# Purchasing Patterns for Nutritional-Enhanced Foods: The case of Calcium-Enriched Orange Juice

By

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## Introduction

In recent times there has been a growing awareness of the importance of nutrition and the nutritional aspects of various foods. Products are now marketed by emphasizing their nutritional properties, and new products are often designed to serve a particular nutritional purpose. Nutrition concern has become an important force in successfully shaping food marketing. Nevertheless, obesity and other nutrition-related health problems have not abated, and in fact have worsened. A possible explanation for these disparate trends is that a subset of nutritionally-concerned consumers– consumers in less need of improved nutrition- is responsible for the majority of healthy food purchases, with most others ignoring the nutritional message. Thus, an important question is who buys foods with salient nutritional features?

In this study we examine this question by examining purchase patterns of one of the more successful nutritionally-enhanced food products, calcium enriched orange juice. Calcium is necessary for strong and healthy bones throughout life, and is especially important for children and older women (Weaver). Nutritional authorities encourage consumers to include calcium-rich foods such as dairy products, dark-green leafy vegetables, fish and tofu in their daily diets. Eating foods fortified with calcium like certain cereals and orange juice can also help reach optimal calcium intake (Keller, Lanou, Barnard). We will examine the issue whether consumers buy calcium enriched orange juice to maintain sufficient calcium intake or just because they have high demand for any healthy food with better nutritious content. This information would be helpful in developing appropriate food policy, and in determining whether “designed” foods can significantly reduce nutritional deficiencies.

**Methodology and Data**

We address the questions (a) who are those households that buy orange juice (OJ) and who are those that do not; (b) who are those households that buy calcium OJ while others buy just regular orange juice; (c) who are the households that buy only calcium orange juice and those who buy both; and (d) what are the purchasing patterns of each group. It is important to keep in mind that price of regular OJ and calcium enriched OJ are the same, so the income level should not play any direct role when deciding which juice to choose.

We use the AC Nielsen Homescan database, consisting of all retail food purchases and prices paid by 7195 US households during 1999. The database contains households' demographic characteristics as well. The first step in the analysis is to group households according to:

1) whether or not they buy OJ;

2) whether the buyers purchase both calcium and regular OJ or just regular OJ;

3) for the buyers of calcium OJ, whether they buy both types or only calcium orange juice.

We use multivariate analysis of variance to compare mean vectors of the groups described above (Johnson and Wichern). Then, we compare groups for each variable. The first set of variables chosen for comparison is a set of demographic measures. The second set is spending on products in other food categories, especially dairy products. This is to test the hypothesis that households buy calcium enriched orange juice to make up for a perceived calcium deficiency due to low consumption of dairy products. Other products, like regular and "healthy" (low fat or fat free) potato chips, regular and diet ice cream and fresh fruits are included in the analysis to test the hypothesis that the households that buy calcium enriched orange juice are those who buy healthy food and avoid unhealthy food, irrespective of particular nutrients.

This analysis serves several purposes. First, it will provide information whether demographics of two populations in each of the three cases described above are similar. Second, it

will provide the answer whether purchasing patterns of two populations in each of the three cases described above are similar, and if not which components differ significantly. Third, it considers the question of whether consumption of calcium orange juice is a response to avoidance of dairy products or simply a demand for food considered more nutritious.

**Results**

The comparison of demographics of each group is provided Table1, which also has the number of households in each group. Notice, that over 1000 households buy no orange juice, and only 202 buy exclusively the calcium-enhanced type.

