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PREPARATION OF FIG POWDER

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Fig powders have been prepared from commercial dried figs by tunnel, vacuum, and drum drying procedures and the resulting powders compared. It was found that the minimum amount of heat damage was incurred in vacuum drying but that drum-drying and tunnel-drying procedures resulted in products considered satisfactory. The latter powders possessed a characteristic fig flavor and, in addition, a slightly caramelized flavor which was considered pleasing. Utilization of fig powder in bakery products is briefly discussed. A colorimetric method for assaying heat damage is described.

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PREPARATION OF FIG POWDER

At the suggestion of the California Fig Institute, Fresno, California, the Western Regional Research Laboratory has undertaken to find new uses and outlets for figs, particularly the small sizes of the Black Mission variety. Retail package trade and bulk sales utilize most of the larger sizes of this variety but only a limited demand exists for the smaller sizes, since, owing to color, they are not considered suitable for the manufacture of paste. On the basis of a brief survey of possible new outlets for figs and several exploratory experiments, it was decided that research be directed toward comparison of low-moisture fig powders prepared by three general methods of drying.

Several methods have been proposed for the production of powders from fruits. Vacuum drying, in particular, has been applied to the reduction of moisture in more concentrated fruits, such as sun-dried or dehydrated products, to a very low level. However, no published reports have been found in which this technique or others have been described as applied to figs. Nevertheless, limited amounts of fig flakes are known to have been produced by a commercial drying process.

We have found that satisfactory fig powders can be produced by tunnel drying, vacuum drying, and drum-drying procedures. Vacuum drying resulted in a powder with a minimum amount of heat damage, while powders produced by tunnel or drum drying possessed a slightly caramelized flavor. In view of the minor quality differences in fig powders prepared by the three methods, it appears that the type of drying process selected should be based primarily on economic considerations.

Drying Procedures

Drying curves were obtained for tunnel and vacuum drying at various temperatures, and the effects of drum speed and solids content of feed were determined for drum drying. Early experiments showed that figs can not be ground to a powder unless the moisture content is reduced to 2 percent or less, regardless of the drying procedure employed. In drying products containing a high percentage of sugars to these low moisture levels, a certain amount of caramelization or heat damage is likely to occur. The extent of this heat damage is dependent on drying time and piece temperature during drying. Both high drying temperatures and long drying times, of course, result in more extensive heat damage. Since the amount of heat damage occurring during drying was considered to be one of the principal factors in determining suitable drying conditions and procedures, an objective method capable of measuring this change was developed.

The progressive development of water-soluble brown color with increasing amounts of heat damage has been used by this Laboratory and others as an index of heat damage to fruit and vegetable products. It was found that the amount of color (optical density) in a clarified water extract, obtained by filtering a 1-percent fig-water slurry, is a suitable index of the extent of heat damage in fig powders. The intensity of the extracted brown color was measured in a colorimeter. Color values obtained from these measurements can be used in comparing drying methods as well as time and temperature effects for a given method. A full description of the method is given on page 4. It is probable that color determinations of this type would not be required in a routine commercial operation. Visual color estimates should prove satisfactory for most purposes.

Tunnel Drying. Whole Black Mission figs were washed by immersion in water and agitation for 2 or 3 minutes. The figs were then ground in a screw-type mill (similar to that used in preparing fig paste), which was equipped with a face plate perforated with a single horizontal line of one-eighth-inch holes. The extruded material was distributed evenly over stainless-steel wire-mesh trays, with tray loadings of 1 and 2 pounds per square foot. The loaded trays were then placed in a tunnel dehydrator (cross-flow air velocity of 600-700 feet per minute) and trays were removed at intervals. Moisture content and heat damage, as measured by water-soluble color values, were determined on these samples.

The drying curves obtained at 200°, 180°, and 160°F. are shown in Figure 1. It will be noted that extruded figs were dried to 2 percent moisture content in 2.5 hours at 200°F., in 7.5 hours at 180°F., and in 20 hours at 160°F. Drying curves (160°F.) obtained at 1 and 2 pounds per square foot of tray loading were quite similar (Fig. 1). When the heavier tray loading was used, it was found that "wet" areas occurred in the material, apparently as a result of uneven distribution on the trays. Such material, when stored in air-tight containers for two or three days to allow equilibration of moisture, could be ground satisfactorily in most cases. No "wet" areas occurred with evenly distributed tray loadings of 1 pound per square foot.

