Use of Oleic Acid Derivatives to Accelerate Drying of Thompson Seedless Grapes[1]

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ABSTRACT

Pilot scale procedures were developed for the use of fatty acid ester emulsions to decrease the time to dry the Thompson seedless grapes to raisins. Both sun and mechanical drying were used in these experiments. Mechanically harvested grapes were dipped in a 1% or 2% fatty acid ester emulsion and dehydrated at drying times less than those required for the soda-dipped raisins. Spraying grapes on the vine with a commercial ethyl ester mixture, which contained an emulsifier and added potassium carbonate, allowed the grapes to dry faster than the conventional sun drying procedures. These procedures produced light colored raisins of acceptable quality. In addition, these methods show savings by decreasing labor costs.

INTRODUCTION

Raisins made from Thompson seedless grapes are an important product of the central valley of California. Of the 246,349 acres of raisin variety grapes, 230,928 acres are of the Thompson seedless variety (1). However, ca. 110,000 acres are used for making raisins, which are mostly naturally sun dried. In a normal year, ca. 200,000 tons of raisins are processed this way, and ca. 20,000 tons are dehydrated mechanically. This represents one-third of the world production of raisins.

The sun-drying process requires considerable hand labor and elaborate cleaning procedures in the processing plant. It also involves considerable risk to the producer, since a minimum of 3 weeks drying time in the field is required. Any inclement weather during this period can cause serious losses to the grower in terms of a lower quality product and reduced salable tonnage.

A smaller percentage of raisins are dried by dehydration in a counter flow tunnel heated by gas and requires 22-24 hr to dry. There is considerable economic incentive to dry the raisins more quickly and to decrease the hand labor required in drying and processing. Since there is continual demand for a cleaner product at point of production, dehydration offers this added benefit.

The standard procedure is to dip Thompson seedless grapes into a 0.25% hot caustic soda solution before dehydration. This causes fine cracks to form on the skin of the grapes which greatly facilitate the rapid escape of water during dehydration. The finished raisin, while acceptable, is rather sticky due to the cracking of the skin as mentioned above.

The use of other dipping solutions to hasten drying time on grapes has been demonstrated by M. Grncarevic (2) in a process that affects the waxy surface of the grapes, thereby increasing their permeability to water.

J.V. Possingham (3) suggests that these cold dipping solutions have the effect of reorienting the individual wax platelets in an upright position, i.e. vertical to the grape surface and the spaces between the individual platelets appear larger, suggesting that this change may facilitate the movement of water from the grape to the atmosphere. Ponting and McBean (4) have studied on a laboratory scale the effects of fatty acid derivative emulsions on drying time of grapes and other waxy fruits.

These experiments demonstrate feasibility of accelerating the drying time of Thompson seedless grapes by drying them on the vine or in a dehydrator using spraying and dipping solutions containing fatty acid derivatives, particularly ester mixtures high in oleates. (The treatment of grapes with fatty acid esters in the U.S. is still in the experimental stage and the ester mixtures applied in these experiments have not yet been approved for this use.) Another benefit of using these chemicals is production of a less sticky and light amber colored raisin similar to the Golden Bleach raisin of California which gets its light color from the sulfur dioxide treatment. Also included in this study is a comparison of the economics of drying raisins on the vine to that of making the traditional natural sun-dried raisins.

MATERIALS AND METHODS

Three procedures were used in this study: natural sun drying, on-the-vine drying, and dehydration following a dip in cold methyl oleate emulsion. The first two were done in the field, whereas the last was done using a forced air dehydrator. The Thompson seedless grape variety was used for all three of these raisin processes.

In making natural sun-dried raisins, the grapes are picked at between 20-23% sugar content (°B) by workers who place the grapes in metal pans. From these pans, the bunches are scattered onto 2 x 3 ft paper trays that are placed on the ground between the rows of grape vines. The soil is prepared in such a manner that a terrace is formed to facilitate drying by the sun further.

