd}	2.37^{c}	90.2^{c}	1818^{e}
2560	5.60^{d}	2.25^{c}	99.5^{cd}	1776^{e}
3840	4.95^{e}	2.00^{d}	107.1^{d}	1562^{f}
		Trial 2		
0	7.31^{a}	2.83^{a}	13.2^{a}	2596^{a}
80	7.08^{ab}	2.77^{a}	9.5^{a}	2403^{ab}
160	6.99^{ab}	2.82^{a}	8.8^{a}	2364^{b}
320	6.72^{bc}	2.67^{ab}	27.9^{b}	2248^{bc}
640	6.35^{c}	2.58^{b}	66.1^{cd}	2272^{bc}
1280	5.63^{d}	2.40^{c}	69.2^{c}	2102^{cd}
1920	5.92^{d}	2.36^{c}	82.8^{de}	1963de
2560	5.29^{e}	2.12^{d}	94.6^{ef}	1816^{e}
3840	5.00^{e}	2.06^{d}	99.9^{f}	1523^{f}

Means with the same letter are not significantly different. Letters within each cell apply to that cell only.

Figure 1


Acceptance Ranges
3.00
2.33
1.67
1.00
Acceptable
Marginal
Unacceptable

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APPENDIX A

CONSUMER PANEL QUESTIONNAIRE

Name_____ Panel # 180

Panelist # _____ January 22, 1993

Today you will be evaluating nine samples of milk. You will receive three sets of three. this is the first set. Before you begin tasting, please answer these questions about yourself.

- What is your age category?

  ☐ Under 18
  ☐ 18 - 35 years
  ☐ 36 - 54 years
  ☐ Over 55 years

- What is your gender?

  ☐ Female
  ☐ Male

- What is your attitude about Milk?

  ☐ I like milk
  ☐ I neither like nor dislike milk
  ☐ I dislike milk

Instructions:

- Please evaluate the samples within each set FROM LEFT TO RIGHT making sure that the numbers on the samples match the numbers on the questionnaire.
- Answer the two questions about each sample by CHECKing THE one BOX for each question that best describes your opinion.
- SMELL the sample before you TASTE it. While tasting move the sample around in your mouth making sure that it covers all surfaces (even back in the throat).
- We suggest that you don't swallow the sample but the you SPIT IT OUT into the paper cup provided. Your sense of taste will be more keen if you don't swallow.
- Between samples FRESHEN YOUR MOUTH by taking a sip of water and a bite of cracker.
- Turn the page and evaluate the samples.

MILK CONSUMER TEST

- Indicate how much you like the FLAVOR of these samples.

	Sample #'s		
	_____	_____	_____
Like extremely	☐	☐	☐
Like very much	☐	☐	☐
Like moderately	☐	☐	☐
Like slightly	☐	☐	☐
Neither like nor dislike	☐	☐	☐
Dislike slightly	☐	☐	☐
Dislike moderately	☐	☐	☐
Dislike very much	☐	☐	☐
Dislike extremely	☐	☐	☐

- Please indicate the acceptability of the flavor of each sample.

Acceptable	☐	☐	☐
Marginal	☐	☐	☐
Unacceptable	☐	☐	☐

Please place the sample and tray in the pass-through compartment and **FLASH THE GREEN LIGHT** by pushing the toggle to the **RIGHT** a few times until you are noticed. You will receive the next sample.

APPENDIX B
DESCRIPTIVE PANEL QUESTIONNAIRE
Descriptive Milk Panel 188

Panelist # _____ Name _____

We would like you to judge 18 samples of milk for the presence of "sunlight oxidized" flavor and to judge its intensity if present.

First taste the two controls, one with the oxidized flavor present and one without to refresh you memory. The scales have been marked according to how they were previously judged.

Control without "sunlight oxidized" flavor

Sample No._____

No Sunlight Oxidized Flavor — Sunlight Oxidized Flavor Very Strong

Control with "sunlight oxidized" flavor

Sample No._____

No Sunlight Oxidized Flavor — Sunlight Oxidized Flavor Very Strong

Now start at the booth indicated at the top of the next page and taste the samples in order from left to right, then continue on to the next booth. Take a bite of cracker and a sip of water to refresh your sense of taste between samples.

Please make sure that the numbers on the cup match the number on the questionnaire.

Please start at booth # _____

Sample No._____

No Sunlight Oxidized Flavor ——— Sunlight Oxidized Flavor Very Strong

Sample No._____

No Sunlight Oxidized Flavor ——— Sunlight Oxidized Flavor Very Strong

Sample No._____

No Sunlight Oxidized Flavor ——— Sunlight Oxidized Flavor Very Strong

Sample No._____

No Sunlight Oxidized Flavor ——— Sunlight Oxidized Flavor Very Strong

Sample No._____

No Sunlight Oxidized Flavor ——— Sunlight Oxidized Flavor Very Strong

Sample No._____

No Sunlight Oxidized Flavor ——— Oxidized Flavor Very Strong

Sample No._____

No Sunlight Oxidized Flavor ——— Oxidized Flavor Very Strong

APPENDIX C

EXPANDED EXPLANATION OF METHODS FOR QUANTIFICATION OF VITAMIN A

Apparatus and Reagents

(a) The High Performance Liquid Chromatograph (HPLC) was made up of an Altex model 110a pump fitted with an Altex 210 vented injector and a 20 μl loop. The column was an Alltech Econosphere C18 5U Column, 150 mm X 4.6 mm ID (Cat. No. 70065). The detector was a Beckman Model 165 Variable Wavelength UV Detector (set at 325 nm) connected to a Recorder Company Series 4500 Microscribe Strip Chart Recorder (model 4520).

(b) The mobile phase was 95:5 HPLC methanol:water at a flow rate of 0.8 ml/minute. The time constant was 1.0, the range was 0.02 and the chart recorder speed was 1.0 cm/minute.

Preparation of Standard

The stock solution was prepared by weighing approximately 25 mg of all-trans retinol acetate (synthetic, R-4632, lot # 59F0522, Sigma Chemical Co., St. Louis, MO 63178) into a 100 ml volumetric flask and bringing this to volume with absolute ethanol. The standard solution was made by accurately diluting 5 ml of the stock solution to 100 ml with absolute ethanol in a volumetric flask. Both flasks were covered with aluminum foil to protect from light. Retinol concentrations of the standard were determined by evaporating 5 ml of the

standard solution in a 15 ml capped test tube under nitrogen and then immediately redissolving the residue in 5 ml spectro-grade isopropanol. The absorbance of this solution was read at 325, 310 and 334 nm in a Milton Roy Spectronic 1001- Plus Spectrophotometer. The concentrations in ug/ml were determined using the following equation:

$$\text{Concentration}=(6.815A_{325}-2.555A_{310}-4.260A_{334})*5.49$$

Saponification and Extraction

Milk samples were allowed to come to room temperature and carefully mixed to prevent the formation of foam. Two ml of sample were added to a 50 ml centrifuge tube, followed by 5 ml of absolute ethanol containing .1% ascorbic acid, followed by 2 ml 50% (wt/vol) KOH. Tubes were capped, agitated carefully, and placed in an agitating water bath at 80 degrees C for 20 minutes. The tubes were then cooled under running water and placed in an ice water bath. Twenty ml of 50:50 diethyl ether:petroleum ether containing .01% (wt/vol) BHT was added. A nylon liner was placed in the tube's cap and securely screwed on the tube to prevent spilling. Tubes were mixed vigorously with a vortex mixer for 1 minute, allowed to stand for two minutes and then, mixed again for 1 minute. Fifteen ml of cold water (kept in ice water bath) were added to the tubes and tubes were inverted 10 times. The tubes were centrifuged for ten minutes at 1000 x g to separate phases.

Ten ml of the upper, organic layer were accurately pipetted into a 15 ml tube and evaporated to dryness under nitrogen. The residue was immediately redissolved in 1 ml of HPLC grade methanol and the tubes were capped and agitated in the vortex mixer.

Standard Solutions - The same procedures used to prepare the milk samples for HPLC quantification were also used for the standards with the following modifications: From .2 to 3.3 ml of the standard (see appendix D) were used along with .1 ml peanut oil (Spectrum Chemical Mfg. Corp., Gardena, California 90248) before saponification (to prevent retinol from oxidizing during evaporation of the solvent); 5 ml of the organic phase were evaporated and the residue was redissolved in 5 ml of HPLC grade methanol for injection.

Determination of Retinol

Peak heights of retinol from milk sample extracts were measured and compared to those of the standards.

APPENDIX D
SAS COMMAND FILES AND MODELS

Flavor and Acceptance

```
OPTIONS LS=80;
FILENAME MILK "MILK.DAT";
DATA MILK;
     INFILE MILK;
     INPUT PANELIST AGE SEX MILKATT SAMPLE FLAVOR ACCEPT;
PROC FREQ;
     TITLE 'MILK CONSUMER TEST - TABLES';
     TABLES AGE SEX MILKATT;
     TABLES SAMPLE*(FLAVOR ACCEPT);
PROC GLM;
     TITLE 'MILK CONSUMER TEST - ANALYSIS';
     CLASS PANELIST AGE SEX SAMPLE;
     MODEL FLAVOR -- ACCEPT = AGE SEX AGE*SEX
           PANELIST(AGE*SEX) SAMPLE AGE*SAMPLE SEX*SAMPLE;
     MANOVA H=SEX AGE E=PANELIST(AGE*SEX);
     MANOVA H=PANELIST (SEX*AGE) SAMPLE AGE*SAMPLE SEX*SAMPLE;
     TEST H=AGE E=PANELIST(AGE*SEX);
MEANS SAMPLE/DUNCAN;
ENDSAS;
```

Off-Flavor Quantification

```
OPTIONS LS=80;
FILENAME MILK "MILK.DAT";
DATA MILK;
        INFILE MILK;
        INPUT PANELIST SAMPLE TREATMNT OFFLAVOR;
PROC SORT;
        BY PANELIST;
PROC GLM;
        TITLE 'MILK ONE-WAY - ANALYSIS';
        CLASS PANELIST TREATMNT;
        MODEL OFFLAVOR = TREATMNT PANELIST TREATMNT*PANELIST;
        MEANS TREATMNT PANELIST/DUNCAN;
PROC GLM;
        TITLE 'MILK BY PANELIST - ANALYSIS - 2/9/93 - BYU';
        BY PANELIST;
        CLASS TREATMNT;
        MODEL OFFLAVOR = TREATMNT;
        MEANS TREATMNT/DUNCAN;
ENDSAS;
```

Vitamin A Concentrations

```
OPTIONS LS=80;
FILENAME VITADATA "VITADATA.DAT";
DATA VITADATA;
        INFILE VITADATA;
        INPUT TREATMNT VITA;
PROC SORT;
        BY TREATMNT;
PROC GLM;
        TITLE 'VITA ONE-WAY BY TREATMENT - ANALYSIS;
        BY TREAMNT
        CLASS TREATMNT;
        MODEL VITA = TREATMNT;
        MEANS TREATMNT/DUNCAN;
ENDSAS;
```

Ten ml of the upper, organic layer were accurately pipetted into a 15 ml tube and evaporated to dryness under nitrogen. The residue was immediately redissolved in 1 ml of HPLC grade methanol and the tubes were capped and agitated in the vortex mixer.

