STUDIES ON THE UTILIZATION OF GRAPE PART II. PRODUCTION OF GRAPE JUICE FOR DR1NK

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By

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Koch (1) recommended that grape juice should be stored under high pressure of carbon dioxide or at low temperature after removal of microorganisms through a germ-proofing filter such as Zeitz filter, because the flavor of grape juice could be improved by the action of its own enzyme during the storage. And, he concluded that grape juice must not be treated with any heat, even though flash pasteurization.

In the production of red grape juice such as *Concord*, however, the crushed grape mass have been usually heated for the extraction of color constituents and the heat-destruction of enzymes damaging the characteristic flavor of fresh *Concord* grape during storage.

In Watari region of Miyagi Prefecture, grapes have been produced since 1897. Recently, abont 80 per cent of produced grapes have been consumed as raw material of commercial juice and 20 per cent for dessert, wine, etc. In 1953, both the yield and quality of grape dropped below the those of a common year on account of the influence of unfavorable weather. Most of grapes in this region are *Concord*. Therefore, the commercial grape juice is produced exclusively from this variety. In the conventional preparation of juice, the crushed grape mass is heated to develop the full *Concord* grape color and pressed on hydraulic press. The obtained juice is put into containers, pasteurized and stored in a cool place to allow the occurrence of argol cristallization and sedimentation. Thereafter, the upper juice is separated from the precipitates, mixed with sugar and pigment, bottled, repasteurized and marketed.

In America (2), the stemmed and washed *Concord* grapes are usually pulped, heated to approximately 71 to 74°C in the aluminium or stainless steel vessels and pressed in a rack and cloth press. The resulting juice is flash heated to 85 to 93°C, flash cooled to -1.1 to $+1.7$°C, and stored at -3.3 to -2.2°C for

4 to 6 months to allow crystallization of the argols and sedimentation to take place. The juice is then separated from the sediments, bottled, and repasteurized.

Generally, as above mentioned, red grape juice is chiefly prepared from *Concord* which have the characteristic color and flavor. The heating treatment for color extraction, destruction of enzyme and pasteurization, often deteriorates the juice quality. Air contact with juice during processing is also detrimental to the color, aroma and flavor of the juice. And, long storage time is required for the crystallization of agrols and sedimentation.

These problems in the red grape juice preparation have been until now studied by many workers.

In our experiment, the pressed juice was stored at low temperature to precipitate the argols after essence recovery and vacuum concentration, while the preparation method by Homiller *et al.* (3) was that the hot-pressed juice was stored at room temperature before essence recovery. *Concord* grapes, harvested in Watari region in October 1953, were used as raw material. And, two ways of hot-pressing and cold-pressing were adopted in this experiment. The volatile essences were recovered in two stages. These two essences were then blended with the concentrated stripped juice. The blended juice was made up with water to original juice volume and used for tasting. However, the result was not adequate, which was supposed to be due to our short experience and the poor quality of original grapes.

Detailed experimental data will be shown below. Moreover, the all glass evaporator improved for the fruit juice concentration will be also described.

Experimental

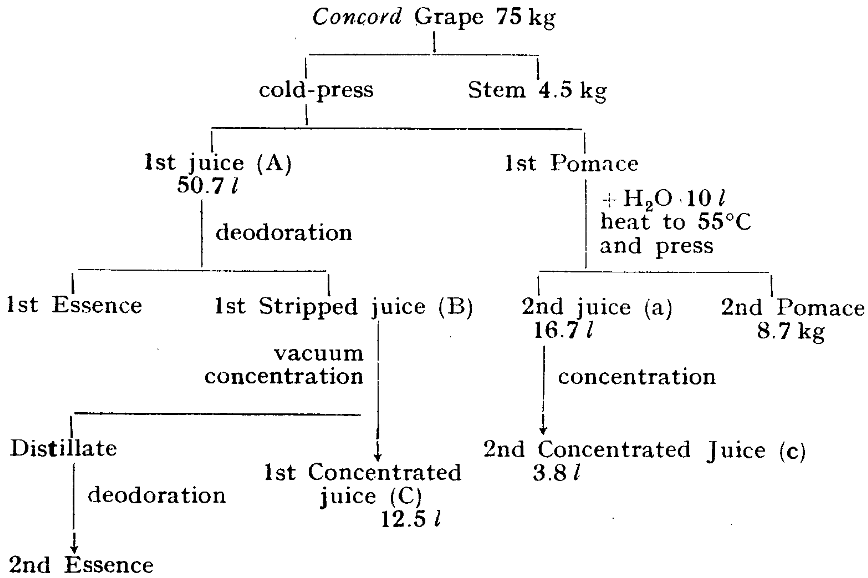
A. *Essence Recovery and Vacuum Concentration of Grape Juice*

