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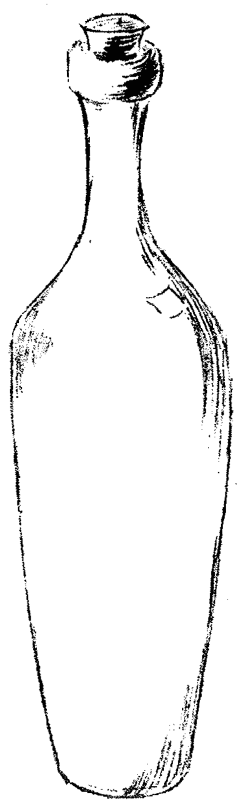
FROM NEW YORK STATE WINES



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CONTINUOUS PRODUCTION OF FLOR SHERRY FROM NEW YORK STATE WINES[1/]

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SPANISH FLOR SHERRY and the Vins Jaunes of the Chalon region of France owe their reputation to a special flavor derived from the growth of yeasts on the surface of the wines stored in partially filled barrels. After the initial alcoholic fermentation, the so-called "flor" yeasts gradually form heavy and sometimes wrinkled films having a waxy appearance on the surface of the wine. During this secondary or oxidative fermentation, the flor character develops. For top quality flor sherry, a subsequent aging period of 4 to 6 years is considered minimal.

During the secondary fermentation by the flor yeast of the genus Saccharomyces, a number of chemical changes occur. Among them is the oxidation of the ethyl alcohol to acetaldehyde. Since flor character has been observed to parallel aldehyde formation, the latter has been used to follow the course of flor fermentation. Changes in the glycerol content have been suggested by Saavedra and Garrido (1959) as a good indication of flor sherry production. Other changes occurring during flor fermentation have been mentioned by Van Zyl (1958) such as the oxidation of glycerol to lactic acid and dihydroxyl acetone, the reduction of total and volatile acid contents, pH, specific gravity, and an increase in volatile esters.

Under normal conditions, the secondary flor fermentation may proceed very slowly and require months or years for completion. Studies have been made in Australia, Canada, and the United States to adopt the findings of Cruess (1948), Fornachon (1953), and Van Zyl (1958) on the basic microbiology of flor fermentation to a more rapid process. Crowther and Truscott (1955, 1957) produced flor sherries in approximately

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3 weeks by recirculating the wine periodically with a pump. Later, Ough and Amerine (1958, 1960), Amerine (1958), and Ough (1961) showed that this method could be successful if there is sufficient aeration of the wine. Additionally, they studied submerged fermentation with yeasts, wines, and aeration as the variables. Flor type sherries having aldehyde contents of 1100 mg/L were obtained in 3 to 4 weeks using an oxygen pressure of 3 psig.

The purpose of the present study was to determine if New York State wines might be used for flor sherry production and if such a process could be made continuous and accelerated.

EXPERIMENTAL

A mixture of white wines from varietal studies was used along with Delaware wine and wines from hot and cold pressed Concord juice. Excessive color in the Delaware wine and those from the cold pressed Concord juice was removed by adding 1.5 grams of an activated carbon[a] to each gallon of wine and stirring for 10 to 20 minutes at room temperature. Concord wines from hot pressed juice were unsatisfactory because the Concord flavor and color could not be removed with activated carbon. The natural alcoholic content of these wines was 8-11 per cent, and this had to be increased to 13 per cent by volume for flor fermentation.

Eight strains of yeast were obtained from Australia, France, and Switzerland. Of these, a yeast Saccharomyces oviformis, strain "STV 31" from the Arbois region of France gave the best results in terms of growth and wine organoleptic properties. This yeast was used throughout the present study. The optimal temperature for fermentation was found to be 18-20°C (64-68°F). Generally, the wines used in this study contained enough growth factors, but it was possible to improve growth noticeably by adding yeast extract and/or ammonium sulfate. However, it is doubtful if such additions should be recommended generally, although they may be of decisive importance in exceptional cases.

