developing fertilizer programs in groves having different potash requirements.

Potassium levels of 0.8% and less were found associated with fruit drop and probably losses in yields. There is evidence that levels of 0.8% leaf potassium are not always associated with reduced yields. However, considering the precision of the sampling procedure and the year to year variability in potash utilization, it is recommended that the potassium level of five to seven month old spring flush leaves should not be permitted to drop below 1.0% for fertilizer control purposes.

REFERENCES


Further consideration in attempting to correlate clarification with viscosity is that a viscosity measurement is rapid and simple to make, although very specific conditions must be used. A previous report (3) presented some data indicating that such a relationship did exist concerning changes in viscosity and clarification which occurred when Valencia orange concentrate was stored at 80°F. This study was undertaken to obtain further confirmation of this relationship between viscosity and physical stability of these products, as well as to determine the effect of stabilization temperature on these characteristics.

EXPERIMENTAL PROCEDURE

Preparation of Samples.—Valencia oranges were obtained from Station plots at Lake Alfred and on the Florida east coast. Fruit was washed, graded, thoroughly mixed, and then divided into a number of equal lots, depending upon the number of stabilization temperatures to be used. All fruit was held at 40°F. until processed. Juices were extracted using a Food Machinery In-Line extractor, finished through a Model 35 Food Machinery finisher, and
Using a Walker Wallace heat exchanger prior to concentration, samples were withdrawn at various degrees of concentration for immediate analysis. During the evaporation process samples were withdrawn at various degrees of concentration for immediate analysis and samples for storage at 80°F. were packed and closed in 6 oz. cans.

Stabilization of the juices was accomplished and closed in 6 oz. cans. and samples for storage at 80°F. were withdrawn along with the initial sample, closed in 6 oz. cans, and immediately placed in a 80°F. water bath. They were then examined at 1, 2, 4, and 24 hours after being placed in the bath.

The pulp or centrifuged material in the orange concentrates was determined after reconstituting the products to 12° Brix by a centrifugal method (9).

A Photovolt Lumetron colorimeter, Model 402-E with a 730 μm filter and a 10 mm. rectangular 14 ml. cell, was used to determine the cloud or turbidity of the centrifuged reconstituted juices.

**Results and Discussion**

*Effect of Stabilization Temperature on Initial Viscosities.* — The effect of stabilization

**Analytical Methods.** — A Brookfield Model LVT synchroelectric rotational viscometer was used for all viscosity measurements. It was used with either the No. 2 or 3 spindle, with the guard attached, and with the concentrate in a 6 oz. can. A spindle speed of 12 r.p.m. was used, and readings were taken 1 minute after turning on the instrument. For the initial viscosity determination samples were withdrawn from the evaporator at different degrees of concentration, usually at 80°F. Thirty seconds after withdrawing the sample the viscosity was measured. The samples for storage at 80°F. were withdrawn along with the initial sample, closed in 6 oz. cans, and immediately placed in a 80°F. water bath. They were then examined at 1, 2, 4, and 24 hours after being placed in the bath.

Table 1. Changes in viscosity, light transmittance, and centrifuged material of Valencia orange concentrates after storage at 80°F.

<table>
<thead>
<tr>
<th>Approx.</th>
<th>Not heated</th>
<th>165°F.</th>
<th>175°F.</th>
<th>185°F.</th>
<th>195°F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 hr.</td>
<td>4 hr.</td>
<td>24 hr.</td>
<td>0 hr.</td>
<td>4 hr.</td>
<td>24 hr.</td>
</tr>
</tbody>
</table>

- **Viscosity** of concentrate - centipoises
- **Light transmittance of reconstituted juice** - %

**Centrifuged material in reconstituted juice** - % by vol.

1. Based on 12° Brix juice.
2. Measured at 80°F., Brookfield LVT viscometer using No. 2 spindle after 1 minute at 12 r.p.m.
3. No. 3 spindle used.
4. Measured at 72°F.
temperature on the initial viscosity of concentrates, prepared from Valencia oranges from Station plots at Lake Alfred, is shown in Fig. 1; also evident is the relationship between viscosity and degree of concentration. Results are included when the evaporator feed was not heated and when stabilization temperatures of 165°, 175°, and 185°F. were used. The data for the 195°F. temperature are not included since the temperature of this sample was 72°F. when it was withdrawn from the evaporator; all of the other samples were at 80°F. As shown by this curve, stabilization temperature had no effect on the initial viscosities. The same results were obtained when two concentrates were prepared from Valencia oranges obtained from a Station grove on the Florida east coast. One of these products was made from unheated juice and a stabilization temperature of 175°F. was used in processing the other concentrate.

**Effect of Stabilization Temperature on Viscosities after Storage of Concentrates at 80°F.**

Data shown in Tables 1, 2, and 3 confirmed a previous report (3) indicating that the viscosity of orange concentrates changed during storage at 80°F., partly because of thixotropic properties of the concentrates and partly because of chemical changes taking place during clarification of the products. It is evident from these data that the viscosity at each fold increased considerably upon storage at 80°F. for 4 hours and to an even greater degree upon holding for 24 hours.

The effect of stabilization temperature upon these increases in viscosity after storage is more readily seen from the calculated values presented in Table 2, which shows the percentage increase in viscosity for each concentrate that was processed from fruit obtained from groves at Lake Alfred. After 4 hours storage at 80°F., the differences in the percentage increase in viscosity, at any one level of concentration, were not very large. However, there was a tendency for the percentage increase to be less at the higher stabilization temperatures. Increases in viscosity were greatest at the 4-fold concentration. After storage for 24 hours, greater increases in viscosity of all products were evident and the percentage increase became less as the temperature of stabilization was raised. Also, the percentage increase was larger in the 3- and 4-fold concentrates.