1). *Cold-Pressed Juice*

Concord grapes harvested in Watari region were stemmed, crushed and pressed by laboratory press. The resulting juice was fed to the essence recovery equipment which was the same as that used for recovery of the volatile essence from apple juice (4). The recovered essence is shown as the first essence in Fig, 1. The stripped juice was concentrated under vacuum. However, since the distillate obtained during the vacuum concentration had a characteristic grape juice odor, the distillate was again passed through the essence equipment. Thus, the second essence was obtained.

On the other hand, the pomace was mixed with water and heated with stirring to about 55°C for the extraction of full *Concord* grape color. The cooked mass was pressed instantly and the pressed juice was concentrated under vacuum. These two (C and c in Figure 1) concentrated juices were separated from argols and sediments after the storage at low temperature, blended with the first

Fig. 1. Process of Essence Recovery and Concentration of Cold-Pressed Grape Juice.



and second essences, and diluted with water to make a juice which would be equivalent to original juice. This reconstituted juice was tested organoleptically. But this did not give the good flavor and taste.

Analyses of juices in each step of processes resulted in Table 1. No sucrose was contained in this *Concord* grapes.

Table 1. Chemical Compositicn of Cold-Pressed and Concentrated Grape Juices

	pH	Ballg. (15°C) deg.	Reducing sugar (as glucose) g/100 ml	Glucose g/100 ml	Fructose g/100 ml	Total acid (as tartaric) g/100 ml
A	2.7	10.76	8.49	4.48	3.93	1.36
B	2.7	11.65	9.41	5.07	4.27	1.50
C	2.0	—	29.07	15.31	13.43	3.19
a	2.4	—	4.98	3.13	1.77	1.05
b	1.8	—	18.63	11.40	7.15	2.90

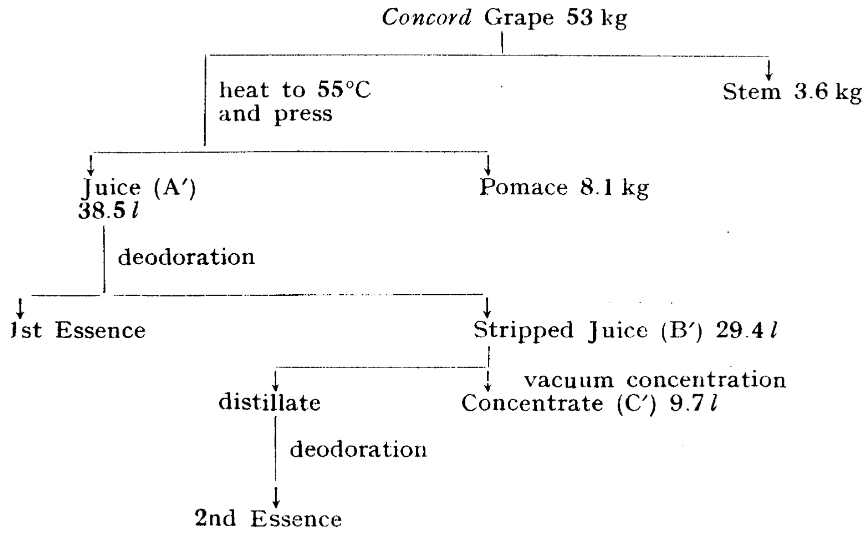
2). *Hot-Pressed Juice*

The stemmed and crushed grapes were put into an enameled vessel, heated with stirring to 55°C for the development of *Concord* grape color and instantly pressed. Subsequent procedures are shown in Fig. 2.