The initial fermentations were made with still liquids in Fernbach flasks or partially

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[a] Darco, KB, mfgd. by Atlas Chemical Industries, Wilmington, Delaware

filled 1-gallon bottles. These tests helped in the selection of the proper fermentation temperature and of the most suitable strain of yeast. Later, the work was extended to the use of a percolation column and a submerged fermentor.

The column consisted of a glass tube, 4.5 cm diameter x 115 cm high filled with 6 mm Intalox saddles.[b] Before packing, the saddles were washed with hot water. The packed column was filled with a fresh yeast suspension in wine, left standing overnight, and then slowly emptied. In this way, a major portion of the yeast was deposited on the saddles. Then, the column was lightly aerated from below and let stand for 2 days before the experimental wine was introduced from above so that it wetted the saddles as uniformly as possible.

Submerged fermentations were carried out in a 7-liter glass fermentor[c] operated in a room maintained at 23° C. A paddle type agitator revolving at 250 rpm to give a peripheral speed of 200 feet per minute was used to disperse air supplied below the turbine at a rate of 0.3 liter/min/liter of wine. To an initial volume of 3.8 liters wine was added 20 grams of centrifuged fresh yeast. When operating the fermentor in a continuous manner, the effluent sherry was centrifuged to recover the yeast cells for readdition to the fermentor contents.

The chemical analyses used in this study were performed according to the standard methods described by Amerine (1955). However, for the aldehyde determinations, the Juffman's distillation apparatus described by Tanner (1961) was used because of its simplicity and rapidity of operation (2-3 analyses per hour). For total and free SO_2 contents, the simplified procedure described by Rentschler and Tanner (1960) was used. As in previously reported studies, the formation of aldehyde was used as a measure for the development of sherry character.

RESULTS AND DISCUSSION

STILL FERMENTATION--The optimal concentration of ethyl alcohol in the base wine was determined by periodically measuring the total aldehyde content over 1 month (Figure 1). The aldehyde content was found to fluctuate in varying degrees according

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[b] Manufactured by U. S. Stoneware Inc., Akron, Ohio

[c] New Brunswick Scientific Co., New Brunswick, N. J., Model F-07

to the initial alcohol content (Figure 2). In some instances, there were temporary aldehyde losses of more than 100 mg/liter per day. Such fluctuations in aldehyde content have been observed by Fornachon (1963) and by Amerine (1958). It is believed that these fluctuations are due to variation in the predominance of aerobic and anaerobic yeast metabolism wherein acetaldehyde is continuously produced and then partially consumed. In the present study, these changes in the type of metabolism occurred early in the flor fermentation with wine having a low alcohol content. When the base wines had an alcohol content of at least 13 per cent (by volume), the aldehyde losses were small. Hence, there was a more rapid accumulation of flor flavor.

The most favorable temperature for flor fermentation was found to be 18-20°C., but because of a lack of adequate cooling facilities, the studies reported here were conducted at 23°C.

CONTINUOUS FERMENTATION IN A COLUMN--Within 8-10 days after seeding the column, a marked increase of yeast cells was noted on the ceramic rings and the glass tube. During this time, the efficiency of the column steadily increased. The column was used continuously for 5 weeks with different base wines. During this period, it was possible to attain a reasonably constant aldehyde production at a desired level provided the base wine feed and aeration were maintained at reasonably constant rates. A series of readings taken at 20 minute intervals while the column was operating are given in Table 1 to show the normal variations in the total aldehyde content of the effluent.

The output of the column with an aldehyde concentration of approximately 335 mg/L amounted to 20 liters per 24 hours. The preparation and operation of the column required considerable care and this led to a consideration of a laboratory fermentor for obtaining the same results with less precise control of conditions.

EXPERIMENTS WITH A LABORATORY FERMENTOR--The preliminary experiments on the production of flor type sherry by submerged fermentation were conducted on a batch basis using 3.8 liters of base wine. The production of aldehydes was quite rapid (Figure 3), and within 12 hours the aldehyde concentration reached a level of approximately 400 mg/liter which was considered to be optimal with respect to flor flavor.