Water-soluble color values, indicative of browning, were found to become progressively larger as drying proceeded at the various temperatures (Fig. 1). Color values obtained from samples dried to 2 percent moisture content at various temperatures were as follows: 0.245 at 160°F., 0.220 at 180°F., and 0.295 at 200°F. as compared with 0.120 obtained from the original material. Based on drying times and water-soluble color values, 180°F. was considered to be the most suitable temperature for this operation. Powders prepared from material dried at 160° and 180°F. had a characteristic fig taste and, in addition, a slight caramel flavor which was judged to be pleasant. Those prepared at 200°F. were definitely scorched and were somewhat bitter.

Vacuum Drying. The figs were washed and extruded in the same manner as for tunnel drying. Tray-load limitations were found to be similar to those for the tunnel dehydrator. The vacuum drier used in these experiments is equipped with a three-stage steam ejector which will maintain pressures down to 4 mm. of mercury in the drying chamber. The hollow shelves in the drier are heated by hot water or steam. Drying temperatures shown in Figure 2 are the temperatures of steam or water in the shelves.

With pressure of 4 mm. of mercury and a shelf temperature of 245°F., the time required to reduce the moisture content to 2 percent was 33 minutes; at 200°F. about 45 minutes was required. Drying curves at 245°F. and 200°F. and the relationship between soluble color and drying time at these temperatures are shown in Figure 2. Identical color values were obtained at shelf temperatures of 245° and 200°F. This value (0.14) was only slightly higher than that of the original material.

Drum Drying. Whole figs were soaked overnight in an equal weight of water and disintegrated sufficiently to pass a screen with perforations 0.03 inch in diameter. Purees containing 15 to 40 percent solids were dried successfully. It was found possible to transfer the purees containing up to 25 percent solids to the rolls by means of a small pump. Because of high viscosities, batches containing higher solids required manual handling.

A conventional atmospheric drum drier with two steam-heated chromium-plated steel rolls 18 inches long and 12 inches in diameter was used in this experiment. The pureed material was introduced into the trough or dam formed by the two rolls and, after drying, was removed by doctor blades as a thin sheet which became brittle when cooled.

The drum drier was operated at 90 pounds per square inch of steam pressure and drum contact times of 21 to 31 seconds. The rolls were spaced 0.006 inch apart. Drum speed was altered to suit the condition of the material being dried. In general, purees with high solids contents required longer contact times (slower drum speeds) for satisfactory drying than low-solids purees. In the case of a puree containing 40 percent solids, the optimum drum residence time was 24 seconds. The product dried at this speed contained 1.9 percent moisture and its soluble color value was 0.160. This indicates negligible heat damage. The rate of production under these conditions was about 25 pounds of dry product per hour. With a drum residence time of 21 seconds, the product proved to be too wet to be ground to a powder. With a residence time of 31 seconds, a product was obtained which contained only 1 percent moisture. Color values of all drum-dried samples were lower than those obtained by tunnel drying. Data for drum-dried products appear in Figure 3.

Grinding

In preparing large batches of fig powder for special uses, the following procedure was found satisfactory. The dried product was detrayed and placed in air-tight containers immediately upon removal from the drier in order to prevent absorption of water from the air. A rotary cutting mill equipped with a perforated screen (0.040 inch) was used in the grinding operation. Prior to grinding, 2 percent by weight of powdered tricalcium phosphate was mixed with the dried extruded figs. This improved the grinding characteristics of the material and reduced caking in the stored powder. Fig powder containing 2 percent moisture is at equilibrium with air at about 11 percent relative humidity. It is important, therefore, to conduct the grinding operation in a room maintained at low relative humidity.

Utilization

Among various uses suggested for fig powder, incorporation in baked goods and breakfast cereals seems most promising. On the basis of experimental bakery tests it appears that addition of 1 percent of fig powder to the dough yields whole wheat bread with improved flavor and color as compared to the control. For this purpose, Black Mission fig powder proved to be superior to powder prepared from the Adriatic variety. In another experiment, addition of fig powder to the extent of 6 percent in the mix yielded a granular breakfast cereal of better flavor than the control. While no tests have been made, it appears probable that fig powder would prove convenient for use in manufacture of fillings for fruit bars and other pastries. The use of fruit powders mixed with sugar and a gelling agent has been suggested for "instant" dessert mixes.

Analytical Methods

Moisture Content. The moisture content of the fig samples was determined on samples (ground to pass through a 20-mesh screen) by drying in vacuum (4 mm. of mercury pressure) at 60°C. for 30 hours. Material that was too wet to grind was pre-dried in vacuum at 60°C. for 6 hours. The percentage of weight loss is reported as percentage of moisture.