Data for the packs prepared using Valencia oranges from the east coast of Florida are

<table>
<thead>
<tr>
<th>Approx. fold</th>
<th>Viscosity of concentrates</th>
<th>Light transmittance of reconstituted juices</th>
<th>Centrifuged material in reconstituted juices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not heated</td>
<td>165°F</td>
<td>175°F</td>
</tr>
<tr>
<td>2</td>
<td>69</td>
<td>44</td>
<td>33</td>
</tr>
<tr>
<td>3</td>
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<td>5.5</td>
<td>83</td>
<td>84</td>
<td>71</td>
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<table>
<thead>
<tr>
<th>Approx. fold</th>
<th>Light transmittance of reconstituted juices</th>
<th>Centrifuged material in reconstituted juices</th>
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<tr>
<td>2</td>
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<td>5.5</td>
<td>23</td>
<td>23</td>
</tr>
</tbody>
</table>

1 Based on 12° Brix juice.
2 Initial viscosities used in computations for 195°F., were calculated values at 80°F.
that the changes, which occurred during storage at 80°F., in concentrates processed from fruit obtained from two different citrus areas in Florida were the same. However, it is important to note the differences in the magnitude of these changes, i.e., range for percent clarification in concentrated than for those made from juices heated at 175°F. Thus it is evident that the degree of clarification decreased and separation was eventually prevented as the temperature was increased. When clarification occurred, it was greatest in the 3- and 4-fold products. Gellation was not evident in any of the concentrates, either initially or after storage at 80°F. Of the stabilized concentrates that changed in cloud, those (Table 1 and 2) made from juices heated at 165° and 175°F. showed the most cloud loss, and it was identical for each temperature. Clarification did not occur during storage in the products when higher stabilization temperatures were used.

Rouse, Atkins, and Moore (8) have shown that there is an increase in the centrifuged material in a reconstituted juice when clarification occurs because of the precipitation and separation of insoluble pectinates and pectates. Similar data, included in Tables 1, 2, and 3 show such increases in centrifuged material upon clarification of the juices.

Relationship Between Changes in Viscosity after Storage and Degree of Clarification. — As mentioned earlier, the changes that occur in the viscosity of orange concentrates, during storage, are due to two factors, i.e., thixotropic increase and stability of the products. Since there was no clarification in any of the products stabilized at 195°F., it is believed that the viscosity increases found were due only to

given in Table 3. After 24 hours storage, much larger percentage increases in viscosity were noted in the 3-, 4-, and 5-fold concentrates than in the 2-, 6-, and 7-fold products. Also, the increases were larger for the unstabilized concentrates than for those made from juices heated to 175°F. Therefore, it is evident that the degree of clarification decreased and separation was eventually prevented as the temperature was increased. When clarification occurred, it was greatest in the 3- and 4-fold products. Gellation was not evident in any of the concentrates, either initially or after storage at 80°F. Of the stabilized concentrates that changed in cloud, those (Table 1 and 2) made from juices heated at 165° and 175°F. showed the most cloud loss, and it was identical for each temperature. Clarification did not occur during storage in the products when higher stabilization temperatures were used.

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thixotropy, and any greater changes in the concentrates, produced when other temperatures were used, were due to instability of the products. Comparison of changes in viscosity in concentrates in which clarification occurred showed that as the temperature of sabilization was increased, the percentage increases in both viscosity and light transmittance were decreased. The data in Tables 1, 2, and 3 also indicate that the largest increases in both viscosity and light transmittance after 24 hours storage were in the 3- and 4-fold products, showing these levels of concentration were the least stable. It should be noted again that the changes in viscosity were much larger in the concentrates made from the fruit from the east coast area. Also instability was evident in all of these unheated packs and in the 5-fold, as well as the 3- and 4-fold, for the heated packs. In the light of these results it seems possible that viscosity determinations might be developed into a useful tool for rapidly measuring the stability of orange concentrates.

Summary
A relationship was found between viscosity changes and the degree of clarification which occurred when Valencia orange concentrates were stored at 80°F. Large increases in viscosity of the concentrates resulted as the stability of the products decreased, as was indicated by increase in light transmittance in the reconstituted juices. Generally the most unstable concentrates were 3- and 4-fold.

Stabilization temperature had no significant effect on the initial viscosity, cloud, or pulp content. However, upon storage at 80°F., viscosity, light transmittance, and amount of centrifuged material differed, depending upon the stabilization temperature. Data indicated that as the temperature of stabilization was increased, the changes in viscosity and centrifuged material became smaller and the degree of stability increased.

LITERATURE CITED

EFFECT OF PROCESSING VARIABLES ON UV ABSORPTION OF GRAPEFRUIT JUICE

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Florida Citrus Experiment Station
Lake Alfred

In a prior investigation (1) of a more specific method for analyzing naringin, a very significant development occurred. A procedure was found that appeared capable of measuring quantity of peel extractives, as well as the effect of other abusive processing conditions. This procedure involves the measurement of a juice sample's ultraviolet absorption in the wavelength range of 260 to 360 millimicrons. Useful application is very conceivable in light of the ultraviolet absorption variations caused by extractor pressure, finisher variations, heat stabilization, etc.

In view of the many processing changes that have occurred in the citrus industry in