Standard Solutions - The same procedures used to prepare the milk samples for HPLC quantification were also used for the standards with the following modifications: From .2 to 3.3 ml of the standard (see appendix D) were used along with .1 ml peanut oil (Spectrum Chemical Mfg. Corp., Gardena, California 90248) before saponification (to prevent retinol from oxidizing during evaporation of the solvent); 5 ml of the organic phase were evaporated and the residue was redissolved in 5 ml of HPLC grade methanol for injection.

Determination of Retinol

Peak heights of retinol from milk sample extracts were measured and compared to those of the standards.

APPENDIX D
SAS COMMAND FILES AND MODELS

Flavor and Acceptance

```
OPTIONS LS=80;
FILENAME MILK "MILK.DAT";
DATA MILK;
     INFILE MILK;
     INPUT PANELIST AGE SEX MILKATT SAMPLE FLAVOR ACCEPT;
PROC FREQ;
     TITLE 'MILK CONSUMER TEST - TABLES';
     TABLES AGE SEX MILKATT;
     TABLES SAMPLE*(FLAVOR ACCEPT);
PROC GLM;
     TITLE 'MILK CONSUMER TEST - ANALYSIS';
     CLASS PANELIST AGE SEX SAMPLE;
     MODEL FLAVOR -- ACCEPT = AGE SEX AGE*SEX
           PANELIST(AGE*SEX) SAMPLE AGE*SAMPLE SEX*SAMPLE;
     MANOVA H=SEX AGE E=PANELIST(AGE*SEX);
     MANOVA H=PANELIST (SEX*AGE) SAMPLE AGE*SAMPLE SEX*SAMPLE;
     TEST H=AGE E=PANELIST(AGE*SEX);
MEANS SAMPLE/DUNCAN;
ENDSAS;
```

Off-Flavor Quantification

```
OPTIONS LS=80;
FILENAME MILK "MILK.DAT";
DATA MILK;
        INFILE MILK;
        INPUT PANELIST SAMPLE TREATMNT OFFLAVOR;
PROC SORT;
        BY PANELIST;
PROC GLM;
        TITLE 'MILK ONE-WAY - ANALYSIS';
        CLASS PANELIST TREATMNT;
        MODEL OFFLAVOR = TREATMNT PANELIST TREATMNT*PANELIST;
        MEANS TREATMNT PANELIST/DUNCAN;
PROC GLM;
        TITLE 'MILK BY PANELIST - ANALYSIS - 2/9/93 - BYU';
        BY PANELIST;
        CLASS TREATMNT;
        MODEL OFFLAVOR = TREATMNT;
        MEANS TREATMNT/DUNCAN;
ENDSAS;
```

Vitamin A Concentrations

```
OPTIONS LS=80;
FILENAME VITADATA "VITADATA.DAT";
DATA VITADATA;
        INFILE VITADATA;
        INPUT TREATMNT VITA;
PROC SORT;
        BY TREATMNT;
PROC GLM;
        TITLE 'VITA ONE-WAY BY TREATMENT - ANALYSIS;
        BY TREAMNT
        CLASS TREATMNT;
        MODEL VITA = TREATMNT;
        MEANS TREATMNT/DUNCAN;
ENDSAS;
```

APPENDIX E
DATA FROM REPORTED EXPERIMENTS

Standards:

REGRESSION TABLE FOR STANDARDS for Preliminary and Trial 1

Amt. Standard used (ml)	Conc. of Standard (I.U./Quart)	Peak Height (mm)
0.4	400.93	29
0.4	400.93	24
0.7	701.62	28
1	1002.32	46
1	1002.32	52
1.3	1303.02	87
1.6	1603.71	102
1.6	1603.71	103
1.9	1904.41	114
1.9	1904.41	122
2.2	2205.10	149
2.2	2205.10	152
2.5	2505.80	168
2.5	2505.80	176

The regression equation is
stconc = 162 + 13.9 stpeakht

Predictor	Coef	Stdev	t-ratio	p
Constant	161.95	55.82	2.90	0.009
stpeakht	13.8579	0.5232	26.49	0.000

s = 112.1 R-sq = 97.2% R-sq(adj) = 97.1%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	8819234	8819234	701.60	0.000
Error	20	251405	12570		
Total	21	9070639			

Predicted Y Values for Preliminary Trial

Sample Peak Ht. (mm)	Fit	Stdev. Fit	95% C.I.	95% P.I.
149	2226.8	36.4	(2150.7, 2302.8)	(1980.8, 2472.8)
151	2254.5	37.2	(2176.8, 2332.2)	(2008.0, 2501.0)
148	2212.9	36.1	(2137.7, 2288.2)	(1967.2, 2458.7)
147	2199.1	35.7	(2124.7, 2273.5)	(1953.6, 2444.6)
153	2282.2	38.1	(2202.8, 2361.6)	(2035.2, 2529.3)
150	2240.6	36.8	(2163.8, 2317.5)	(1994.4, 2486.9)
140	2102.1	33.0	(2033.1, 2171.0)	(1858.2, 2345.9)
137	2060.5	32.0	(1993.8, 2127.2)	(1817.2, 2303.7)
140	2102.1	33.0	(2033.1, 2171.0)	(1858.2, 2345.9)
132	1991.2	30.3	(1928.0, 2054.4)	(1748.9, 2233.5)
141	2115.9	33.4	(2046.2, 2185.6)	(1871.8, 2360.0)
134	2018.9	31.0	(1954.3, 2083.5)	(1776.2, 2261.6)
142	2129.8	33.8	(2059.3, 2200.2)	(1885.5, 2374.1)
125	1894.2	28.2	(1835.4, 1953.0)	(1653.0, 2135.4)
126	1908.1	28.5	(1848.6, 1967.5)	(1666.7, 2149.4)
121	1838.8	27.1	(1782.1, 1895.4)	(1598.1, 2079.5)
86	1353.7	24.5	(1302.6, 1404.9)	(1114.3, 1593.2)
91	1423.0	24.1	(1372.8, 1473.2)	(1183.8, 1662.3)

Predicted Y Values for Panel #1

Sample Peak Ht. (mm)	Fit	Stdev. Fit	95% C.I.	95% P.I.
177	2614.8	48.5	(2513.7, 2715.9)	(2360.0, 2869.7)
171	2531.7	45.8	(2436.2, 2627.1)	(2279.0, 2784.3)
165	2448.5	43.1	(2358.6, 2538.5)	(2197.9, 2699.1)
162	2406.9	41.8	(2319.7, 2494.2)	(2157.3, 2656.6)
167	2476.2	44.0	(2384.4, 2568.0)	(2224.9, 2727.5)
158	2351.5	40.1	(2267.8, 2435.2)	(2103.1, 2600.0)
148	2212.9	36.1	(2137.7, 2288.2)	(1967.2, 2458.7)
160	2379.2	41.0	(2293.7, 2464.7)	(2130.2, 2628.3)
147	2199.1	35.7	(2124.7, 2273.5)	(1953.6, 2444.6)
148	2212.9	36.1	(2137.7, 2288.2)	(1967.2, 2458.7)
132	1991.2	30.3	(1928.0, 2054.4)	(1748.9, 2233.5)
138	2074.4	32.3	(2006.9, 2141.8)	(1830.9, 2317.8)
120	1824.9	26.9	(1768.8, 1881.0)	(1584.3, 2065.5)
119	1811.0	26.7	(1755.4, 1866.7)	(1570.6, 2051.5)
120	1824.9	26.9	(1768.8, 1881.0)	(1584.3, 2065.5)
113	1727.9	25.4	(1674.8, 1781.0)	(1488.0, 1967.8)
99	1533.9	23.9	(1483.9, 1583.8)	(1294.7, 1773.1)
103	1589.3	24.2	(1538.9, 1639.7)	(1350.0, 1828.6)

REGRESSION TABLE FOR STANDARDS Panel 2

Amt. Standard used (ml)	Conc. of Standard (I.U./Quart)	Peak Height (mm)
0.3	297.34	18
0.3	297.34	21
0.6	594.68	39
0.6	594.68	37
0.9	892.02	52
0.9	892.02	57
1.2	1189.36	77
1.2	1189.36	84
1.5	1486.70	93
1.5	1486.70	90
1.8	1784.03	105
1.8	1784.03	120
2.1	2081.37	133
2.1	2081.37	134
2.4	2378.71	157
2.4	2378.71	155
2.7	2676.05	172
2.7	2676.05	169

The regression equation is
stconc = 17.2 + 15.4 stpeakht

Predictor	Coef	Stdev	t-ratio	p
Constant	17.15	33.09	0.52	0.611
stpeakht	15.4418	0.3084	50.07	0.000

s = 64.85 R-sq = 99.4% R-sq(adj) = 99.3%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	10541931	10541931	2507.00	0.000
Error	16	67280	4205		
Total	17	10609211			

