in accord with the observation that raffinose occurs in relative greater abundance when growth is slow and disappears with growth resumption (9).

Maltose was also found in leaves, stems, buds and roots of *Rhododendron* but was more abundant in roots. Similar observations have been made in sugar maple roots where maltose occurs from late summer to late spring (10). The metabolic role of maltose in *Rhododendron* is unknown but it is probably a breakdown product of starch.

Based upon its slow migration rate in TLC and long GLC retention time, and unidentified sugar in *Rhododendron* appears to be a relatively large molecule resembling either a trisaccharide or a tetrasaccharide. Like raffinose, it is probably also a storage sugar.

Literature Cited

1. Aung, L. H., F. Tognoni and A. A. DeHertogh. 1973. Changes in the carbohydrates of tulip bulbs during development. *Hort Science* 8:207–208.
2. Hepting, G. H. 1945. Reserve food storage in shortleaf pine in relation to little-leaf disease. *Phytopathology* 35:106–119.
3. Jeremias, K. 1972. Zur winterlichen zuckeranhaeufung in vegetativen pflanzenteilen. *Biol. Abstr.* 53 (2):1068.
4. Jones, C. H. and J. L. Bradlee. 1933. The carbohydrate contents of the maple tree. *VT Agr. Expt. Sta. Bul.* 358.
5. McNair, H. M. and E. J. Bonelli. 1968. Basic gas chromatography. Varian Aerograph, Walnut Creek, CA
6. Murneek, A. E. 1942. Quantitative distribution of nitrogen and carbohydrates in apple tree. *MO Agr. Expt. Sta. Res. Bul.* 348.
7. Nelson, N. 1944. Photometric adaptation of the Somogyi method for the detection of glucose. *J. Biol. Chem.* 153:375–380.
8. Parkerson, R. H. and F. W. Whitmore. 1972. A correlation of stem sugars, starch and liquid with wood formation in Eastern White pine. *Forest Sci.* 18:178–183.
9. Pazar, J. H., M. Shadahsharasaany and G. E. Meidell. 1962. The metabolism of oligosaccharides in germinating soybean, *Glycine max*. *Arch. Biochem. Biophys.* 99:78–85.
10. Wargo, P. M. 1971. Seasonal changes in carbohydrates levels in roots of sugar maple. *U. S. Forest Ser. Res. Pap. N. E.* 213:1–8.
11. Zimmerman, M. H. 1957. Translocation of organic substances in trees. I. The nature of the sugars in the sieve tube exudates of trees. *Plant Physiol.* 32:288–291.

An Economic Evaluation of Consumer Characteristics Affecting Sweet Potato Consumption[1]

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Abstract. The purpose of this report was to relate several economic and social characteristics of sweet potato consumers to level of fresh sweet potato consumption. National cross-sectional data were used to identify consumption patterns using the least squares regression procedure. Relationships were estimated for white and non-white households.

The relationships for white households indicated that price of sweet potatoes, family income, number of meals eaten- at-home, family size, and expenditures for white potatoes were important determinants of weekly sweet potato consumption. Regional, urbanization, and seasonal differences were also apparent for white households. Education, age, and employment status were not critical in determining consumption patterns.

The relationship for the non-white households was similar structurally to the white household relationship but the sample size was not sufficiently large to yield statistically significant coefficients for some of the variables found important in the white household. Nevertheless, price, age and number of households did exhibit statistically significant coefficient. Seasonal and urbanization differences were noted.

Sweet potato merchants should find the relationships useful in market segmentation. Sales efforts should take into account at least regional, seasonal, and urbanization differences.

Per capita consumption of sweet potatoes has been declining for several years. Annual consumption of fresh sweet potatoes has declined from around 15 pounds in the mid-1940's to about 3 pounds per capita today (3). This change in consumption level has resulted from a decline in number of households purchasing sweet potatoes, and the amount of potatoes each household purchases per week. For example, a national survey of 6,060 households in the spring of 1955 indicated that 7.1 percent of households purchased sweet potatoes. The average weekly purchase in the spring of 1955 amounted to .16 pounds per household for all households. Weekly per capita consumption was .67 pounds for those household actually purchasing sweet potatoes (2). The situation changed considerably during the next 10 years. The 1965 spring survey of 7,532 households detected only 4.7 percent of all households purchasing sweet potatoes. Weekly household consumption dropped to .09 pounds for all households. Weekly per capita consumption was .58 pound for those households actually purchasing sweet potatoes (4).