In 10-14 days the paper trays are turned so that the bunches will dry uniformly. Six-ten days later, the fruit,

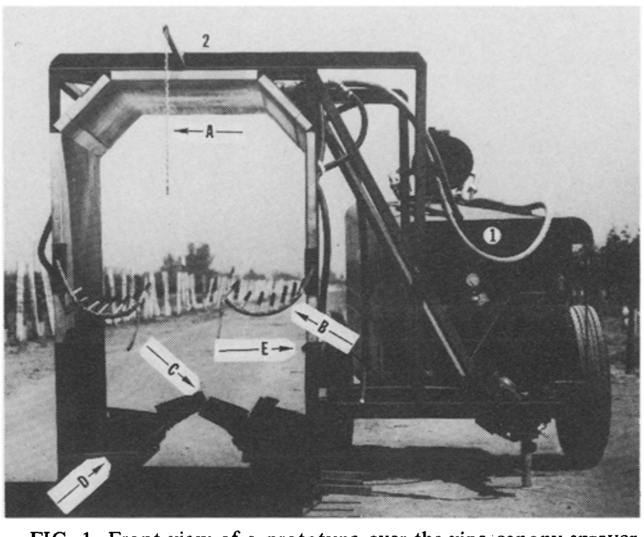

FIG. 1. Front view of a prototype over-the-vine canopy sprayer pointing out (A) row centering device, (B) cane lifter, (C) spray collecting frame, (D) trough which returns excess spray run-off to the spray rig, (1) which is emitted from spray nozzles located on each side at E.

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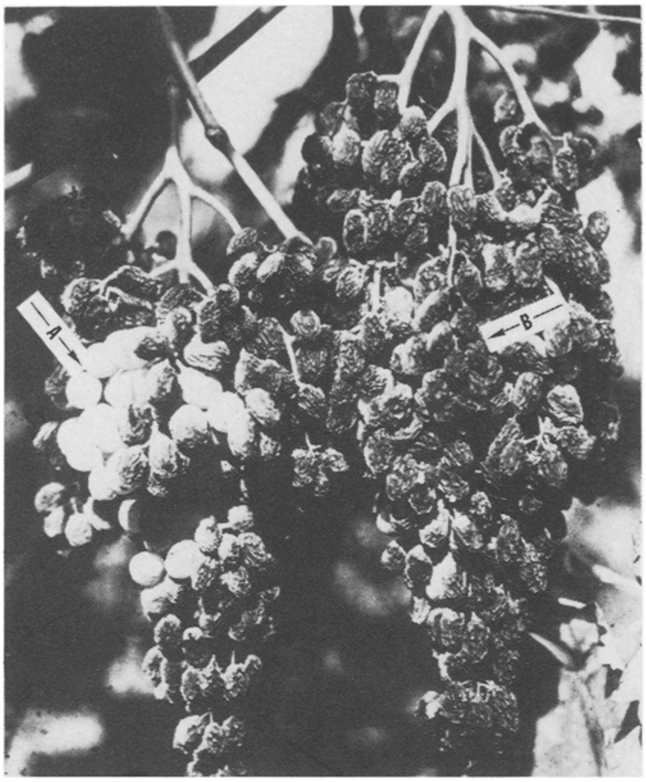

FIG. 2. To ensure complete and rapid drying, every berry must be covered by the spray. In A the berries escaped the spray, while berries, B, were covered completely and dried uniformly.

which ranges between 16-18% moisture, then is rolled up in biscuit fashion and allowed to dry further to 14-16% moisture. The rolled trays of raisins are picked up and emptied into sweat boxes which, when full, contain 180-200 lb of raisins. They are fumigated and, in due course, delivered to the processing plant.