Predicted Y Values for Panel #2

Sample Peak Ht.(mm)	Fit	Stdev. Fit	95% C.I.	95% P.I.
168	2611.4	27.2	(2553.8, 2669.0)	(2462.3, 2760.5)
166	2580.5	26.7	(2524.0, 2637.0)	(2431.8, 2729.2)
162	2518.7	25.7	(2464.3, 2573.1)	(2370.8, 2666.6)
147	2287.1	22.1	(2240.2, 2334.0)	(2141.8, 2432.4)
160	2487.8	25.2	(2434.5, 2541.2)	(2340.3, 2635.3)
144	2240.8	21.5	(2195.3, 2286.3)	(2095.9, 2385.6)
148	2302.5	22.3	(2255.2, 2349.9)	(2157.1, 2448.0)
141	2194.4	20.8	(2150.3, 2238.6)	(2050.0, 2338.9)
144	2240.8	21.5	(2195.3, 2286.3)	(2095.9, 2385.6)
148	2302.5	22.3	(2255.2, 2349.9)	(2157.1, 2448.0)
135	2101.8	19.6	(2060.2, 2143.4)	(1958.1, 2245.4)
135	2101.8	19.6	(2060.2, 2143.4)	(1958.1, 2245.4)
128	1993.7	18.3	(1954.8, 2032.6)	(1850.8, 2136.6)
124	1931.9	17.7	(1894.4, 1969.4)	(1789.4, 2074.5)
119	1854.7	17.0	(1818.8, 1890.7)	(1712.6, 1996.9)
114	1777.5	16.4	(1742.8, 1812.2)	(1635.7, 1919.3)
97	1515.0	15.3	(1482.6, 1547.4)	(1373.7, 1656.3)
98	1530.4	15.3	(1498.0, 1562.9)	(1389.2, 1671.7)

Preliminary Experiment
Consumer Panel

P	O	G	A	S	F	X	P	O	G	A	S	F	X	P	O	G	A	S	F	X
001	3	2	3	187	8	3	006	3	2	2	472	7	3	011	3	1	3	734	8	3
001	3	2	3	251	7	3	006	3	2	2	598	7	3	011	3	1	3	863	8	3
001	3	2	3	319	8	3	006	3	2	2	625	5	2	011	3	1	3	946	6	3
001	3	2	3	472	6	2	006	3	2	2	734	6	3	012	1	2	3	187	8	3
001	3	2	3	598	7	3	006	3	2	2	863	7	3	012	1	2	3	251	4	2
001	3	2	3	625	7	3	006	3	2	2	946	6	2	012	1	2	3	319	7	3
001	3	2	3	734	7	3	007	2	2	3	187	8	3	012	1	2	3	472	6	2
001	3	2	3	863	8	3	007	2	2	3	251	7	2	012	1	2	3	598	8	3
001	3	2	3	946	7	3	007	2	2	3	319	7	3	012	1	2	3	625	2	1
002	3	1	3	187	6	3	007	2	2	3	472	9	3	012	1	2	3	734	9	3
002	3	1	3	251	4	2	007	2	2	3	598	7	2	012	1	2	3	863	7	3
002	3	1	3	319	5	3	007	2	2	3	625	8	3	012	1	2	3	946	2	1
002	3	1	3	472	5	3	007	2	2	3	734	8	3	013	2	1	3	187	8	3
002	3	1	3	598	6	3	007	2	2	3	863	8	3	013	2	1	3	251	6	2
002	3	1	3	625	4	1	007	2	2	3	946	6	2	013	2	1	3	319	8	3
002	3	1	3	734	7	3	008	2	1	3	187	6	2	013	2	1	3	472	7	3
002	3	1	3	863	5	3	008	2	1	3	251	7	3	013	2	1	3	598	8	3
002	3	1	3	946	6	3	008	2	1	3	319	9	3	013	2	1	3	625	9	3
003	2	2	3	187	7	3	008	2	1	3	472	7	2	013	2	1	3	734	8	3
003	2	2	3	251	5	3	008	2	1	3	598	6	2	013	2	1	3	863	9	3
003	2	2	3	319	6	3	008	2	1	3	625	8	3	013	2	1	3	946	9	3
003	2	2	3	472	7	3	008	2	1	3	734	8	3	014	2	2	3	187	7	3
003	2	2	3	598	4	2	008	2	1	3	863	8	3	014	2	2	3	251	4	1
003	2	2	3	625	5	2	008	2	1	3	946	7	2	014	2	2	3	319	6	2
003	2	2	3	734	7	3	009	2	1	3	187	8	3	014	2	2	3	472	3	1
003	2	2	3	863	7	3	009	2	1	3	251	8	3	014	2	2	3	598	7	2
003	2	2	3	946	6	3	009	2	1	3	319	8	3	014	2	2	3	625	8	3
004	3	1	3	187	5	2	009	2	1	3	472	8	3	014	2	2	3	734	7	3
004	3	1	3	251	3	1	009	2	1	3	598	6	2	014	2	2	3	863	8	3
004	3	1	3	319	5	2	009	2	1	3	625	3	1	014	2	2	3	946	6	2
004	3	1	3	472	5	2	009	2	1	3	734	8	3	015	1	1	3	187	8	3
004	3	1	3	598	4	1	009	2	1	3	863	8	3	015	1	1	3	251	7	3
004	3	1	3	625	3	1	009	2	1	3	946	8	3	015	1	1	3	319	6	3
004	3	1	3	734	6	3	010	2	1	3	251	7	3	015	1	1	3	472	4	2
004	3	1	3	863	4	1	010	2	1	3	251	6	3	015	1	1	3	598	6	3
004	3	1	3	946	4	1	010	2	1	3	319	8	3	015	1	1	3	625	3	1
005	2	2	3	187	7	3	010	2	1	3	472	8	3	015	1	1	3	734	7	3
005	2	2	3	251	7	3	010	2	1	3	598	9	3	015	1	1	3	863	8	3
005	2	2	3	319	8	3	010	2	1	3	625	8	3	015	1	1	3	946	7	3
005	2	2	3	472	6	2	010	2	1	3	734	7	3	016	2	2	3	187	9	3
005	2	2	3	598	9	3	010	2	1	3	863	8	3	016	2	2	3	251	9	3
005	2	2	3	625	7	3	010	2	1	3	946	7	3	016	2	2	3	319	8	3
005	2	2	3	734	8	3	011	3	1	3	187	7	3	016	2	2	3	472	9	3
005	2	2	3	863	8	3	011	3	1	3	251	3	2	016	2	2	3	598	9	3
005	2	2	3	946	7	3	011	3	1	3	319	8	3	016	2	2	3	625	9	3
006	3	2	2	187	3	1	011	3	1	3	472	7	3	016	2	2	3	734	9	3
006	3	2	2	251	4	1	011	3	1	3	598	4	2	016	2	2	3	863	9	3
006	3	2	2	319	6	2	011	3	1	3	625	4	3	016	2	2	3	946	8	3

P	O	G	A	S	F	X	P	O	G	A	S	F	X	P	O	G	A	S	F	X
017	3	1	3	187	6	3	022	2	1	3	472	4	2	027	3	2	3	734	5	2
017	3	1	3	251	4	1	022	2	1	3	598	8	3	027	3	2	3	863	6	3
017	3	1	3	319	7	3	022	2	1	3	625	9	3	027	3	2	3	946	5	2
017	3	1	3	472	6	3	022	2	1	3	734	7	3	028	3	2	2	187	7	2
017	3	1	3	598	6	3	022	2	1	3	863	8	3	028	3	2	2	251	4	2
017	3	1	3	625	5	2	022	2	1	3	946	9	3	028	3	2	2	319	7	3
017	3	1	3	734	7	3	023	3	2	3	187	7	3	028	3	2	2	472	4	2
017	3	1	3	863	7	3	023	3	2	3	251	3	1	028	3	2	2	598	8	3
017	3	1	3	946	4	2	023	3	2	3	319	6	3	028	3	2	2	625	7	3
018	2	2	3	187	1	1	023	3	2	3	472	6	3	028	3	2	2	734	6	3
018	2	2	3	251	1	1	023	3	2	3	598	8	3	028	3	2	2	863	7	3
018	2	2	3	319	9	3	023	3	2	3	625	7	3	028	3	2	2	946	6	2
018	2	2	3	472	1	1	023	3	2	3	734	7	3	029	3	1	3	187	7	2
018	2	2	3	598	9	3	023	3	2	3	863	8	3	029	3	1	3	251	4	1
018	2	2	3	625	1	1	023	3	2	3	946	4	2	029	3	1	3	319	6	2
018	2	2	3	734	9	3	024	2	1	3	187	8	3	029	3	1	3	472	6	3
018	2	2	3	863	9	3	024	2	1	3	251	5	2	029	3	1	3	598	5	2
018	2	2	3	946	1	1	024	2	1	3	319	7	3	029	3	1	3	625	3	1
019	2	1	3	187	3	2	024	2	1	3	472	4	1	029	3	1	3	734	9	3
019	2	1	3	251	4	2	024	2	1	3	598	7	3	029	3	1	3	863	7	2
019	2	1	3	319	6	3	024	2	1	3	625	6	2	029	3	1	3	946	5	2
019	2	1	3	472	2	1	024	2	1	3	734	7	3	030	1	1	3	187	8	3
019	2	1	3	598	5	3	024	2	1	3	863	7	3	030	1	1	3	251	3	1
019	2	1	3	625	4	2	024	2	1	3	946	5	2	030	1	1	3	319	9	3
019	2	1	3	734	7	3	025	2	2	3	187	7	3	030	1	1	3	472	4	1
019	2	1	3	863	7	3	025	2	2	3	251	2	1	030	1	1	3	598	8	3
019	2	1	3	946	4	2	025	2	2	3	319	7	3	030	1	1	3	625	6	2
020	2	2	3	187	5	3	025	2	2	3	472	6	3	030	1	1	3	734	7	2
020	2	2	3	251	5	3	025	2	2	3	598	8	3	030	1	1	3	863	9	3
020	2	2	3	319	8	3	025	2	2	3	625	6	3	030	1	1	3	946	8	3
020	2	2	3	472	5	3	025	2	2	3	734	8	3	031	2	1	3	187	3	1
020	2	2	3	598	4	3	025	2	2	3	863	7	3	031	2	1	3	251	3	1
020	2	2	3	625	5	3	025	2	2	3	946	7	3	031	2	1	3	319	3	1
020	2	2	3	734	8	3	026	2	2	3	187	4	2	031	2	1	3	472	1	1
020	2	2	3	863	7	3	026	2	2	3	251	3	1	031	2	1	3	598	3	1
020	2	2	3	946	4	3	026	2	2	3	319	4	2	031	2	1	3	625	3	1
021	3	1	3	187	5	2	026	2	2	3	472	7	3	031	2	1	3	734	7	3
021	3	1	3	251	2	1	026	2	2	3	598	.	2	031	2	1	3	863	7	3
021	3	1	3	319	6	3	026	2	2	3	625	7	3	031	2	1	3	946	3	1
021	3	1	3	472	4	2	026	2	2	3	734	3	1	032	1	1	3	187	4	2
021	3	1	3	598	6	3	026	2	2	3	863	8	3	032	1	1	3	251	4	1
021	3	1	3	625	7	3	026	2	2	3	946	4	2	032	1	1	3	319	6	3
021	3	1	3	734	7	3	027	3	2	3	187	4	2	032	1	1	3	472	5	2
021	3	1	3	863	8	3	027	3	2	3	251	4	1	032	1	1	3	598	3	1
021	3	1	3	946	2	1	027	3	2	3	319	8	3	032	1	1	3	625	4	2
022	2	1	3	187	4	2	027	3	2	3	472	6	3	032	1	1	3	734	6	3
022	2	1	3	251	9	3	027	3	2	3	598	7	3	032	1	1	3	863	5	3
022	2	1	3	319	6	3	027	3	2	3	625	8	3	032	1	1	3	946	3	1