Population in the United States has increased at a rate which has tended to offset the effects of downward per capita consumption leaving total consumption of sweet potatoes almost unchanged over the period. Prices have increased during the period but not rapidly enough to yield increasing real prices after taking account of inflation (1).

Several economic and social characteristics of consumers are no doubt important in explaining the downward trend of per capita consumption of sweet potatoes. The 1965 National Consumer Survey of Household Consumption is the most recent source of data which can be used to measure the importance of these characteristics on consumption. The purpose of this report is to present the results of an analysis of these data to identify factors that are important in determining 1) whether consumers buy sweet potatoes and 2) what amount is consumed if the decision is to purchase.

Materials and Methods

Consumption relationships were estimated by ordinary least squares regression using cross-sectional data. These data, obtained

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from the USDA, were provided by the spring and fall 1965 and winter 1966 household surveys (4). There were 10,255 white households and 1,496 non-white households.

Consumption relationships for fresh sweet potatoes were estimated using the following structural form:

$$(1) \quad Q_{w,nw} = f(P, I, E, A, M, V, W, N, S_i, R_i, U_i, Z)$$

where:

- $Q_{w,nw}$ = pounds of sweet potatoes purchased/household/week by white and non-white households, respectively,
- P = estimated retail expenditures for sweet potatoes divided by quantity purchased,
- I = annual income per household,
- E = educational level of housewife in years of schooling,
- A = age of housewife (14–99 years of age),
- M = weekly number of meals eaten at home adjusted by the expected number of meals,
- V = household expenditures for white potatoes, a potential substitute product,
- W = employment status of housewife,
- N = number of members in the household,
- $S_{w,s}$ = season-of-year shift variables for winter and spring, respectively,
- $R_{ne,nc,w}$ = regional shift variables for North East, North Central and the West,
- $U_{u,rn}$ = urbanization shift variables for urban and rural nonfarm,
- Z = non-purchasing households.

All of the explanatory variables are continuous except the employment status shifters (W), seasonal shifters (S_i), regional shifters (R_i), the urbanization shifters (U_i), and (Z) non-purchasing household. For these discrete variables, zero-one dummy variables were generated to measure their effects on consumption patterns.

Two zero-one variables were created for employment status of the housewife. These were (1) employed and (2) unemployed. The latter was selected as the base.

The season-of-year shifters utilized zero-one variables for the seasons of spring, 1965, fall, 1965 and winter, 1966. The fall, 1965, season was selected as the base.

Regional zero-one shift variables were generated for the 4 geographic regions of the South, West, North East, and the North Central. The South was selected as the base region.

The urbanization effects were accounted for by the use of zero-one variables for the rural farm, rural-nonfarm and urban households. Rural farm households were selected as the base.

Non-consuming households were included in the model by the use of a zero-one variable with consuming households as the base. The characteristics of these non-consuming households were considered important in identifying the relevant factors underlying whether or not and how much is consumed by a given household.

It was assumed that each member of the household would normally eat 3 meals a day. These meals could be eaten at or away from home. Therefore the value of M for a given week would be zero if each member of the family ate 21 meals at home during a given week. M would be positive if all members ate the 21 meals at home and guests were recorded as eating with the particular family.

Preliminary analysis suggested that rather distinct consumption habits existed for the 2 groups. Therefore, separate relationships were estimated for white and non-white households.

Results and Conclusions

The white households

The results of relating weekly household consumption in pounds of fresh sweet potatoes per household to the several economic and social characteristics of white consumers nationally are presented in Equation 2. An asterisk by the variable denotes statistical significance of the coefficient at the .01 level. The "goodness of fit" is indicated by the "R^2" statistic.

$$(2) \quad Q_w = 3.91 - 9.133P^* - .413^{10\text{-}5}I^* - .001E + .293^{10\text{-}3}A + .011W + .002M^* + .116V^* + .030N^* - .100S_w^* - .106S_s^* - .082U_u^* - .097U_{rn}^* - .074R_{ne}^* - .106R_{nc}^* - .073R_w^* - 3.846Z^* \qquad R^2 = .42$$