Table 1. Comparison of demographic characteristics of different household groups.

| Demographic characteristic | Households buying OJ vs. households that never buy OJ | | Households buying calcium and regular OJ vs. households buying only regular OJ | | Households buying only calcium OJ vs. households buying calcium and regular OJ | |
|---|---|---|---|---|---|---|
| | Buy OJ | Never buy OJ** | Buy calcium and regular OJ | Buy only regular OJ** | Buy calcium only OJ | Buy calcium and regular OJ |
| Number of observations | *6106* | *1089* | *2977* | *3129* | *202* | *2775* |
| Household size | 2.62 | 2.26* | 2.7 | 2.5* | 2.58 | 2.71 |
| Household income per year, $1000 | 56 | 45* | 59 | 53* | 56 | 53 |
| Percent of households that have education level college or higher (average for household heads) | 35% | 30%* | 38% | 33%* | 41% | 38% |
| Percent of households that have completed high school but do not have college degree (average for household heads) | 60% | 66%* | 58% | 62%* | 54% | 58% |
| Percent of households that have education level less than high school | 5% | 4% | 4% | 5%* | 4% | 5% |
| Percent of households where average age of heads is 50 or older | 52% | 51% | 52% | 52% | 43% | 53%* |
| Percent of households where average age of heads is between 35 and 49 | 38% | 39% | 37% | 38% | 44% | 36%* |
| Percent of households where average age of heads is less than 35 | 10% | 10% | 11% | 10% | 13% | 11% |
| Percent of household with children under 6 years old | 10% | 9% | 11% | 9%* | 14% | 11% |
| Percent of households with children between 6 and 12 years old | 17% | 15% | 18% | 15%* | 19% | 18% |
| Percent of households with children between 12 and 17 years old | 15% | 11%* | 16% | 15% | 16% | 16% |
| Percent of households without children | 69% | 75%* | 67% | 71%* | 62% | 66%* |
| Percent of households with married heads | 67% | 50%* | 71% | 62%* | 64% | 71%* |
| Percent of Hispanic | 6% | 6% | 7% | 6% | 8% | 7% |
| Percent of white | 83% | 86%* | 84% | 83% | 85% | 83% |
| Percent of black | 11% | 8%* | 10% | 12%* | 8% | 12% |
| Percent of oriental | 1% | 2% | 2% | 1%* | 2% | 1% |
| Percent of households in East region | 21% | 15%* | 22% | 21% | 12% | 23%* |
| Percent of households in West region | 19% | 28%* | 18% | 19% | 20% | 18% |
| Percent of households in South region | 35% | 33%* | 34% | 35% | 46% | 33%* |
| Percent of households in Central region | 26% | 24% | 26% | 25% | 23% | 26% |

* indicate that hypothesis of equal means is rejected at 5% significance level.
** indicate that hypothesis that mean vectors are equal is rejected at 5% significance level.

First, we compare the households buying any kind of OJ with those never purchasing. On average, the income level of households buying OJ is significantly higher than that of the non-buyers which may be due to larger household size. Households buying OJ are more educated and have more children, especially in the age between 12 and 17, perhaps reflecting the demand of teenagers. It follows that these households have a higher percentage of families where households' heads are married. There are also geographical differences. They imply, for example, that a Western household is more likely to be among the non-buyers than is an Eastern household, i.e. that orange juice demand is higher in the East. The same sort of argument applies to the racial variables. Results for these suggest that a black household is somewhat more likely to buy OJ than is a white household.

The second comparison involves the orange juice purchasing households. This shows that households buying both calcium and regular OJ have larger household sizes, higher income, better education, and a higher proportion of preteenagers than do households who buy only regular. The reason why larger households buy more types is obvious, but significance of income can only be explained by household size effect or as a proxy effect, since there is no price premium for the calcium-enhanced product. The education effect suggests the possibility of a greater demand for nutrition characteristics among more knowledgeable buyers.

Third, the comparison of the small group of households buying only calcium OJ with households buying both kinds shows much less difference in demographic characteristics. Households buying only calcium orange juice have a smaller proportion of "old" households, those headed by individuals with age 50 or more, and have fewer households without kids. The age effect is somewhat surprising, since older women are the group most subject to calcium deficiency diseases. Also, there are some differences in demographic distribution.

Then, we consider all four groups: households never buying OJ (1089 observations), households buying only regular OJ (3129 observations), households buying regular and calcium OJ (2775), and households buying only calcium OJ. We use multivariate analysis of variance to test the hypothesis that mean vectors of demographic variables of these four groups are equal. The

hypothesis is rejected with $p<0.0001$. The Tukey analysis is conducted to compare groups' means for each variable. Results are presented in Table 2.