P	O	G	A	S	F	X
033	2	2	3	187	7	3
033	2	2	3	251	7	3
033	2	2	3	319	8	3
033	2	2	3	472	6	2
033	2	2	3	598	6	2
033	2	2	3	625	6	2
033	2	2	3	734	9	3
033	2	2	3	863	9	3
033	2	2	3	946	7	3
034	3	2	3	187	7	3
034	3	2	3	251	5	2
034	3	2	3	319	7	3
034	3	2	3	472	7	3
034	3	2	3	598	8	3
034	3	2	3	625	7	3
034	3	2	3	734	8	3
034	3	2	3	863	7	3
034	3	2	3	946	4	1
035	1	2	3	187	7	3
035	1	2	3	251	8	3
035	1	2	3	319	7	3
035	1	2	3	472	7	3
035	1	2	3	598	8	3
035	1	2	3	625	7	3
035	1	2	3	734	7	3
035	1	2	3	863	7	3
035	1	2	3	946	8	3
036	2	2	3	187	6	3
036	2	2	3	251	7	3
036	2	2	3	319	7	3
036	2	2	3	472	6	3
036	2	2	3	598	7	3
036	2	2	3	625	7	3
036	2	2	3	734	6	3
036	2	2	3	863	6	2
036	2	2	3	946	7	3
037	3	2	2	187	4	2
037	3	2	2	251	3	1
037	3	2	2	319	7	3
037	3	2	2	472	6	3
037	3	2	2	598	4	2
037	3	2	2	625	8	3
037	3	2	2	734	6	2
037	3	2	2	863	8	3
037	3	2	2	946	5	2
038	2	2	3	187	7	2
038	2	2	3	251	8	3
038	2	2	3	319	9	3
038	2	2	3	472	6	2
038	2	2	3	598	7	2
038	2	2	3	625	7	3
038	2	2	3	734	8	3
038	2	2	3	863	9	3
038	2	2	3	946	9	3
039	3	2	3	187	5	3
039	3	2	3	251	7	3
039	3	2	3	319	7	3
039	3	2	3	472	6	3
039	3	2	3	598	7	3
039	3	2	3	625	2	1
039	3	2	3	734	4	1
039	3	2	3	863	5	2
039	3	2	3	946	6	3
040	3	2	3	187	6	3
040	3	2	3	251	4	1
040	3	2	3	319	6	3
040	3	2	3	472	2	1
040	3	2	3	598	5	2
040	3	2	3	625	5	2
040	3	2	3	734	7	3
040	3	2	3	863	5	2
040	3	2	3	946	7	3
041	2	2	2	187	3	1
041	2	2	2	251	4	2
041	2	2	2	319	6	2
041	2	2	2	472	6	3
041	2	2	2	598	6	3
041	2	2	2	625	4	2
041	2	2	2	734	5	2
041	2	2	2	863	5	2
041	2	2	2	946	6	3
042	3	2	3	187	7	3
042	3	2	3	251	3	1
042	3	2	3	319	7	3
042	3	2	3	472	4	2
042	3	2	3	598	7	2
042	3	2	3	625	4	2
042	3	2	3	734	8	3
042	3	2	3	863	8	3
042	3	2	3	946	6	2
043	2	1	3	187	4	2
043	2	1	3	251	6	2
043	2	1	3	319	8	3
043	2	1	3	472	1	1
043	2	1	3	598	4	2
043	2	1	3	625	3	2
043	2	1	3	734	8	3
043	2	1	3	863	7	2
043	2	1	3	946	1	1
044	2	1	3	187	6	3
044	2	1	3	251	6	3
044	2	1	3	319	5	2
044	2	1	3	472	6	2
044	2	1	3	598	7	3
044	2	1	3	625	5	2
044	2	1	3	734	6	3
044	2	1	3	863	7	3
044	2	1	3	946	4	1
045	2	1	3	187	7	3
045	2	1	3	251	4	1
045	2	1	3	319	8	3
045	2	1	3	472	7	3
045	2	1	3	598	7	3
045	2	1	3	625	7	3
045	2	1	3	734	9	3
045	2	1	3	863	8	3
045	2	1	3	946	4	1
046	3	1	3	187	7	3
046	3	1	3	251	3	2
046	3	1	3	319	8	3
046	3	1	3	472	2	1
046	3	1	3	598	8	3
046	3	1	3	625	4	2
046	3	1	3	734	8	3
046	3	1	3	863	8	3
046	3	1	3	946	6	2
047	2	2	3	187	8	3
047	2	2	3	251	4	3
047	2	2	3	319	6	3
047	2	2	3	472	7	3
047	2	2	3	598	7	3
047	2	2	3	625	5	3
047	2	2	3	734	7	3
047	2	2	3	863	7	3
047	2	2	3	946	6	3
048	3	1	3	187	2	1
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110	3	1	3	598	8	3
110	3	1	3	625	9	3
110	3	1	3	734	9	3
110	3	1	3	863	8	3
110	3	1	3	946	8	3

DESCRIPTIVE PANEL

P	S	T	Y
001	134	9	109
001	162	3	3
001	260	2	2
001	274	6	79
001	345	9	110
001	391	4	50
001	412	6	64
001	481	8	111
001	519	1	0
001	576	1	2
001	623	8	112
001	693	7	78
001	750	5	74
001	785	3	1
001	832	4	21
001	847	5	21
001	927	2	3
001	958	7	67
002	134	9	119
002	162	3	102
002	260	2	34
002	274	6	31
002	345	9	83
002	391	4	10
002	412	6	68
002	481	8	74
002	519	1	5
002	576	1	6
002	623	8	112
002	693	7	30
002	750	5	23
002	785	3	45
002	832	4	71
002	847	5	75
002	927	2	5
002	958	7	48
003	134	9	133
003	162	3	3
003	260	2	3
003	274	6	119
003	345	9	117
003	391	4	28
003	412	6	80
003	481	8	134
003	519	1	14
003	576	1	3
003	623	8	117
003	693	7	30
003	750	5	33
003	785	3	2
003	832	4	41
003	847	5	45
003	927	2	0
003	958	7	61
004	134	9	98
004	162	3	3
004	260	2	2
004	274	6	49
004	345	9	28
004	391	4	5
004	412	6	33
004	481	8	77
004	519	1	3
004	576	1	4
004	623	8	71
004	693	7	55
004	750	5	6
004	785	3	5
004	832	4	3
004	847	5	27
004	927	2	4
004	958	7	30
005	134	9	110
005	162	3	28
005	260	2	1
005	274	6	68
005	345	9	107
005	391	4	58
005	412	6	20
005	481	8	82
005	519	1	30
005	576	1	0
005	623	8	106
005	693	7	32
005	750	5	21
005	785	3	11
005	832	4	27
005	847	5	84
005	927	2	22
005	958	7	67
006	134	9	108
006	162	3	3
006	260	2	2
006	274	6	38
006	345	9	43
006	391	4	48
006	412	6	47
006	481	8	115
006	519	1	13
006	576	1	45
006	623	8	78
006	693	7	38
006	750	5	88
006	785	3	1
006	832	4	0
006	847	5	48
006	927	2	22
006	958	7	16
007	134	9	90
007	162	3	7
007	260	2	5
007	274	6	40
007	345	9	92
007	391	4	7
007	412	6	50
007	481	8	91
007	519	1	6
007	576	1	7
007	623	8	80
007	693	7	40
007	750	5	49
007	785	3	5
007	832	4	13
007	847	5	6
007	927	2	7
007	958	7	90
008	134	9	105
008	162	3	63
008	260	2	104
008	274	6	100
008	345	9	58
008	391	4	12
008	412	6	86
008	481	8	15
008	519	1	38
008	576	1	12
008	623	8	15
008	693	7	102
008	750	5	97
008	785	3	15
008	832	4	105
008	847	5	13
008	927	2	117
008	958	7	13
009	134	9	117
009	162	3	10
009	260	2	2

P	S	T	Y
009	274	6	49
009	345	9	104
009	391	4	39
009	412	6	38
009	481	8	78
009	519	1	10
009	576	1	2
009	623	8	75
009	693	7	74
009	750	5	10
009	785	3	11
009	832	4	4
009	847	5	51
009	927	2	9
009	958	7	74

General Linear Models Procedure

Dependent Variable: FLAVOR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	114	1381.2108535	12.1158847	6.53	0.0001
Error	845	1568.5297715	1.8562483		
Corrected Total	959	2949.7406250			

R-Square	C.V.	Root MSE	FLAVOR Mean
0.468248	21.36117	1.3624420	6.3781250

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AGE	2	0.4907754	0.2453877	0.13	0.8762
SEX	1	2.1839226	2.1839226	1.18	0.2784
AGE*SEX	2	12.2404519	6.1202259	3.30	0.0375
PANELIST(AGE*SEX)	101	1024.1565357	10.1401637	5.46	0.0001
SAMPLE	8	326.9980062	40.8747508	22.02	0.0001

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	SAMPLE
A	6.8598	107	391
A			
A	6.8286	105	576
A			
A	6.8131	107	260
A			
A	6.7944	107	785
A			
A	6.7757	107	847
B	6.3832	107	412
B			
B	6.1869	107	958
C	5.6204	108	623
D	5.1509	106	134

General Linear Models Procedure

Dependent Variable: FLAVOR ACCEPTANCE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	114	181.59797875	1.59296473	4.94	0.0001
Error	845	272.33535459	0.32229036		
Corrected Total	959	453.93333333			

R-Square	C.V.	Root MSE	ACCEPT Mean
0.400054	22.78420	0.5677062	2.4916667

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AGE	2	1.16528676	0.58264338	1.81	0.1646
SEX	1	0.32332588	0.32332588	1.00	0.3168
AGE*SEX	2	3.05630494	1.52815247	4.74	0.0090
PANELIST(AGE*SEX)	101	116.80849443	1.15651975	3.59	0.0001
SAMPLE	8	57.06742319	7.13342790	22.13	0.0001