The signs and the magnitudes of the coefficients of the respective variables provide information to sweet potato merchants who are trying to develop a sales program. Let us assume that the objective of a sales program is to reach the segment of the population which has characteristics most favorable to greater sweet potato consumption. The relationship presented in equation 2 indicates that the education, employment and age characteristics are not critical in market segmentation. The coefficients for these 3 variables are not significantly different from zero statistically. Income of the consuming household is critical in that a negative coefficient significantly different from zero was obtained. This suggests that consuming households should be segmented according to income. It implies that sales of sweet potatoes could be increased if sales and promotion efforts are directed at the lower end of the income scale. The negative income coefficient provides additional evidence that sweet potatoes are an inferior product for consumers. The relative responsiveness of consumption to income changes is estimated at −.11 at mean household quantity and income levels, *i.e.*, if real family income increases one percent, consumption of sweet potatoes would tend to decline by .11 percent.

The number of meals eaten-at-home and size of family exhibited expected positive signs. These coefficients were significantly different from zero. These expected relationships with weekly household consumption are consistent with the income relationship. The suggested strategy of the merchant is that he directs his sales program at the low income families with large families which eat relatively few meals away-from-home.

The shift variables provide considerable information to the sweet potato merchant. For example, the seasonal shift variables (S_w and S_s) indicate that weekly household consumption in the fall season is significantly greater than during the winter and spring seasons.

The urbanization shift variables which exhibited statistically significant coefficients indicate that families in the rural farm sector consume significantly larger quantities than the urban (U_u) and rural nonfarm (U_{rn}) sectors.

The regional shift variables also suggest that families in the South tend to consume more sweet potatoes than consumers in the North West (R_{nw}), North Central (R_{nc}) and the West (R_w). Merchandising strategy should take these seasonal, urbanization and regional differences into account.

The non-consuming shift variable (Z) is negative as expected and is only slightly less than the intercept value. The interpretation of this coefficient is that weekly household consumption of non-consuming households is nil at mean values of all the independent variables.

The non-white households

The size of the sample of non-white households was considerably smaller than the white household sample but a rather interesting relationship resulted. The results for non-white households is presented in equation 3.

$$(3) \quad Q_{nw}{}^5 = 5.55 - 12.801P^* - .201^{10\text{-}4}I + .007E + .008A^* - .098W - .490^{10\text{-}3}M - .027V + .188N^* - .460S_s^* - .064S_w - 1.148U_u^* - .853U_{rn}^* + .156R_{ne} + .212R_{nc} + .304R_w - 5.350Z^* \qquad R^2 = .36$$

The coefficients for several of the consumer characteristics were not significantly different from zero and the regional shift variables were not significantly different from the base region of the South. There were few non-white households in the sample from the West and North Central regions. The income (I), education (E), employment (W), number of meals eaten at home (M), and white potato expenditure (V) were not significantly different from zero. The age coefficient was significantly different from zero and its sign was positive, implying that consumers tend to eat more sweet potatoes as they age.

The size of family variable again exhibited a large positive coefficient as expected. Each additional member of the family would increase weekly family consumption by almost .2 pound.

The spring shift variable coefficient was negative and significantly different from the fall base. The winter season shift coefficient was not significantly different than the fall base.

The same pattern in urbanization existed for non-white households as observed for white households. The urban and rural nonfarm households consumed significantly less sweet potatoes than the rural farm consumers.

The non-consuming households was of course significantly different from the consumption levels of consumers. The fact of the coefficients' significance is not as interesting as the fact that its absolute value closely approximated the constant value. Thus, the relationship would predict zero consumption levels for these households at mean values of the variables. This provides some evidence of the predictive power of the relationship.

Literature Cited

1. Schrimper, R. A. and G. A. Mathia. 1975. Reservation and market demands for sweet potatoes at the farm level. Ame. J. Agr. Econ. 57:119–121.
2. USDA. 1956. Food consumption of households in the United States Household Food Consumption Survey 1955, Report No. 1. U. S. Govt. Printing Office, Washington, DC.
3. USDA. 1968. Food consumption, prices, and expenditures. Agr. Econ. Rept. No. 138 and Ann. Suppl. U. S. Govt., Printing Office, Washington, DC.
4. USDA. 1968–1972. Food consumption of households in the United States. Household Food Consumption Survey 1965–66, Reports No. 1–12. U. S. Govt. Printing Office, Washington, DC.