Water-Soluble Color Value. Seventy-five grams of the extruded material was blended for 5 minutes with 425 ml. of distilled water. Twenty-five grams of this slurry was transferred to a 500-ml. volumetric flask and distilled water was added to bring the volume to 500 ml. After thorough mixing this diluted sample was allowed to stand at room temperature for 15 minutes in order to obtain more complete extraction of color. The homogenate was then blended with 2.5 grams of analytical-grade filter aid for 1 minute, and this mixture was filtered at reduced pressure through a fine filter paper until a clear filtrate was obtained. The water-soluble color value (optical density) of a 2 cm. column of the filtrate was measured in a photoelectric colorimeter using a 420 millimicron filter. Color measurements are expressed here as $E^{1\%}_{1\ cm.}$, or 2 minus the logarithm of the percent transmission of light of 420 millimicron wave length through a 1 cm. column of the clarified 1 percent water extract (dry weight basis).

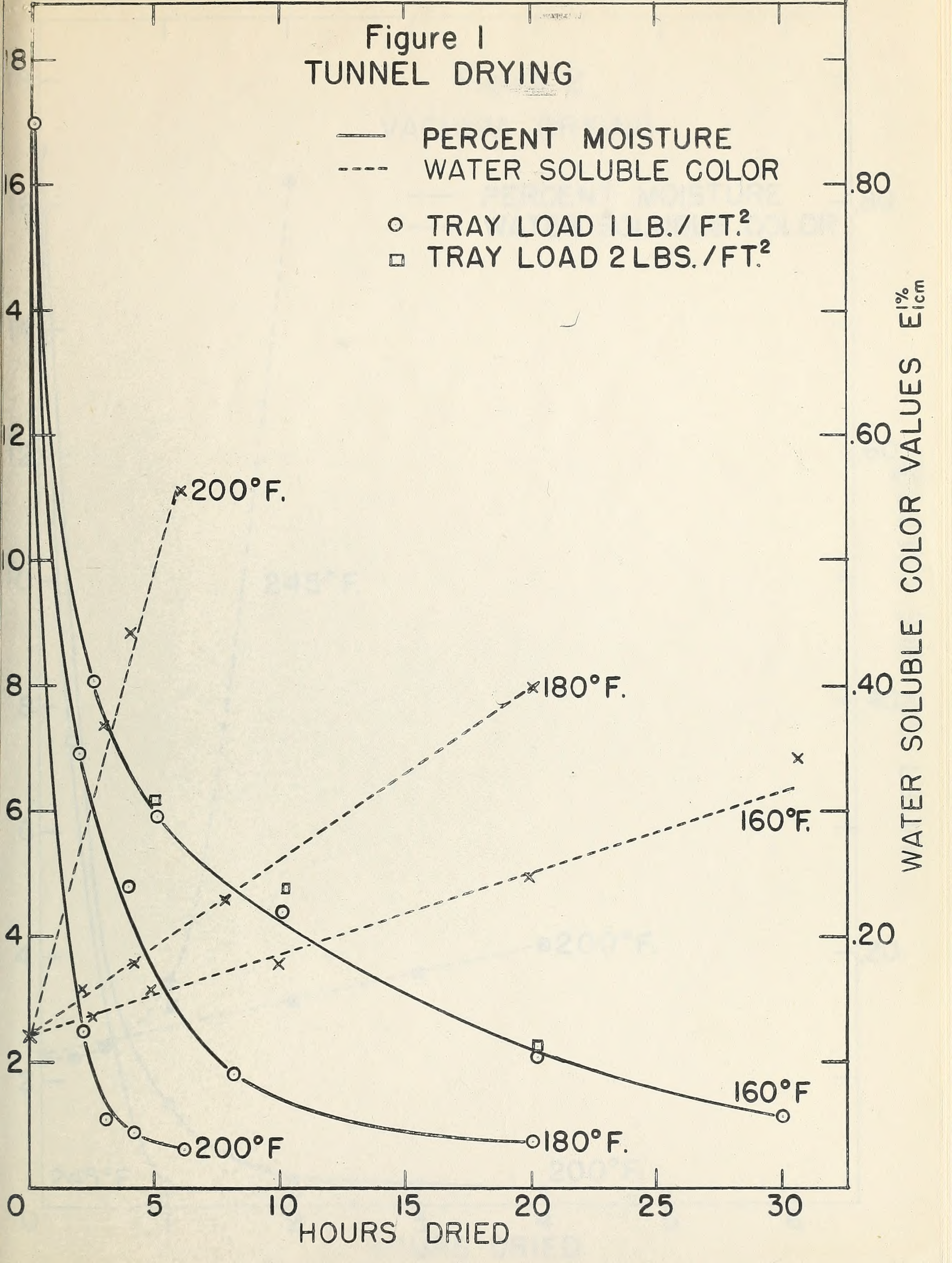

Figure 1
TUNNEL DRYING
PERCENT MOISTURE
WATER SOLUBLE COLOR
TRAY LOAD 1 LB./FT.²
TRAY LOAD 2 LBS./FT.²
200°F.
180°F.
160°F.
160°F
180°F.
200°F
18
16
14
12
10
8
6
4
2
0
5
10
15
20
25
30
HOURS DRIED
.80
.60
.40
.20
WATER SOLUBLE COLOR VALUES $E^{1\%}_{1cm}$

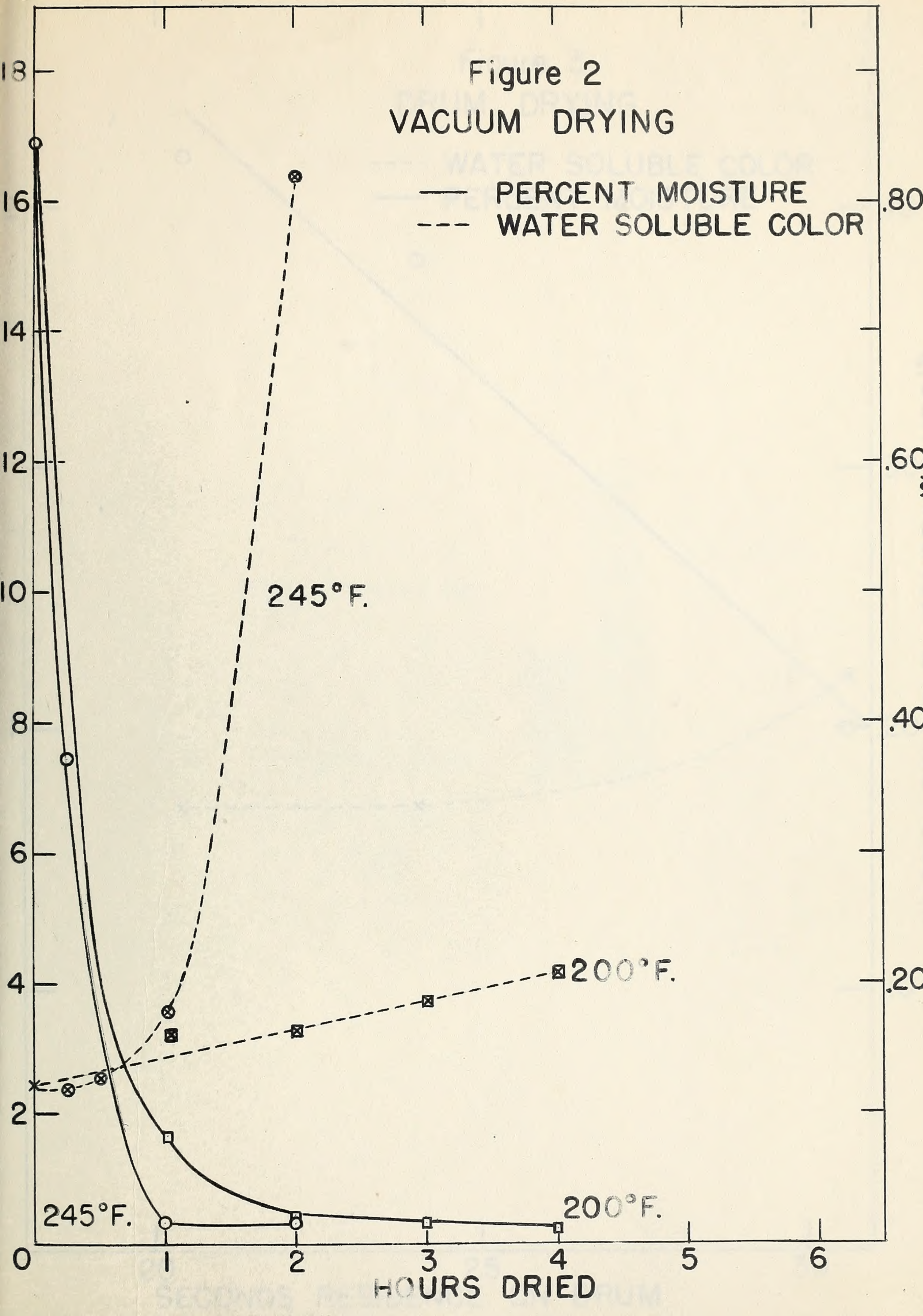

Figure 2
VACUUM DRYING
PERCENT MOISTURE
WATER SOLUBLE COLOR
245°F.
200°F.
245°F.
200°F.
HOURS DRIED
WATER SOLUBLE COLOR 1% 1cm.
0
2
4
6
8
10
12
14
16
18
1
2
3
4
5
6
.20
.40
.60
.80