Duncan Grouping	Mean	N	SAMPLE
A	2.71698	106	847
A			
A	2.70093	107	576
A			
A	2.67290	107	785
A			
A	2.66355	107	260
A			
A	2.63551	107	391
B	2.43925	107	412
B			
B	2.42991	107	958
C	2.20370	108	623
D	1.97170	106	134

General Linear Models Procedure

Dependent Variable: OFF-FLAVOR QUANTIFICATION

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	71	185529.15972	2613.08676	6.40	0.0001
Error	72	29400.50000	408.34028		
Corrected Total	143	214929.65972			

R-Square	C.V.	Root MSE	OFFLAVOR Mean
0.863209	45.58781	20.207431	44.326389

Source	DF	Type III SS	Mean Square	F Value	Pr > F
TREATMNT	8	149039.472	18629.934	45.62	0.0001
PANELIST	7	9379.493	1339.927	3.28	0.0044
PANELIST*TREATMNT	56	27110.194	484.110	1.19	0.2466

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	TREATMNT
A	98.000	16	9
A			
A	94.563	16	8
B	54.563	16	6
B			
B	51.875	16	7
B			
B	41.313	16	5
C	26.563	16	4
C			
C	15.000	16	3
D			
D	9.375	16	1
D			
D	7.688	16	2

General Linear Models Procedure

Dependent Variable: VITAMIN A CONCENTRATION

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	1137585.6178	142198.2022	28.05	0.0001
Error	9	45619.5000	5068.8333		
Corrected Total	17	1183205.1178			

R-Square	C.V.	Root MSE	VITA Mean
0.961444	3.525084	71.195740	2019.6889

Source	DF	Type III SS	Mean Square	F Value	Pr > F
TREATMNT	8	1137585.6178	142198.2022	28.05	0.0001

Duncan Grouping			Mean	N	TREATMNT
	A		2261.40	2	3
	A				
B	A		2240.65	2	1
B	A				
B	A	C	2206.00	2	2
B		C			
B	D	C	2081.30	2	4
	D	C			
	D	C	2067.40	2	6
	D	C			
	D	C	2046.65	2	5
	D				
E	D		2012.00	2	7
E					
E			1873.45	2	8
	F		1388.35	2	9

Experiment 1 Consumer panel

P	O	G	A	S	F	X	P	O	G	A	S	F	X	P	O	G	A	S	F	X
001	3	2	3	187	8	3	006	3	2	2	472	7	3	011	3	1	3	734	8	3
001	3	2	3	251	7	3	006	3	2	2	598	7	3	011	3	1	3	863	8	3
001	3	2	3	319	8	3	006	3	2	2	625	5	2	011	3	1	3	946	6	3
001	3	2	3	472	6	2	006	3	2	2	734	6	3	012	1	2	3	187	8	3
001	3	2	3	598	7	3	006	3	2	2	863	7	3	012	1	2	3	251	4	2
001	3	2	3	625	7	3	006	3	2	2	946	6	2	012	1	2	3	319	7	3
001	3	2	3	734	7	3	007	2	2	3	187	8	3	012	1	2	3	472	6	2
001	3	2	3	863	8	3	007	2	2	3	251	7	2	012	1	2	3	598	8	3
001	3	2	3	946	7	3	007	2	2	3	319	7	3	012	1	2	3	625	2	1
002	3	1	3	187	6	3	007	2	2	3	472	9	3	012	1	2	3	734	9	3
002	3	1	3	251	4	2	007	2	2	3	598	7	2	012	1	2	3	863	7	3
002	3	1	3	319	5	3	007	2	2	3	625	8	3	012	1	2	3	946	2	1
002	3	1	3	472	5	3	007	2	2	3	734	8	3	013	2	1	3	187	8	3
002	3	1	3	598	6	3	007	2	2	3	863	8	3	013	2	1	3	251	6	2
002	3	1	3	625	4	1	007	2	2	3	946	6	2	013	2	1	3	319	8	3
002	3	1	3	734	7	3	008	2	1	3	187	6	2	013	2	1	3	472	7	3
002	3	1	3	863	5	3	008	2	1	3	251	7	3	013	2	1	3	598	8	3
002	3	1	3	946	6	3	008	2	1	3	319	9	3	013	2	1	3	625	9	3
003	2	2	3	187	7	3	008	2	1	3	472	7	2	013	2	1	3	734	8	3
003	2	2	3	251	5	3	008	2	1	3	598	6	2	013	2	1	3	863	9	3
003	2	2	3	319	6	3	008	2	1	3	625	8	3	013	2	1	3	946	9	3
003	2	2	3	472	7	3	008	2	1	3	734	8	3	014	2	2	3	187	7	3
003	2	2	3	598	4	2	008	2	1	3	863	8	3	014	2	2	3	251	4	1
003	2	2	3	625	5	2	008	2	1	3	946	7	2	014	2	2	3	319	6	2
003	2	2	3	734	7	3	009	2	1	3	187	8	3	014	2	2	3	472	3	1
003	2	2	3	863	7	3	009	2	1	3	251	8	3	014	2	2	3	598	7	2
003	2	2	3	946	6	3	009	2	1	3	319	8	3	014	2	2	3	625	8	3
004	3	1	3	187	5	2	009	2	1	3	472	8	3	014	2	2	3	734	7	3
004	3	1	3	251	3	1	009	2	1	3	598	6	2	014	2	2	3	863	8	3
004	3	1	3	319	5	2	009	2	1	3	625	3	1	014	2	2	3	946	6	2
004	3	1	3	472	5	2	009	2	1	3	734	8	3	015	1	1	3	187	8	3
004	3	1	3	598	4	1	009	2	1	3	863	8	3	015	1	1	3	251	7	3
004	3	1	3	625	3	1	009	2	1	3	946	8	3	015	1	1	3	319	6	3
004	3	1	3	734	6	3	010	2	1	3	251	7	3	015	1	1	3	472	4	2
004	3	1	3	863	4	1	010	2	1	3	251	6	3	015	1	1	3	598	6	3
004	3	1	3	946	4	1	010	2	1	3	319	8	3	015	1	1	3	625	3	1
005	2	2	3	187	7	3	010	2	1	3	472	8	3	015	1	1	3	734	7	3
005	2	2	3	251	7	3	010	2	1	3	598	9	3	015	1	1	3	863	8	3
005	2	2	3	319	8	3	010	2	1	3	625	8	3	015	1	1	3	946	7	3
005	2	2	3	472	6	2	010	2	1	3	734	7	3	016	2	2	3	187	9	3
005	2	2	3	598	9	3	010	2	1	3	863	8	3	016	2	2	3	251	9	3
005	2	2	3	625	7	3	010	2	1	3	946	7	3	016	2	2	3	319	8	3
005	2	2	3	734	8	3	011	3	1	3	187	7	3	016	2	2	3	472	9	3
005	2	2	3	863	8	3	011	3	1	3	251	3	2	016	2	2	3	598	9	3
005	2	2	3	946	7	3	011	3	1	3	319	8	3	016	2	2	3	625	9	3
006	3	2	2	187	3	1	011	3	1	3	472	7	3	016	2	2	3	734	9	3
006	3	2	2	251	4	1	011	3	1	3	598	4	2	016	2	2	3	863	9	3
006	3	2	2	319	6	2	011	3	1	3	625	4	3	016	2	2	3	946	8	3

P	O	G	A	S	F	X
017	3	1	3	187	6	3
017	3	1	3	251	4	1
017	3	1	3	319	7	3
017	3	1	3	472	6	3
017	3	1	3	598	6	3
017	3	1	3	625	5	2
017	3	1	3	734	7	3
017	3	1	3	863	7	3
017	3	1	3	946	4	2
018	2	2	3	187	1	1
018	2	2	3	251	1	1
018	2	2	3	319	9	3
018	2	2	3	472	1	1
018	2	2	3	598	9	3
018	2	2	3	625	1	1
018	2	2	3	734	9	3
018	2	2	3	863	9	3
018	2	2	3	946	1	1
019	2	1	3	187	3	2
019	2	1	3	251	4	2
019	2	1	3	319	6	3
019	2	1	3	472	2	1
019	2	1	3	598	5	3
019	2	1	3	625	4	2
019	2	1	3	734	7	3
019	2	1	3	863	7	3
019	2	1	3	946	4	2
020	2	2	3	187	5	3
020	2	2	3	251	5	3
020	2	2	3	319	8	3
020	2	2	3	472	5	3
020	2	2	3	598	4	3
020	2	2	3	625	5	3
020	2	2	3	734	8	3
020	2	2	3	863	7	3
020	2	2	3	946	4	3
021	3	1	3	187	5	2
021	3	1	3	251	2	1
021	3	1	3	319	6	3
021	3	1	3	472	4	2
021	3	1	3	598	6	3
021	3	1	3	625	7	3
021	3	1	3	734	7	3
021	3	1	3	863	8	3
021	3	1	3	946	2	1
022	2	1	3	187	4	2
022	2	1	3	251	9	3
022	2	1	3	319	6	3
022	2	1	3	472	4	2
022	2	1	3	598	8	3
022	2	1	3	625	9	3
022	2	1	3	734	7	3
022	2	1	3	863	8	3
022	2	1	3	946	9	3
023	3	2	3	187	7	3
023	3	2	3	251	3	1
023	3	2	3	319	6	3
023	3	2	3	472	6	3
023	3	2	3	598	8	3
023	3	2	3	625	7	3
023	3	2	3	734	7	.
023	3	2	3	863	8	3
023	3	2	3	946	4	2
024	2	1	3	187	8	3
024	2	1	3	251	5	2
024	2	1	3	319	7	3
024	2	1	3	472	4	1
024	2	1	3	598	7	3
024	2	1	3	625	6	2
024	2	1	3	734	7	3
024	2	1	3	863	7	3
024	2	1	3	946	5	2
025	2	2	3	187	7	3
025	2	2	3	251	2	1
025	2	2	3	319	7	3
025	2	2	3	472	6	3
025	2	2	3	598	8	3
025	2	2	3	625	6	3
025	2	2	3	734	8	3
025	2	2	3	863	7	3
025	2	2	3	946	7	3
026	2	2	3	187	4	2
026	2	2	3	251	3	1
026	2	2	3	319	4	2
026	2	2	3	472	7	3
026	2	2	3	598	.	2
026	2	2	3	625	7	3
026	2	2	3	734	3	1
026	2	2	3	863	8	3
026	2	2	3	946	4	2
027	3	2	3	187	4	2
027	3	2	3	251	4	1
027	3	2	3	319	8	3
027	3	2	3	472	6	3
027	3	2	3	598	7	3
027	3	2	3	625	8	3
027	3	2	3	734	5	2
027	3	2	3	863	6	3
027	3	2	3	946	5	2
028	3	2	2	187	7	2
028	3	2	2	251	4	2
028	3	2	2	319	7	3
028	3	2	2	472	4	2
028	3	2	2	598	8	3
028	3	2	2	625	7	3
028	3	2	2	734	6	3
028	3	2	2	863	7	3
028	3	2	2	946	6	2
029	3	1	3	187	7	2
029	3	1	3	251	4	1
029	3	1	3	319	6	2
029	3	1	3	472	6	3
029	3	1	3	598	5	2
029	3	1	3	625	3	1
029	3	1	3	734	9	3
029	3	1	3	863	7	2
029	3	1	3	946	5	2
030	1	1	3	187	8	3
030	1	1	3	251	3	1
030	1	1	3	319	9	3
030	1	1	3	472	4	1
030	1	1	3	598	8	3
030	1	1	3	625	6	2
030	1	1	3	734	7	2
030	1	1	3	863	9	3
030	1	1	3	946	8	3
031	2	1	3	187	3	1
031	2	1	3	251	3	1
031	2	1	3	319	3	1
031	2	1	3	472	1	1
031	2	1	3	598	3	1
031	2	1	3	625	3	1
031	2	1	3	734	7	3
031	2	1	3	863	7	3
031	2	1	3	946	3	1
032	1	1	3	187	4	2
032	1	1	3	251	4	1
032	1	1	3	319	6	3
032	1	1	3	472	5	2
032	1	1	3	598	3	1
032	1	1	3	625	4	2
032	1	1	3	734	6	3
032	1	1	3	863	5	3
032	1	1	3	946	3	1