The experimental process involved in making the on-

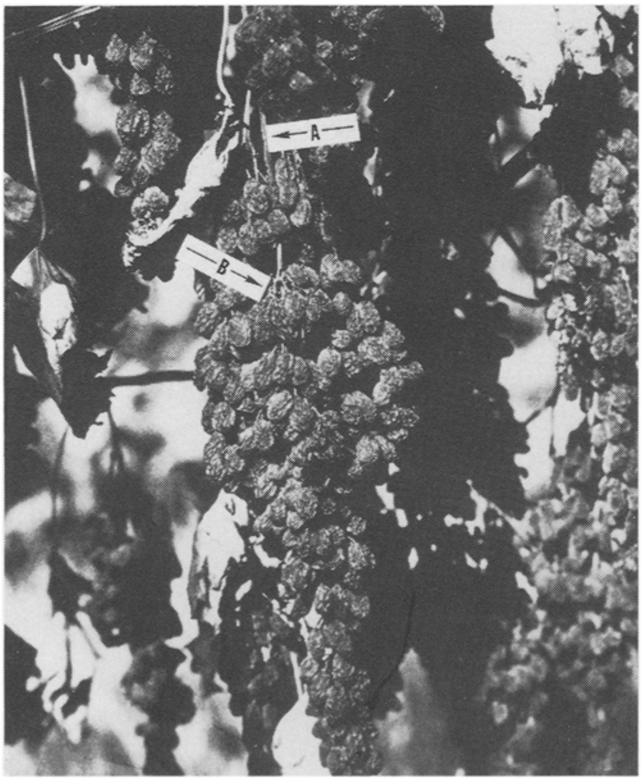

FIG. 3. On the cut canes the main clusters rachis (A) dries at the same rate as the capstem (B) which assists the raisins in remaining on the cluster until shaken off by the mechanical harvester.

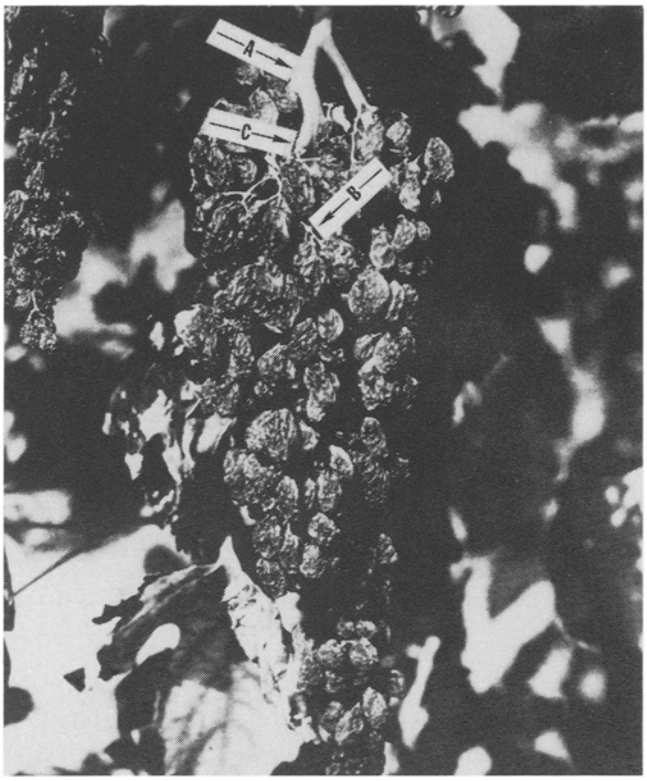

FIG. 4. On the uncut canes the main cluster stem (rachis) remains green (A). Further out on the rachis branches, the berries and capstems (B) dry at the same rate. However, an abscission layer (C) forms at the upper most part of the branch which, if shaken, may fall off prematurely.

the-vine dried raisins is described below. When the fruit is between 20-23°B, a crew of workers come into the field and with the use of hand shears or pneumatic shears cut last year's fruit cane to facilitate even drying and efficient removal of the finished product.

The next step uses an over-the-row canopy sprayer developed at California State University, Fresno, (Fig. 1) to spray the fruit with a 2% emulsion of Eemulsoyle and potassium carbonate. The spraying is done at the rate of 1364 gal/acre, 44% of which is recovered and reused by the sprayer for a net usage of 764 gal/acre. The Eemulsoyle was found to contain a mixture of ethyl esters with an emulsifier; it is a proprietary product of the Victorian Chemical Company, Richmond, Australia.

Ca. 5 days later, a second application of one-half the concentration (1% Eemulsoyle and potassium carbonate) is applied at the rate of 909 gal/acre, which gives a net usage

FIG. 5. The on-the-vine dried raisins, when mechanically harvested, come off in single berries (A) with the majority of the capstems (B) attached.

FIG. 6. The majority of the cluster rachi (B) remain attached to the vines fruit canes (A).

of 609 gal/acre in the second application. The second spray is used to penetrate further into the grape bunches, since the outer berries have become dehydrated. Ten days later, when the fruit has dried to ca. 16% moisture, a mechanical harvester can be used to remove the raisins from the vines.