Table 2. Results of Tukey studentized range test for demographic variables.

| Demographic characteristic | Households never buying OJ, 1089 | Households buying only regular OJ, 3129 | Households buying calcium and regular OJ, 2775 | Households buying only calcium OJ, 202 |
|---|---|---|---|---|
| Households size | C | B | A | A |
| Household income per year, $1000 | C | B | A | A, B |
| Percent of households that have education level college or higher (average for household heads) | B | B | A | A |
| Percent of households that have completed high school but do not have college degree (average for household heads) | A | A | B | A,B |
| Percent of households where average age of heads is 50 or older | A, B | A | A | B |
| Percent of household with children under 6 years old | B | B | A | A |
| Percent of households with children between 6 and 12 years old | C,B | C,B | A | A,B |
| Percent of households with children between 12 and 17 years old | B | A | A | A, B |
| Percent of households without children | A | B | C | C |
| Percent of households with married heads | C | B | A | A, B |
| Percent of black | B | A | A, B | A, B |
| Percent of households in East region | B | A | A | B |
| Percent of households in South region | B | B | B | A |
| Percent of households in West region | A | B | B | B |

Means with the same letter are not significantly different at 0.05 significance level. "A" corresponds to the highest level, "C" to the lowest level of means. Demographic characteristics included in this table are only those for which statistically significant differences among groups are found.

Summarizing these comparisons, higher income, better education and presence of children corresponds to more "discriminate" choice of food.

The chief strength of the Nielsen data set is that it permits analysis of purchases of all products purchased by the household. Hence the important part of this study is to test for differences in purchases of specific other products by the four household types, with special concern for dairy products and for products with salient nutritional features. If people who buy relatively high levels of calcium enhanced orange juice buy relatively low levels of dairy products, this is evidence supporting a hypothesis that the orange juice is playing the role of a "functional" food, that is, it is a "designed" food serving a particular nutritional role in the diet. If these households do not show reduced levels of dairy purchases, there is no such evidence, and if they also buy higher/lower levels of foods commonly viewed as healthy/unhealthy, this is evidence supporting a hypothesis that calcium enhanced juice is being purchased for nutrition, whatever its nature, and not specifically for calcium.

To test this hypothesis we compare the four household groups with respect to consumption of various dairy products, fresh fruits, potato chips, and ice cream. The latter two are obviously included to represent less healthy foods, but we include within these "less unhealthy" versions, such as reduced fat potato chips. We also include low fat versions of dairy products.

The consumption patterns comparisons are presented in Tables 3 and 4. The comparison is based on per household member consumption measured in dollars of sales.[1] Per member consumption comparison is chosen because, as shown in Table 2, there are significant differences in household size across considered groups.

As shown in Table 3, there are no differences in income per person. So, we can argue that differences in consumption patterns are due to differences in preferences only. First we compare the orange juice buying households to the non-buying households. A hypothesis that the purchasing patterns are equal for these two groups is rejected at $p<0.0001$. Consumption of milk products and fresh fruits is higher for those buying orange juice. It is interesting that the difference in fresh oranges is particularly large, suggesting no substitution between oranges and orange juice (and

[1] In the database, purchased quantities are reported in terms of bags for some of the products and in terms of units of weight for other products. We use dollars of sales to overcome this problem.

perhaps that few consumers squeeze their own orange juice). Potato chip consumption, the representative junk food, does not differ across the types of household, for either regular or low fat. However, in the dairy category, the orange juice households buy significantly more products in low fat and fat free categories, including ice cream. It can be concluded that households buying OJ maintain better diets in general than those who do not. However, since the majority of households do buy orange juice, it may be better to think of it as a negative indicator, i.e. that its absence is a signal of a less healthy choice of grocery purchases.