An Attempt to Overcome Iron-Induced Manganese Deficiency in 'July Elberta' Peach Trees with Manganese Chelate[1]

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Abstract. Disodium manganous ethylenediamine tetraacetate (MnEDTA), applied to the soil with 113 and 227 g sodium ferric ethylenediamine di-(o-hydroxyphenylacetate) (FeEDDHA), increased the concentration of Mn and reduced the concentration of Fe in 'July Elberta' peach leaves (*Prunus persica* (L) Batsch). Both rates of the Fe chelate increased Fe and reduced Mn and K in the leaves when compared to non-treated ones. Both rates of the Fe chelate reduced Fe chlorosis and increased shoot growth and size and yield of fruit. Mangenase chelate with 113 g Fe chelate reduced N in the leaves and increased trunk growth. Manganese chelate with 227 g Fe chelate reduced P in leaves. The Zn content in leaves, size of fruit, leaf chlorosis, trunk and shoot growth were not affected by Mn chelate applied with Fe chelate.

Shive et al (6, 9, 10) and Twyman (12, 13) reported that high Mn levels reduced Fe absorption from nutrient solutions, lowering water-soluble Fe levels in plant tissue. High Fe levels likewise depressed Mn absorption from nutrient solutions and reduced the level of water-soluble Mn in plant tissue, although to a much lesser degree than the effects of Mn on Fe (14). Previous work (3) indicated that FeEDDHA at 113 and 227 g, plus 1620 g $(NH_4)_2SO_4$, per tree induced Mn deficiency in bearing 'Sungold' peach.

Roy (5), in Florida, found that soil applications of 2.72 kg of $MnSO_4$ per tree to 19-yr-old 'Parson Brown' orange trees (*Citrus sinensis* Osbeck) increased the Mn concn in leaves, accelerated sugar formation in the fruit, and improved fruit color. Smith and Rasmussen in Florida (7) showed that soil-applied $MnSO_4$ at 33.63 and 67.24 kg metal equivalent per ha increased the Mn concn in 2-yr-old 'Valencia' orange (*Citrus sinesis* Osbeck) on 'Rough Lemon' [*Citrus jambhiri* Lush (Macf.)] rootstocks. Beyers and Terblanche (1) in South Africa found that 3 kg $MnSO_4$ and compost applied in holes in the soil around peach trees growing in alkaline soils corrected Mn deficiency. My purposes were to induce Mn deficiency in bearing 'July Elberta' peach trees with 113 and 227 g of FeEDDHA and attempt to correct the Mn deficiency with Mn chelate (MnEDTA).

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Materials and Methods

Nine Fe and Mn treatments: no-fertilizer controls, and 2 levels of Fe, each with 4 levels of Mn, were applied to Fe-chlorotic 'July Elberta' peach trees. The treatments in g per tree, are shown in Table 1. FeEDDHA was applied annually, 1968–1972: MnEDTA was applied annually, 1970–1972. Fe chelate was applied along the first 2 irrigation furrows on either side of the trees and covered with 2.54 to 5.08 cm of soil. The Mn chelate was applied along the second 2 irrigation furrows on either side of the trees and covered with 2.54 to 5.08 cm of soil.

Samples of 100 leaves per tree were taken from the middle of terminal shoots in June, July, August, and September. The samples were washed in 0.1N HCl, a detergent, "Joy", and deionized H_2O; dried in a forced draft oven for 12 hr at 65°C, ground in a Wiley Mill, passed through a 20-mesh screen, and placed in sample bottles for chemical analysis. Leaf-N was determined by the Kjeldahl method; and Fe, Zn, and Mn by atomic absorption spectroscopy. Phosphorus was determined with a Bausch and Lomb Spectronic 20 Spectrophotometer (venadomolybdophosphoric yellow method); and K by a Beckman Du with a flame attachement. Leaf color was measured as described earlier (3). Trunk and shoot growth, yield, and fruit size were determined as described earlier (3). Analysis of variance was calculated using methods of Snedecor (8).

The experimental design permitted comparisons of the long time peach tree response to Fe chelate applied at 113 and 227 g rates and the response to Mn chelate at various levels superimposed on the Fe chelate. Since increasing amounts of the elements were applied, it was possible to study the response as a polynomial regression. Within the range of the treatment levels, the mean responses to the supplements