P	O	G	A	S	F	X
033	2	2	3	187	7	3
033	2	2	3	251	7	3
033	2	2	3	319	8	3
033	2	2	3	472	6	2
033	2	2	3	598	6	2
033	2	2	3	625	6	2
033	2	2	3	734	9	3
033	2	2	3	863	9	3
033	2	2	3	946	7	3
034	3	2	3	187	7	3
034	3	2	3	251	5	2
034	3	2	3	319	7	3
034	3	2	3	472	7	3
034	3	2	3	598	8	3
034	3	2	3	625	7	3
034	3	2	3	734	8	3
034	3	2	3	863	7	3
034	3	2	3	946	4	1
035	1	2	3	187	7	3
035	1	2	3	251	8	3
035	1	2	3	319	7	3
035	1	2	3	472	7	3
035	1	2	3	598	8	3
035	1	2	3	625	7	3
035	1	2	3	734	7	3
035	1	2	3	863	7	3
035	1	2	3	946	8	3
036	2	2	3	187	6	3
036	2	2	3	251	7	3
036	2	2	3	319	7	3
036	2	2	3	472	6	3
036	2	2	3	598	7	3
036	2	2	3	625	7	3
036	2	2	3	734	6	3
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088	3	1	3	319	8	3	093	3	2	3	625	4	2	098	2	1	3	946	6	3

P	O	G	A	S	F	X
099	3	2	3	187	3	2
099	3	2	3	251	3	2
099	3	2	3	319	7	3
099	3	2	3	472	3	2
099	3	2	3	598	7	3
099	3	2	3	625	6	3
099	3	2	3	734	6	3
099	3	2	3	863	8	3
099	3	2	3	946	6	3
100	2	2	3	187	6	2
100	2	2	3	251	7	2
100	2	2	3	319	6	2
100	2	2	3	472	8	3
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100	2	2	3	734	7	2
100	2	2	3	863	7	2
100	2	2	3	946	8	3
101	3	1	3	187	6	3
101	3	1	3	251	8	3
101	3	1	3	319	7	3
101	3	1	3	472	7	3
101	3	1	3	598	6	2
101	3	1	3	625	8	3
101	3	1	3	734	7	3
101	3	1	3	863	7	3
101	3	1	3	946	6	2
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102	3	2	3	251	7	3
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102	3	2	3	472	7	2
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102	3	2	3	625	6	2
102	3	2	3	734	9	3
102	3	2	3	863	8	3
102	3	2	3	946	8	3
103	3	1	3	187	8	3
103	3	1	3	251	3	1
103	3	1	3	319	7	3
103	3	1	3	472	2	1
103	3	1	3	598	6	2
103	3	1	3	625	6	2
103	3	1	3	734	8	3
103	3	1	3	863	7	3
103	3	1	3	946	4	2
104	2	1	3	187	7	3
104	2	1	3	251	4	2
104	2	1	3	319	8	3
104	2	1	3	472	4	2
104	2	1	3	598	8	3
104	2	1	3	625	4	2
104	2	1	3	734	6	3
104	2	1	3	863	8	3
104	2	1	3	946	4	2
105	2	1	3	187	6	2
105	2	1	3	251	4	1
105	2	1	3	319	8	3
105	2	1	3	472	7	2
105	2	1	3	598	8	3
105	2	1	3	625	6	2
105	2	1	3	734	8	3
105	2	1	3	863	8	3
105	2	1	3	946	5	2
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106	2	1	3	472	8	3
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106	2	1	3	625	9	3
106	2	1	3	734	4	1
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107	2	1	3	472	4	2
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107	2	1	3	625	4	1
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108	2	2	3	946	8	3
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110	3	1	3	251	7	3
110	3	1	3	319	9	3
110	3	1	3	472	7	3
110	3	1	3	598	8	3
110	3	1	3	625	9	3
110	3	1	3	734	9	3
110	3	1	3	863	8	3
110	3	1	3	946	8	3

DESCRIPTIVE PANEL

P	S	T	Y
001	143	6	30
001	187	5	2
001	251	9	95
001	278	8	95
001	319	2	5
001	394	9	95
001	457	1	4
001	472	6	30
001	562	7	91
001	598	4	4
001	625	8	69
001	685	3	3
001	716	5	68
001	734	1	4
001	829	2	4
001	863	3	3
001	931	4	3
001	946	7	69
002	143	6	5
002	187	5	17
002	251	9	28
002	278	8	82
002	319	2	4
002	394	9	63
002	457	1	8
002	472	6	32
002	562	7	56
002	598	4	3
002	625	8	17
002	685	3	4
002	716	5	35
002	734	1	7
002	829	2	5
002	863	3	4
002	931	4	4
002	946	7	74
003	143	6	56
003	187	5	30
003	251	9	74
003	278	8	87
003	319	2	12
003	394	9	128
003	457	1	28
003	472	6	132
003	562	7	96
003	598	4	16
003	625	8	107
003	685	3	75
003	716	5	90
003	734	1	28
003	829	2	24
003	863	3	42
003	931	4	36
003	946	7	103
004	143	6	90
004	187	5	95
004	251	9	119
004	278	8	122
004	319	2	2
004	394	9	122
004	457	1	3
004	472	6	96
004	562	7	108
004	598	4	6
004	625	8	97
004	685	3	6
004	716	5	105
004	734	1	4
004	829	2	4
004	863	3	4
004	931	4	36
004	946	7	118
005	143	6	92
005	187	5	44
005	251	9	111
005	278	8	106
005	319	2	49
005	394	9	76
005	457	1	27
005	472	6	59
005	562	7	102
005	598	4	15
005	625	8	86
005	685	3	28
005	716	5	67
005	734	1	1
005	829	2	13
005	863	3	1
005	931	4	33
005	946	7	71
006	143	6	114
006	187	5	85
006	251	9	133
006	278	8	125
006	319	2	10
006	394	9	127
006	457	1	0
006	472	6	112
006	562	7	87
006	598	4	31
006	625	8	112
006	685	3	6
006	716	5	121
006	734	1	1
006	829	2	3
006	863	3	2
006	931	4	96
006	946	7	94
007	143	6	88
007	187	5	27
007	251	9	140
007	278	8	130
007	319	2	19
007	394	9	130
007	457	1	10
007	472	6	40
007	562	7	84
007	598	4	5
007	625	8	121
007	685	3	16
007	716	5	58
007	734	1	3
007	829	2	4
007	863	3	3
007	931	4	9
007	946	7	95
008	143	6	47
008	187	5	72
008	251	9	139
008	278	8	116
008	319	2	4
008	394	9	134
008	457	1	4
008	472	6	63
008	562	7	121
008	598	4	2
008	625	8	120
008	685	3	6
008	716	5	64
008	734	1	2
008	829	2	4
008	863	3	5
008	931	4	6
008	946	7	74

General Linear Models Procedure

Dependent Variable: FLAVOR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	122	1493.9060317	12.2451314	6.30	0.0001
Error	834	1621.5192557	1.9442677		
Corrected Total	956	3115.4252874			

R-Square	C.V.	Root MSE	FLAVOR Mean
0.479519	22.38195	1.3943700	6.2298851

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AGE	2	17.40186191	8.70093095	4.48	0.0117
SEX	1	29.36121920	29.36121920	15.10	0.0001
AGE*SEX	2	15.02338685	7.51169343	3.86	0.0214
PANELIST(AGE*SEX)	101	898.7506432	8.89852122	4.58	0.0001
SAMPLE	8	520.8441689	65.10552112	33.49	0.0001
SEX*SAMPLE	8	26.1695236	3.27119046	1.68	0.0988

Duncan Grouping		Mean	N	SAMPLE
	A	7.1604	106	863
	A			
	A	7.1121	107	734
	A			
B	A	6.9065	107	319
B				
B		6.6509	106	598
	C	6.2059	102	187
	C			
D	C	5.8302	106	946
D				
D		5.6981	106	472
D				
D		5.6038	106	625
	E	4.9459	111	251

General Linear Models Procedure

Dependent Variable: FLAVOR ACCEPTANCE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	122	192.30609	1.57627	4.78	0.0001
Error	834	274.94155	0.32966		
Corrected Total	956	467.24764			