Attention turned next to the possibility of producing flor sherry continuously using submerged fermentation. When the same volume was maintained in the fermentor with a flow of 817 ml of wine per hour through the fermentor, it was possible to obtain an average aldehyde content of 300 mg/L. The degree of aeration, wine flows, and aldehyde contents experienced at 45 minute intervals are given in Table 2. The steady aldehyde production was maintained by centrifuging the yeast cells from the effluent and adding them back as the base wine was fed into the fermentor. In other experiments, the aldehyde content of the effluent was increased to 409 mg/liter when the air flow was 42.8 liters/hr and the wine feed rate was decreased to 574 ml per hour.

The results of this preliminary study show that it is possible to produce 20 liters (5.2 gal) of flor type sherry by a continuous process using a small laboratory apparatus. A good flor sherry, however, is not produced by the formation of high aldehyde contents alone, and subsequent aging in wooden barrels over a period of at least several months is essential for the development of a desirable flavor.

Table 1. - Aldehyde Production During Continuous Fermentation in a Column

Temperature	Air Flow	Wine Flow	Aldehyde Content
°C.	1/hr.	1/hr.	mg./1
20.5	18.7	0.75	356
20.5	17.0	1.54	255
20.5	17.0	1.35	255
20.5	25.5	1.26	251
21.0	29.7	1.56	232
21.0	25.5	1.89	216
21.0	27.0	1.54	290
23.0	28.9	2.37	312
23.0	23.8	2.10	330

Table 2. - Continuous Production of Flor Sherry by Submerged Fermentation

Air Flow	Wine Flow	Aldehyde Content
1/hr.	1/hr.	mg./1
56.6	1.66	348
56.6	0.87	343
45.3	0.87	312
68.0	0.87	300
65.1	0.48	300
59.5	0.48	326
59.5	0.67	330
65.1	0.80	312