Table 3. Comparison of consumption patterns of different household groups. Average per household member purchases.

| Product | Households buying OJ vs. households that never buy OJ | | Households buying calcium and regular OJ vs. households buying only regular OJ | | Households buying only calcium OJ vs. households buying calcium and regular OJ | |
|---|---|---|---|---|---|---|
| | Buy OJ | Never buy OJ** | Buy calcium and regular OJ | Buy only regular OJ** | Buy calcium only OJ | Buy calcium and regular OJ |
| Number of observations | 6106 | 1089 | 2977 | 3129 | 202 | 2775 |
| Yogurt | | | | | | |
| fat free yogurt | 3 | 2.21* | 3.49 | 2.53* | 3.58 | 3.49 |
| lite yogurt | 5.44 | 4.72 | 6.18 | 4.74* | 4.63 | 6.3* |
| regular yogurt | 0.35 | 0.32 | 0.40 | 0.34 | 0.20 | 0.40* |
| Milk | | | | | | |
| buttermilk | 0.51 | 0.43 | 0.54 | 0.48 | 0.54 | 0.54 |
| milk less than 2% fat | 6.96 | 5.06* | 7.16 | 6.10* | 5.21 | 8.06* |
| milk 2% fat | 12.76 | 11.32* | 12.50 | 13.00 | 10.08 | 12.69* |
| skim milk | 11.45 | 8.37* | 12.69 | 10.26* | 13.31 | 12.65 |
| whole milk | 6.55 | 7.10 | 5.65 | 7.40* | 5.68 | 5.65 |
| other milk | 2.80 | 0.68* | 0.03 | 0.02 | 0.00 | 0.04 |
| total milk products | 38.25 | 32.3* | 39.29 | 37.27* | 34.83 | 39.62* |
| Cheese | | | | | | |
| cottage cheese regular | 1.86 | 2.13 | 1.85 | 1.88 | 2.27 | 1.82 |
| cottage cheese low fat | 2.34 | 2.88 | 2.48 | 2.21 | 2.61 | 2.47 |
| cottage cheese no fat | 0.80 | 0.70 | 0.89 | 0.71 | 0.67 | 0.90 |
| cheese natural regular | 16.82 | 15.92 | 17.29 | 16.37* | 18.43 | 17.20 |
| cheese natural low fat | 0.91 | 0.7* | 0.97 | 0.86 | 0.82 | 0.98 |
| cheese natural no fat | 0.03 | 0.02 | 0.04 | 0.04 | 1.51 | 3.95 |
| cheese processed regular | 10.13 | 9.94 | 9.87 | 10.38 | 9.28 | 9.91 |
| cheese processed low fat | 1.55 | 1.22* | 1.83 | 1.29* | 1.78 | 1.82 |
| cheese processed no fat | 1.17 | 1.04 | 1.35 | 0.98 | 1.57 | 1.34 |
| total cheese products | 35.64 | 34.59 | 36.57 | 34.75* | 37.48 | 36.50 |
| Fruits | | | | | | |
| fresh oranges | 1.35 | 1.09* | 1.48 | 1.23* | 1.25 | 1.50 |
| fresh apples | 3.88 | 3.44 | 4.15 | 3.62* | 4.28 | 4.14 |
| Total fresh fruits | 18.42 | 15.85* | 20.01 | 16.91* | 19.14 | 20.07 |
| Chips | | | | | | |
| regular potato chips | 8.91 | 8.71 | 8.86 | 8.96 | 8.07 | 8.91 |
| diet potato chips | 1.69 | 1.58 | 1.83 | 1.55* | 1.90 | 1.82 |
| Ice cream | | | | | | |
| regular ice cream | 14.45 | 13.09 | 14.60 | 14.30 | 16.18 | 14.49 |
| diet ice cream | 2.72 | 1.89* | 2.91 | 2.53 | 0.35 | 0.29 |
| Income per person, $1000 | 26.00 | 25.00 | 26.00 | 25.00 | 26.00 | 27.00 |

* indicate that hypothesis of equal means is rejected at 5% significance level.