R-Square	C.V.	Root MSE	ACCEPT Mean
0.411572	22.95223	0.5741656	2.5015674

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AGE	2	1.52148	0.76074	2.31	0.1001
SEX	1	2.49659	2.49659	7.57	0.0061
AGE*SEX	2	0.51933	0.25966	0.79	0.4552
PANELIST(AGE*SEX)	101	116.784	1.15628	3.51	0.0001
SAMPLE	8	66.8327	8.35409	25.34	0.0001
SEX*SAMPLE	8	4.18793	0.52349	1.59	0.1244

Duncan Grouping		Mean	N	SAMPLE
	A	2.78505	107	734
	A			
	A	2.78302	106	863
	A			
	A	2.75701	107	319
	A			
B	A	2.68868	106	598
B				
B		2.53922	102	187
	C	2.36792	106	946
	C			
	C	2.35849	106	472
	C			
	C	2.25472	106	625
	D	2.00000	111	251

General Linear Models Procedure

Dependent Variable: OFF-FLAVOR QUANTIFICATION

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	71	276963.88889	3900.89984	11.66	0.0001
Error	72	24096.00000	334.66667		
Corrected Total	143	301059.88889			

R-Square	C.V.	Root MSE	OFFLAVOR Mean
0.919963	34.53489	18.293897	52.972222

Source	DF	Type III SS	Mean Square	F Value	Pr > F
TREATMNT	8	213184.513	26648.064	79.63	0.0001
PANELIST	7	28189.000	4027.000	12.03	0.0001
PANELIST*TREATMNT	56	35590.375	635.54241	1.90	0.0053

Duncan Grouping	Mean	N	TREATMNT
A	107.125	16	9
A			
B A	99.500	16	8
B			
B	90.188	16	7
C	67.875	16	6
C			
C	61.250	16	5
D	19.063	16	4
D			
D	13.000	16	3
D			
D	10.375	16	2
D			
D	8.375	16	1

General Linear Models Procedure

Dependent Variable: VITAMIN A CONCENTRATIONS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	1906978.04	238372.25	59.90	0.0001
Error	9	35813.00	3979.22		
Corrected Total	17	1942791.04			

R-Square	C.V.	Root MSE	VITA Mean
0.981566	2.971536	63.081077	2122.8444

Source	DF	Type III SS	Mean Square	F Value	Pr > F
TREATMNT	8	1906978.04	238372.2556	59.90	0.0001

Means with the same letter are not significantly different.

Duncan Grouping		Mean	N	
TREATMNT				
	A	2573.25	2	1
	B	2427.70	2	2
	B			
	B	2413.85	2	3
	B			
C	B	2296.05	2	4
C				
C		2206.00	2	5
	D	2032.80	2	6
	E	1817.95	2	7
	E			
	E	1776.40	2	8
	F	1561.60	2	9

P	O	G	A	S	F	X
017	1	1	3	192	7	3
017	1	1	3	230	7	3
017	1	1	3	341	7	3
017	1	1	3	413	7	3
017	1	1	3	584	7	3
017	1	1	3	679	6	3
017	1	1	3	758	7	3
017	1	1	3	826	6	3
017	1	1	3	965	6	3
018	2	1	3	192	4	2
018	2	1	3	230	5	2
018	2	1	3	341	7	3
018	2	1	3	413	5	2
018	2	1	3	584	6	3
018	2	1	3	679	4	2
018	2	1	3	758	4	2
018	2	1	3	826	6	3
018	2	1	3	965	6	3
019	3	2	3	192	8	3
019	3	2	3	230	3	1
019	3	2	3	341	7	3
019	3	2	3	413	8	3
019	3	2	3	584	9	3
019	3	2	3	679	9	3
019	3	2	3	758	8	3
019	3	2	3	826	7	2
019	3	2	3	965	7	2
020	3	1	3	192	8	3
020	3	1	3	230	3	1
020	3	1	3	341	7	2
020	3	1	3	413	4	1
020	3	1	3	584	8	3
020	3	1	3	679	3	1
020	3	1	3	758	7	3
020	3	1	3	826	5	2
020	3	1	3	965	7	2
021	2	2	3	192	2	1
021	2	2	3	230	2	1
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021	2	2	3	413	4	1
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021	2	2	3	679	6	3
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021	2	2	3	826	4	1
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022	3	2	3	341	6	2
022	3	2	3	413	5	2
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022	3	2	3	679	3	1
022	3	2	3	758	2	1
022	3	2	3	826	5	2
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023	2	1	3	230	2	1
023	2	1	3	341	7	2
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023	2	1	3	965	6	2
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024	3	1	3	341	8	3
024	3	1	3	413	4	1
024	3	1	3	584	8	3
024	3	1	3	679	6	2
024	3	1	3	758	8	3
024	3	1	3	826	7	2
024	3	1	3	965	7	2
025	2	1	3	192	4	1
025	2	1	3	230	6	2
025	2	1	3	341	3	1
025	2	1	3	413	6	2
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025	2	1	3	679	3	1
025	2	1	3	758	7	3
025	2	1	3	826	4	1
025	2	1	3	965	4	1
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026	3	2	3	341	9	3
026	3	2	3	413	1	1
026	3	2	3	584	9	2
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026	3	2	3	826	1	1
026	3	2	3	965	1	1
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027	1	2	3	230	1	1
027	1	2	3	341	5	2
027	1	2	3	413	2	1
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027	1	2	3	758	7	3
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030	3	2	2	341	8	3
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032	3	2	3	758	4	2
032	3	2	3	826	8	3
032	3	2	3	965	3	2

P	O	G	A	S	F	X
033	3	2	2	192	7	3
033	3	2	2	230	8	3
033	3	2	2	341	6	3
033	3	2	2	413	7	3
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035	2	2	3	679	4	1
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035	2	2	3	826	7	3
035	2	2	3	965	4	2
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036	1	2	3	230	3	1
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036	1	2	3	413	4	2
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036	1	2	3	679	3	2
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037	3	2	3	413	5	2
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042	3	2	3	341	7	3
042	3	2	3	413	8	3
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006	413	7	41
006	487	9	96
006	512	5	64
006	584	1	47
006	633	7	115
006	679	8	90
006	758	3	21
006	790	1	17
006	824	3	4
006	826	6	23
006	901	2	8
006	965	4	74
007	185	6	73
007	192	5	74
007	230	9	89
007	278	8	90
007	341	2	3
007	372	4	4
007	413	7	89
007	487	9	92
007	512	5	74
007	584	1	4
007	633	7	89
007	679	8	90
007	758	3	5
007	790	1	4
007	824	3	3
007	826	6	89
007	901	2	3
007	965	4	4
008	185	6	86
008	192	5	45
008	230	9	117
008	278	8	96
008	341	2	48
008	372	4	79
008	413	7	122
008	487	9	123
008	512	5	113
008	584	1	3
008	633	7	78
008	679	8	108
008	758	3	19
008	790	1	6
008	824	3	20
008	826	6	104
008	901	2	6
008	965	4	51

General Linear Models Procedure

Dependent Variable: FLAVOR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	116	1746.1502	15.0530	7.70	0.0001
Error	863	1687.5476	1.9554		
Corrected Total	979	3433.6979			

R-Square	C.V.	Root MSE	FLAVOR Mean
0.508533	22.23239	1.3983717	6.2897959

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AGE	2	32.8973	16.4486	8.41	0.0002
AGE*SEX	3	13.1679	4.3893	2.24	0.0817
PANELIST(AGE*SEX)	103	1120.819	10.8817443	5.56	0.0001
SAMPLE	8	576.007	72.0009842	36.82	0.0001

Duncan Grouping		Mean	N	SAMPLE
	A	7.3119	109	584
	A			
B	A	7.0818	110	341
B	A			
B	A	6.9908	109	758
B				
B	C	6.7248	109	965
	C			
	C	6.3486	109	192
	D	5.9266	109	826
	D			
	D	5.9159	107	413
	E	5.2936	109	679
	E			
	E	5.0000	109	230

General Linear Models Procedure

Dependent Variable: FLAVOR ACCEPTABILITY

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	116	206.37446	1.77909	6.03	0.0001
Error	863	254.45308	0.29484		
Corrected Total	979	460.82755			

R-Square	C.V.	Root MSE	ACCEPT Mean
0.447834	21.60529	0.5429983	2.5132653

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AGE	2	3.62149	1.81074	6.14	0.0022
AGE*SEX	3	4.52666	1.50888	5.12	0.0016
PANELIST(AGE*SEX)	103	122.380	1.18816	4.03	0.0001
SAMPLE	8	74.8663	9.35829	31.74	0.0001

Duncan Grouping	Mean	N	SAMPLE
A	2.82569	109	584
A			
A	2.81651	109	758
A			
A	2.77477	111	341
A			
B A	2.66972	109	965
B			
B	2.58333	108	192
C	2.40367	109	826
C			
C	2.36449	107	413
D	2.11927	109	679
D			
D	2.05505	109	230

General Linear Models Procedure

Dependent Variable: OFF-FLAVOR QUANTIFICATION

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	71	248833.55	3504.69	9.05	0.0001
Error	72	27876.000	387.16		
Corrected Total	143	276709.555			

R-Square	C.V.	Root MSE	OFFLAVOR Mean
0.899259	37.518	19.6765	52.444444

Source	DF	Type III SS	Mean Square	F Value	Pr > F
TREATMNT	8	181112.305	22639.038	58.47	0.0001
PANELIST	7	29294.777	4184.968	10.81	0.0001
PANELIST*TREATMNT	56	38426.472	686.187	1.77	0.0112

Duncan Grouping		Mean	N	TREATMNT
	A	99.938	16	9
	A			
B	A	94.563	16	8
B				
B	C	82.813	16	7
	C			
D	C	69.250	16	5
D				
D		66.125	16	6
	E	27.875	16	4
	F	13.188	16	1
	F			
	F	9.500	16	2
	F			
	F	8.750	16	3

General Linear Models Procedure

Dependent Variable: VITAMIN A CONCENTRATION

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	1750322.18	218790.27	27.91	0.0001
Error	9	70555.55	7839.50		
Corrected Total	17	1820877.74			

R-Square	C.V.	Root MSE	VITA Mean
0.961252	4.131712	88.540985	2142.9611

Source	DF	Type III SS	Mean Square	F Value	Pr > F
TREATMNT	8	1750322.1878	18790.2735	27.91	0.0001

Duncan Grouping		Mean	N	TREATMNT
	A	2595.95	2	1
	A			
B	A	2402.90	2	2
B				
B		2364.30	2	3
B				
B	C	2271.65	2	5
B	C			
B	C	2248.45	2	4
	C			
D	C	2101.80	2	6
D				
D	E	1962.80	2	7
	E			
	E	1816.10	2	8
	F	1522.70	2	9