The next experimental process was methyl oleate cold-dip. The fruit was harvested mechanically, thus requiring the canes to be cut 5 days prior to harvesting. This gives cap stems attaching the berries to the rachis of the bunch time to dry, so that the machine-harvested fruit comes off in the form of single berries.

The machine picked fruit is put into 1000 lb bins. At the processing plant the fruit is dumped by means of a bin dumper into an emulsion of water and methyl oleate (1% or 2% by wt). The fruit remains in the dip for 3-5 sec after which it is conveyed to traying tables. As the fruit moves to the traying table, the excess methyl oleate emulsion on the berry surface drains away. Since the fruit is in individual berries, a single layer of fruit is best suited for drying; ca. 3.00 lb of fruit/sq. ft of tray.

Two dehydrator tunnels were used in this study; both were especially designed on a pilot scale, simulating commercial types. The parallel flow tunnel has a capacity of four cars with 25 wooden trays (2 x 3 ft) on each car, whereas the counterflow tunnel holds eight cars. The dehydration procedure was used for drying at 190 F for the first 2.5 hr with air flowing in the same direction as the fruit. At the end of the 2.5 hr the fruit was removed and put into the counterflow tunnel operating at 155 F with air flowing in the direction opposite the fruit movement (5). The fruit remains in this tunnel for 12-14 hr until its moisture content reaches 12-14%.

For the cold-dip dehydration procedure, a methyl oleate product was prepared from high oleic safflower oil by PVO International, San Francisco, Calif. The methyl esters were composed of 78% oleats, 14% linoleate, 2% stearate, and 6% palmitate. Since this product was not distilled, it also contained 10-15% monoglycerides and diglycerides.

Initial attempts to use an emulsifying agent indicated that

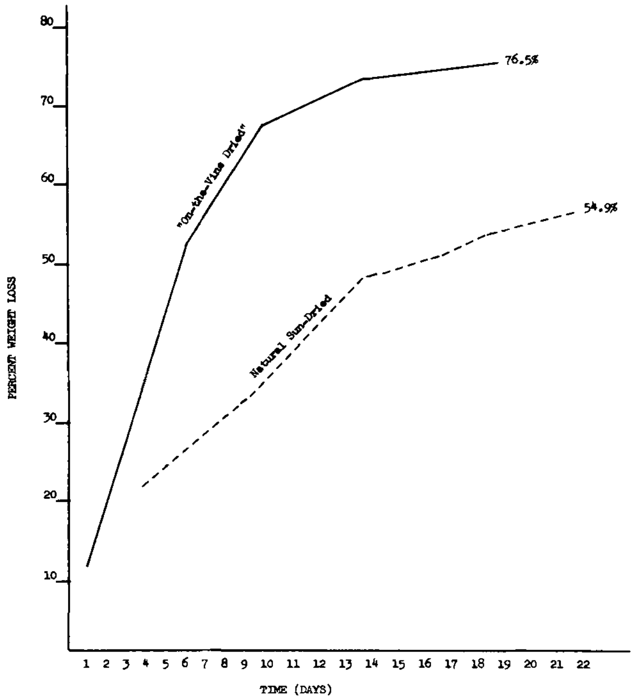

FIG. 7. The on-the-vine dried fruit lost 76.5% original wt in an 18 day period, whereas the natural sun-dried fruit lost only 54.9% original wt during the same 18 day period.

surface-active agents of the Span or Tween type interferred with dehydration. Therefore, the grapes were dipped in an emulsion without additives in which the esters were kept in suspension by vigorous agitation. The commercial Eemulsoyle, however, had ca. 40% products which were not ethyl esters. IR analysis indicated that the hexane insoluble portion of this fraction was probably a nonionic surface-active agent.

The amount of ester adhering to the grapes was not determined on the fresh fruit but on the finished raisins. The procedures for this analysis will be the subject of another paper.

RESULTS

It was found that grapes of the Thompson seedless variety could be dried economically on the vine by using the Eemulsoyle and potassium carbonate treatment. This treatment resulted in 136 ppm ethyl esters on the raisins. It was found that to ensure complete drying of all the berries on the cluster, every berry must be covered with the spray material (Fig. 2). Incomplete cluster coverage results in raisins of different colors. It was further discovered that, in order for the dried raisins to remain firmly attached to the cluster rachis, the canes bearing the fruit had to be severed prior to the chemical spray (Fig. 3). Otherwise, as noted on the unsevered cane, an abscission layer formed at the point of attachment of the primary branches to the main cluster rachis (Fig. 4), causing a portion of the dried fruit to fall to the ground.