** indicate that hypothesis that mean vectors are equal is rejected at 5% significance level.

In the comparison of households buying calcium enriched and regular OJ (2977 observations) and households buying regular OJ only (3129 observations), the hypothesis that the mean consumption vectors are equal is rejected at $p<0.0001$. The consumption of milk products (especially yogurt), fresh fruits, and diet potato chips is higher for those households who buy both calcium and regular orange juice. This group consumes more low fat milk and less whole milk. We conclude that households buying calcium and regular orange juice maintain a better diet than households buying only regular OJ.

The last comparison is spending by the small group of households buying only calcium enhanced orange juice and the group buying both kinds. Hypothesis that mean vectors of dairy consumption of these two groups are equal cannot be rejected ($p = 0.3547$). The table shows that the consumption patterns of these two groups show significant differences only in the dairy group. In particular, households buying both juice types consume considerably more yogurt and milk. Indeed, the per capita milk purchases by calcium-only buyers are the lowest among the OJ households. Furthermore, we computed milk's share of total retail food spending for these four household types. These were I) No OJ, 3.88%; (ii) Regular OJ only, 4.14%; (iii) Both OJ types, 4.16%; and iv) Calcium only, 3.73%. So households buying only calcium enhanced orange juice spend the lowest percent of the food budget on milk.

Thus, there is some evidence that a small subset of buyers are using calcium enhanced orange juice as a milk substitute. But, it is clearly very tentative. This is especially the case given that the purchases of OJ by the calcium only buyers in the sample is rather low. The average consumption of OJ per person for this group is $5.53, with a range from $0.02 to $79.45. The average for the group buying both types is much higher: $13.72, with a range from $0.08 to $462.5. Five dollars worth of orange juice does not represent a great deal of calcium. However, we must also point out that the households buying both types almost surely contain some individuals who *drink* only calcium

enhanced juice, precisely as a substitute for milk. Unfortunately the data does not permit consideration of this question.

To test the hypothesis that consumption patterns (consumption of dairy, fruits, ice cream and potato chips) of four considered groups are similar, we use multivariate analysis of variance. The hypothesis is rejected with $p<0.0001$. The Tukey analysis is conducted to compare groups' means for each variable. Results are presented in Table 4.

Table 4. Results of Tukey studentized range test for consumption variables.

| Purchases per household member, $ | Households never buying OJ, 1089 | Households buying only regular OJ, 3129 | Households buying calcium and regular OJ, 2775 | Households buying only calcium OJ, 202 |
|---|---|---|---|---|
| fat free yogurt | B | B | A | A |
| lite yogurt | B | B | A | B |
| milk less than 2% fat | B | B | A | A, B |
| milk 2% fat | A | A | A | A |
| skim milk | B | A, B | A | A |
| whole milk | A, B | A | B | A, B |
| cheese processed low fat | B | B | A | A, B |
| fresh oranges | B | B | A | A, B |
| fresh apples | A, B | A, B | A | A |
| total fresh fruits | B | B | A | A, B |
| diet ice cream | A, B | A, B | A | A, B |

Means with the same letter are not significantly different at 0.05 significance level. "A" corresponds to the highest level, "C" to the lowest level of means. Products included in the table are only those for which statistically significant differences among groups are found.

As shown in Table 4, there are significant differences in consumption of low fat and fat free categories, fruits and diet ice cream. Four groups can be ranked according to "healthiness" of pattern. Group making the healthiest choice is one that buys both, calcium and regular OJ, which was not expected. We expected this pattern from "only calcium OJ" group, which is second in the "healthiness" ranking. Households that buy only regular OJ and those who never buy OJ take third and fourth places respectively.

## Conclusions

In this paper we examined purchase patterns of orange juice buyers, with a focus on calcium enhanced juice. We found that households that are more likely to buy calcium orange juice are for the most part not less likely to purchase dairy products: on average they purchase more. However, we did find that per capita milk sales for households whose orange juice purchases are confined to calcium enhanced juice were lower than milk sales for other household types, suggesting that some consumers buy the calcium variety because they do not drink milk. However, the balance of the evidence is that consumers buy this product simply because they value nutrition highly. In the analysis households buying calcium juice, either exclusively or along with regular juice, also tended to select more healthy and nutritious products in other

## References

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