SAMPLE KEYS

Panel #1

Exp. Time	Sample #
0	576, 519
20	260, 927
40	785, 162
80	391, 832
160	847, 750
320	412, 274
640	958, 693
1280	623, 481
2560	134, 345

Panel #2

Exp. Time	Sample #
0	734, 457
80	319, 829
160	863, 685
320	598, 931
640	187, 716
1280	472, 143
1920	946, 562
2560	625, 278
3840	251, 394

Panel #3

Exp. Time	Sample #
0	584, 790
80	341, 901
160	758, 160
320	965, 372
640	192, 512
1280	826, 185
1920	413, 633
2560	679, 278
3840	230, 487

Key to consumer panel data

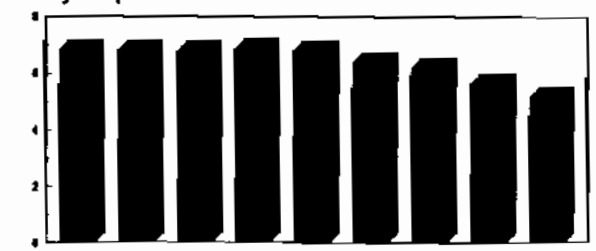
P=panelist
O=age category 1=over 55, 2=36-54, 3=18-35, 4=under 18
G=gender 1=male, 2=female
A=attitude towards milk 1=dislike, 2=neither like nor dislike, 3=like
S=sample number
F=flavor score
X=acceptance score

Key to descriptive panel data

P=panelist
S=sample
T=treatment
Y=response (mm away from extreme left)

Consumer Panel Hedonic Scores

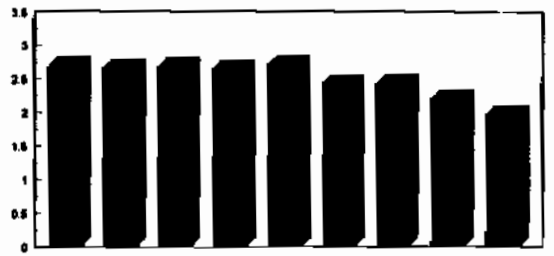
- Preliminary Experiment



Exposure Time	0	20	40	80	160	320	640	1280	2560
Hedonic Score	6.83 a	6.81 a	6.79 a	6.86 a	6.78 a	6.38 b	6.19 b	5.62 c	5.15 d

Consumer Panel Acceptance Scores

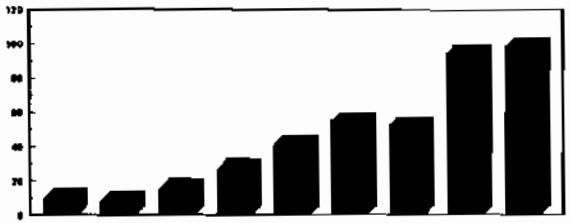
- Preliminary Experiment



Exposure Time	0	20	40	80	160	320	640	1280	2560
Acceptance Score	2.70 a	2.66 a	2.67 a	2.64 a	2.72 a	2.44 b	2.43 b	2.20 c	1.97 d

Descriptive Panel Off-Flavor Quantification

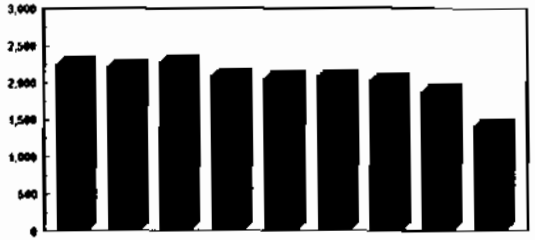
- Preliminary Experiment



Exposure Time	0	20	40	80	160	320	640	1280	2560
Off-flavor Score	9.38 a	7.69 a	15.00 ab	26.60 b	41.30 c	54.60 c	51.90 c	94.60 d	98.00 d

Vitamin A Concentrations

- Preliminary Experiment



Exposure Time	0	20	40	80	160	320	640	1280	2560
Vitamin A Concentration	2,241 ab	2,206 abc	2,261 a	2,081 bcd	2,047 cd	2,057 cd	2,012 de	1,873 e	1,386 f

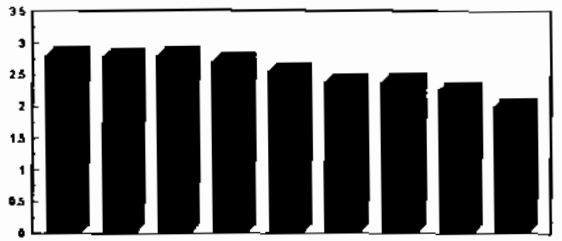
Consumer Panel Hedonic Scores

- Trial One

Exposure Time	0	80	160	320	640	1280	1920	2560	3840
Hedonic Score	7.11 a	6.91 ab	7.18 a	6.65 b	6.21 c	5.70 d	5.83 cd	5.60 d	4.95 e

Consumer Panel Acceptance Scores

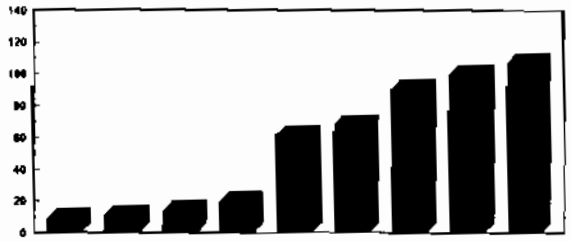
- Trial One



Exposure Time	0	80	160	320	640	1280	1920	2560	3840
Acceptance Score	2.79 a	2.76 a	2.78 a	2.69 ab	2.54 b	2.36 c	2.37 c	2.25 c	2.00 d

Descriptive Panel Off-Flavor Quantification

- Trial One



Exposure Time	0	80	160	320	640	1280	1920	2560	3840
Off-flavor Score	8.4 a	10.4 a	13.0 a	19.1 a	61.3 b	67.9 b	90.2 c	99.5 cd	107.1 d

Vitamin A Concentrations

- Trial One

Exposure Time	0	80	160	320	640	1280	1920	2560	3840
Vitamin A Concentrations	2,573 a	2,428 b	2,414 b	2,296 bc	2,206 c	2,033 d	1,818 e	1,778 e	1,562 f

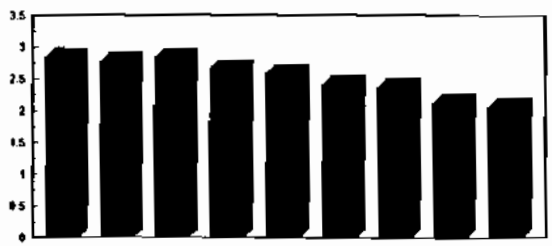
Consumer Panel Hedonic Scores

- Trial Two

Exposure Time	0	80	160	320	640	1280	1920	2560	3840
Hedonic Score	7.31 a	7.08 ab	6.99 ab	6.72 bc	6.35 c	5.63 d	5.92 d	5.29 e	5.00 e

Consumer Panel Acceptance Scores

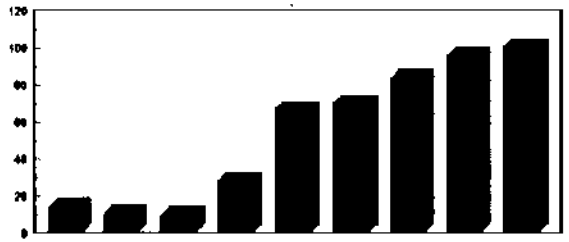
- Trial Two



Exposure Time	0	80	160	320	640	1280	1920	2560	3840
Acceptance Score	2.83 a	2.77 a	2.82 a	2.67 ab	2.58 b	2.40 c	2.36 c	2.12 d	2.06 d

Descriptive Panel Off-Flavor Quantification

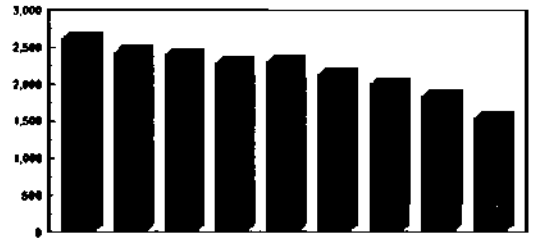
- Trial Two



Exposure Time	0	80	160	320	640	1280	1920	2560	3840
Off-Flavor Score	13.2 a	9.5 a	8.8 a	27.9 b	66.1 cd	69.2 c	82.8 de	94.6 ef	99.9 f

Vitamin A Concentrations

- Trial Two



Exposure Time	0	80	160	320	640	1280	1920	2560	3840
Vitamin A Concentrations	2,586 a	2,403 ab	2,364 b	2,246 bc	2,272 bc	2,102 cd	1,983 de	1,818 e	1,625 f

FORTIFIED 2% MILK EXPOSED TO FLUORESCENT LIGHT: A COMPARISON OF CONSUMER ACCEPTABILITY AND RATE OF VITAMIN A LOSS

Thomas D. Bishop

Department of Food Science and Nutrition

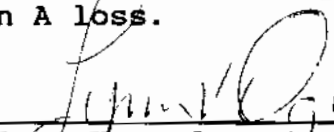
M.S. Degree, August 1993

ABSTRACT

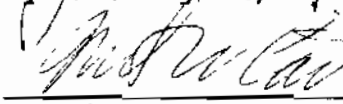
Fortified 2% milk packaged in one-gallon polyethylene bottles was obtained from a local dairy and exposed to fluorescent light (1200 foot-candles) for times ranging from 0 to 64 hours. The flavor and acceptability of the milk was judged using a 100-member consumer panel. The amount of oxidative flavor was quantified in a descriptive panel using eight trained panelists. The concentration of saponified vitamin A from each sample was determined using HPLC. There was a significant drop in flavor acceptability after 5.3 hours of exposure which was accompanied by an average loss of 11.5% vitamin A. When the flavor acceptability score of the milk fell below the acceptable range the concentration of the original vitamin A was still above the minimum level of 1.5 IU per ml (1418 IU per quart).

It appears that milk stored under fluorescent light in retail stores is more susceptible to sensory deterioration than vitamin A loss.

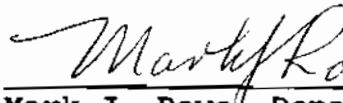
COMMITTEE:



Lynn W. Ogden, Committee Chairman



Melvin W. Carter, Committee Member



Mark J. Rowe, Department Chairman