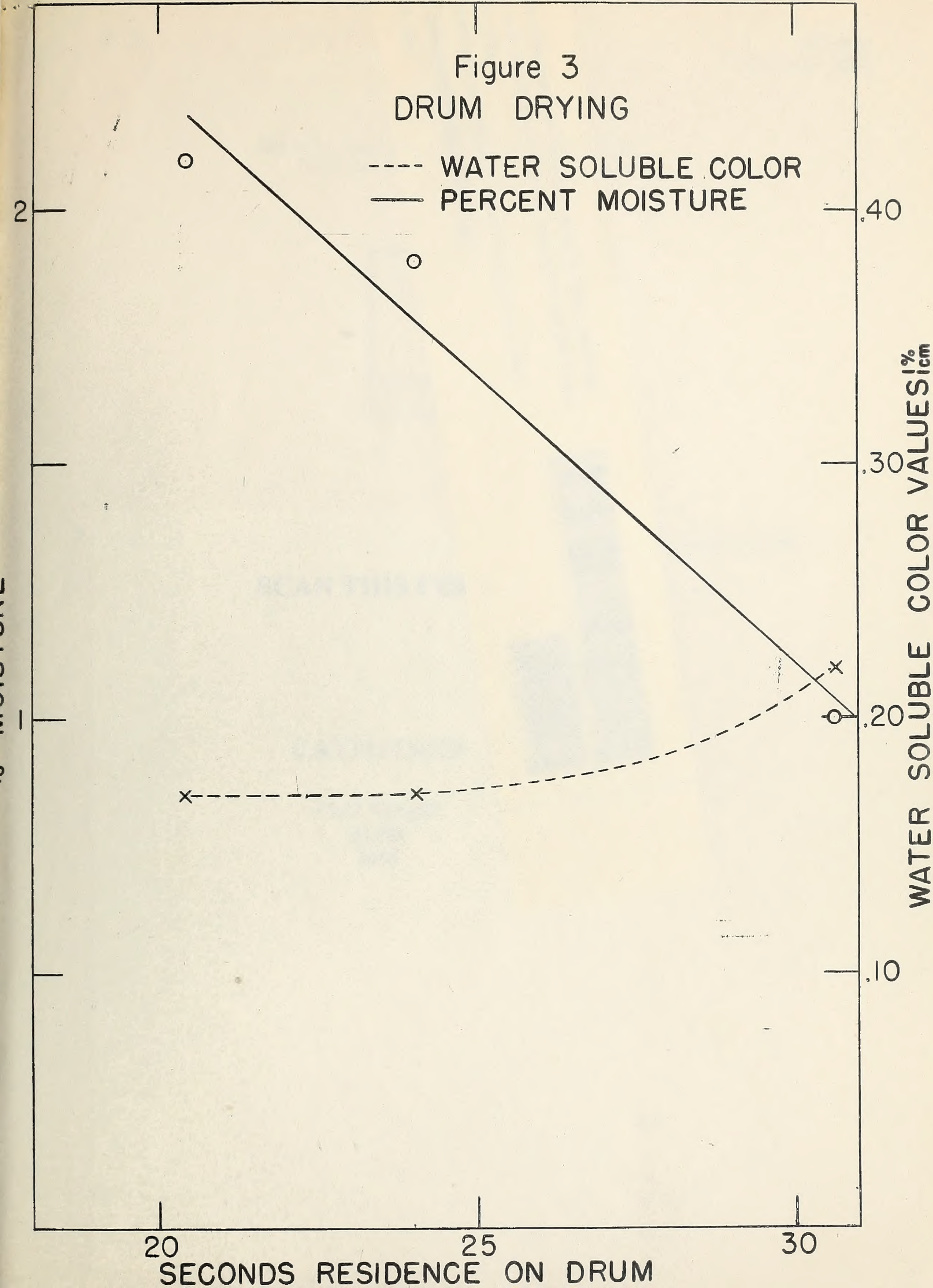
Figure 3
DRUM DRYING
WATER SOLUBLE COLOR
PERCENT MOISTURE
2
1
.40
.30
.20
.10
WATER SOLUBLE COLOR VALUES 1% 1cm
20
25
30
SECONDS RESIDENCE ON DRUM