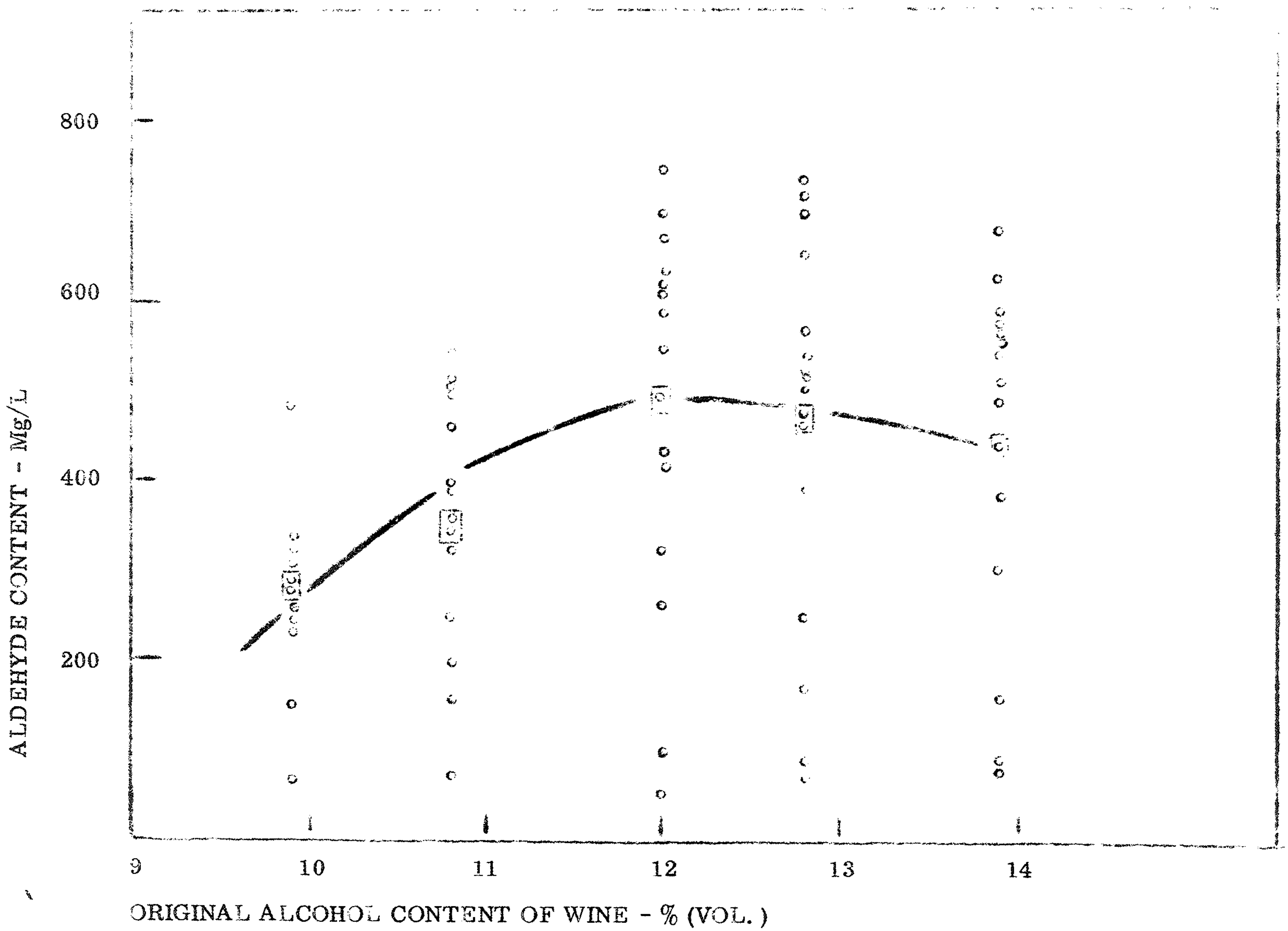

Figure 1. Effect of alcohol content in original Delaware wine on aldehyde formation.