Experience in these trials showed that a light shaking is sufficient (200-250 rpm shaker module) to remove 99% product which comes off mainly in single berries (Fig. 5), leaving some rachi attached to the fruit cane (Fig. 6). Because a mechanical harvester was used, many of the cluster stems were blown out, thus the raisins that are put into bins were much cleaner and require less stemming machinery in the processing plant.

The on-the-vine dried fruit lost 76.5% wt in the 18 day period, while the natural sun-dried fruit lost 54.9% original wt during the same period. The on-the-vine dried fruit lost 53% moisture during the first 5 days as compared to 29% on the natural sun-dried fruit during this same 5 day period

TABLE I

Approximate Costs for Producing Natural Sun-Dried and On-the-Vine Dried Raisins

	Cost/acre (dollars)	
Operation	Natural sun-dried average (3)	On-the-vine dried[a]
Pretreatment	6.66	4.50
Spray		
Materials		91.16
Application		13.12
Harvesting	104.63	45.00
Turning, rolling, boxing	51.26	
Rain insurance	13.16	
Delivery to processor	9.00	9.00
Total	$197.58	$162.78

[a]Experimental lots.

(Fig. 7).

There was no significant difference in drying time between the 1% and 2% methyl oleate dipping treatments, although the residual concentration on the raisins was 138 and 240 ppm, respectively. However, in either case the methyl oleate treated fruit dried ca. 1.5-2.0 hr faster than the hot caustic soda-dip (V.E. Petrucci and N.J. Canata, unpublished data), using the parallel counter flow dehydration principle as previously described.

With dehydration using the 1% methyl oleate cold dip, 26% original wt was lost during the first 2.5 hr of dehydration at a temperature of 190 F in the parallel flow tunnel, and an additional 31% was lost during the final 12.5 hr at 155 F in the counterflow tunnel. By using the 2% methyl oleate dip in the aforementioned manner, wt losses were 34.9 and 24.2%, respectively. Thus, with the higher concentration of methyl oleate the fruit loses a greater percentage of its wt during the initial 2.5 hr of dehydration.

Based upon these experiments, as shown in Table I, the cost of making on-the-vine dried raisins should be $25-$35 less/acre than the cost of making natural sun-dried raisins (6).

The ester mixtures might be expected to affect flavor and texture of raisins, particularly if any rancidity developed. Panel evaluations showed that flavor and texture of the treated raisin products were acceptable. In contrast to the blue-black natural sun-dried raisins, the dipped dehydrated fruits are brown in color, while those dried on the vine are golden with a slight but pleasing greenish cast.

DISCUSSION

Based upon the data presented here, it appears that making raisins on the vine is both economically and commercially feasible. A panel of California's largest raisin packers showed a keen interest in this process which produces a unique, new raisin for this country.

It was necessary to design adequate spraying equipment to ensure thorough coverage of all berries on the cluster and to avoid as much as possible the spray material from getting on the vine's green leaves.

The use of oleic acid derivatives shows a strong indication of shortening the dehydration time when compared to the normal soda dip using caustic soda (sodium hydroxide). A further advantage of oleate esters is that the disassociate the platelets of wax of the berry cuticle, rather than physically cracking the skin as is the case with caustic soda, which permits the escape of grape juice causing stickiness. Thus, the oleate dip produces a freer flowing product which is desired by processors and users.

There is an apparent demand by some California raisin users for a lighter colored raisin without the obvious sulfite taste, which can occur in the present commercial golden bleach products. The methyl oleate dipped raisins are lighter in color and do not require any sulfur treatment; however, their storage stability properties would be different than the sulfured raisins.

On-the-vine drying allows the making of raisins with decreased labor cost. The products can be harvested mechanically directly from the vines, producing a raisin which is cleaner and lighter colored than the current sun-dried product. During drying it is also less susceptible to harm from inclement weather.

No gains in drying rate appear to be derived from using ester dips in excess of 2% concentration. Additional studies will be made to determine minimum effective ester concentrations.

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