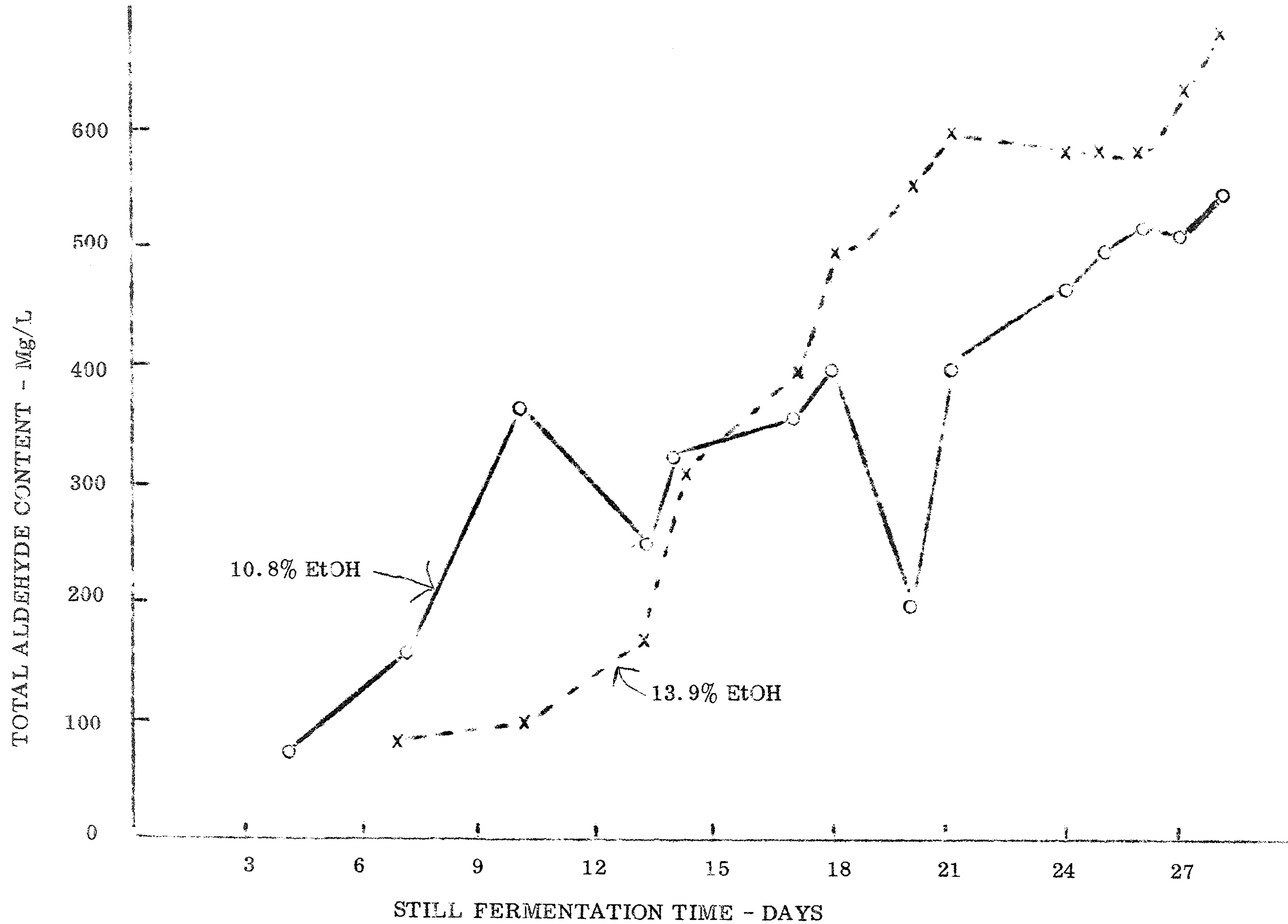

Figure 2. Aldehyde production during still fermentation of Delaware wines having low and high alcohol contents.

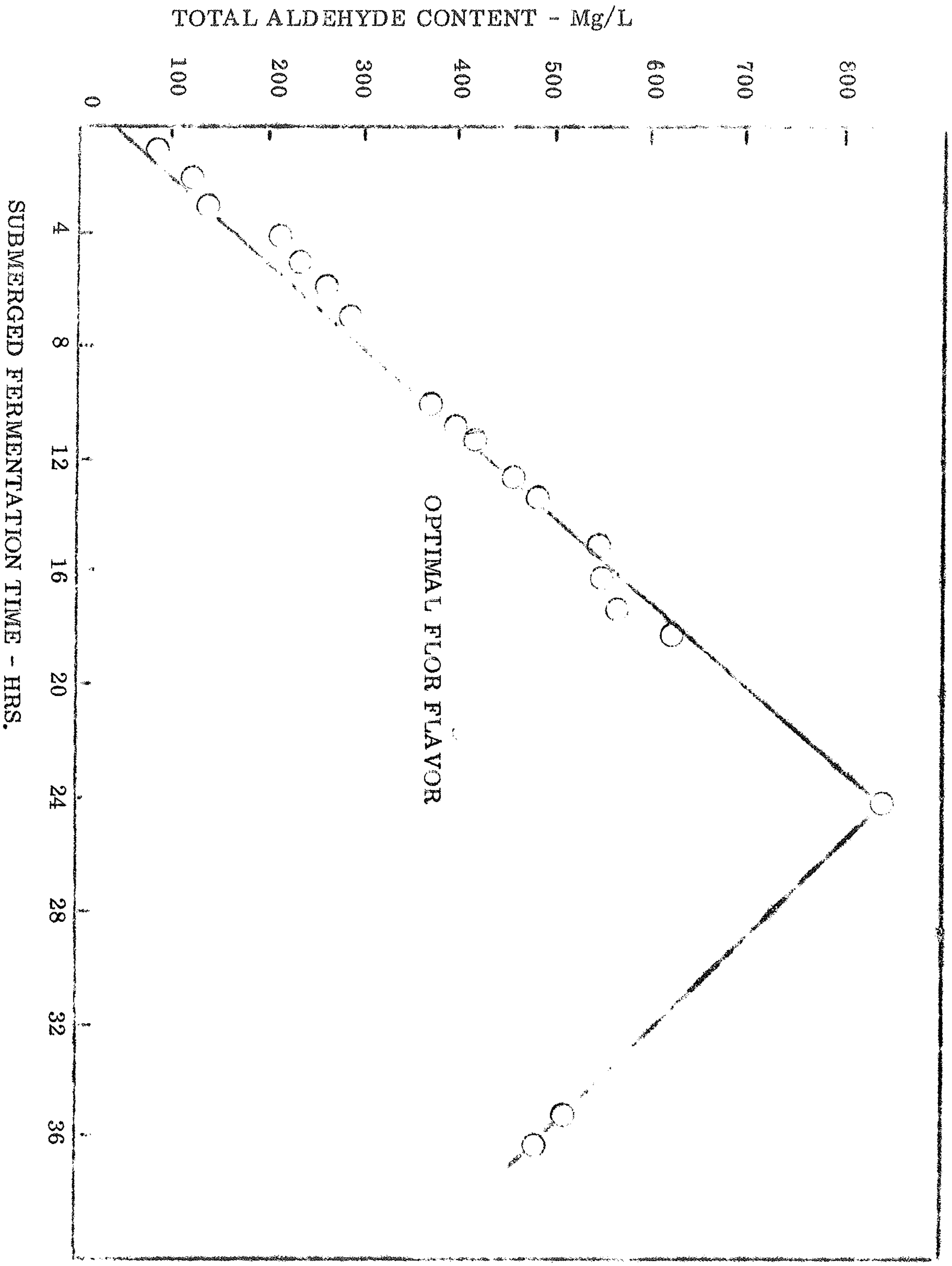

Figure 3. Aldehyde formation during submerged fermentation.

LITERATURE CITED

Amerine, M. A. 1960. Laboratory procedures for enologists. Mimeo 108 p. Dept. of Viticulture and Enology, University of California, Davis.

Amerine, M. A. 1958. Aldehyde formation in submerged cultures of Saccharomyces beticus. Appl. Microbiol. 6 : 160-168.

Crowther, R. F., and J. H. L. Truscott. 1955-56. Flor-type Canadian sherry wine. Ontario Hort. Expt. Sta. and Products Lab. (Vineland) Bienn. Rept. : 75-82.

Crowther, R. F., and J. H. L. Truscott. 1957. The use of agitation in the making of flor sherry. Am. J. Enol. 8 : 11-17.

Cruess, W. V. 1948. Investigations of the flor sherry process. California Agr. Expt. Sta. Bull. No. 710.

Fornachon, J. C. M. 1953. Studies on the sherry flor. Australian Wine Board, Adelaide.

Ough, C. S., and M. A. Amerine. 1958. Studies on aldehyde production under pressure, oxygen and agitation. Am. J. Enol. 9 : 111-122.

Ough, C. S., and M. A. Amerine. 1960. Flor sherry production by submerged culture. Food Technol. 14 : 155-159.

Ough, C. S. 1961. Aldehyde formation in submerged cultures of non film-forming species of Saccharomyces. Appl. Microbiol. 9 : 316-319.

Rentschler, H. and H. Tanner. 1960. Anleitung für die Getränke-Analyse. Eidgenoess. Versuchsanstalt für Obst-Wein-und Gartenbaw, Wädenswil, Schweiz. Flugschr. No. 55.

Saavedra, I. J., and J. M. Garrido. 1959. La levadura de "flor" en la crianza de vinos. Estudio analitico de la evolution de algunos componentes del vino durante la crianza en bodegas. Rev. Cienc. Apl. (Madrid), 13 : 312-321.

Tanner, H. 1961. Moderne weinkontrolle in labor und betrieb. Weinberg und Keller, 8 : 298-316.

Van Zyl, J. A. 1958. Bietrage zur biologie und frage de stoffwechsels der Jerez-und kamhefen. Zentr. Bakteriol. Parasitank. II Abt. III : 33-79.