The concentrated juice was stored at low temperature to allow the precipitation of argols and then separated from precipitates. The two (first and second) essences were added to this concentrate. The blended concentrate was reconstituted with water into a product which had the original jucie volume, and examined organoleptically.

Chemical composition of juices in each step of processes was analysed. The

Fig. 2. Process of Essence Recovery and Concentration of Hot-pressed Juice.



results are shown in Table 2.

Table 2. Chemical Composition of Hot-Pressed and Concentrated Grape Juices

	pH	Ballg. (15°C) deg.	Reduing sugar (as glucose) g/100 ml	Glucose g/100ml	Fructose g/100 ml	Total acid (as tartaric) g/100 ml
A'	2·4	10.96	8.65	5.02	3.51	1.33
B'	2.4	12.35	10.24	5.94	4.75	1.60
C'	2.0	—	29.78	16.49	12.06	3.71

3) *Argol*

As before-mentioned, the crystals of argol and other sediments were partially precipitated during the concentration of stripped juice. This precipitation was accomplished during the storage of concentrated juice at nearly freezing point for one or two days. Then, the precipitates separated from the concentrated juice were once washed with water, filtered, dried and weighed. Determination of potassium tartarate in argols was made by Nikuni-Tatsumi method (5).

Table 3. Yield and Purity of Argol

	Yield g	Purity (K-tartarate), %
1=Fig. 1, C	158	52.89
2=Fig. 1, c	98	91.49
3=Fig. 2, C'	220	81.18

Discussion

As indicated by Homiller *et al.*, the recovery of volatile flavors was more difficult in grape than apple. In our experiment, the collected essence was not good although recovered in two stages. This might be due to the poor quality of original grapes and our short experience. Our efforts will be continued to gain the desirable result.

In the concentration of grape juice, the sugar content could not be raised over 30 per cent, because of the increased viscosity during concentration. If pectin is hydrolysed by pectolytic enzyme, sugar content can be raised above 60 per cent. The decomposition of pectin renders the juice clear. Which is the better, clarified or cloudy juice? This can not be easily decided, but takes an important significance in the commercial juice production.

The used grape juice had low sugar and high acid content, and consequently gave a sour taste. The juice which was properly diluted after addition of sugar, gave comparatively pleasant taste. But, the reconstitution of recovered essence into this juice could not reach to the expected result because of the bad quality of raw materials.

Argols and other sediments in concentrated juice can be precipitated completely for shorter period, such as a few days, than in original juice. On the other hand, it is disadvantageous that the decrease of acidity and color occurs at the same time. This problem will be also investigated another day.

B. *Improved All-Glass Laboratory Scale Evaporator*

For evaporating heat-sensitive solutions, the usual batchwise procedure for concentration in flasks is often unsatisfactory. Long-tube type evaporator, which provides short contact time for the evaporating liquid at moderate temperatures and high evaporation rates, has been used advantageously in the laboratory. The original apparatus was made for the concentration of apple juice (4).

This time, for higher efficiency of evaporation and more simplicity of operation, some parts of apparatus have been improved as follows:

1). The concentrate receiver as well as the distillate receiver has become a couple. The continuous operation, even if feed volume exceeds the capacity of the receiver, has been accomplished by the alternative exchange of stopcock connection with receivers.

2). For producing higher vacuum, which has been maintained by two water glass-aspirator in the original system, the metalic aspirator (Figure 3) made in France has been added in the new system. To multiply the capacity of vapor condensation, the number of condenser tube has been doubled.

Thus, the temperature at the vapor head (the top of steam-jacketed heating tube) has been held below 38°C during the processing, and evaporation rate has been increased by about 20 per cent.

3). The number of ground-glass semiball joints, which have provided the

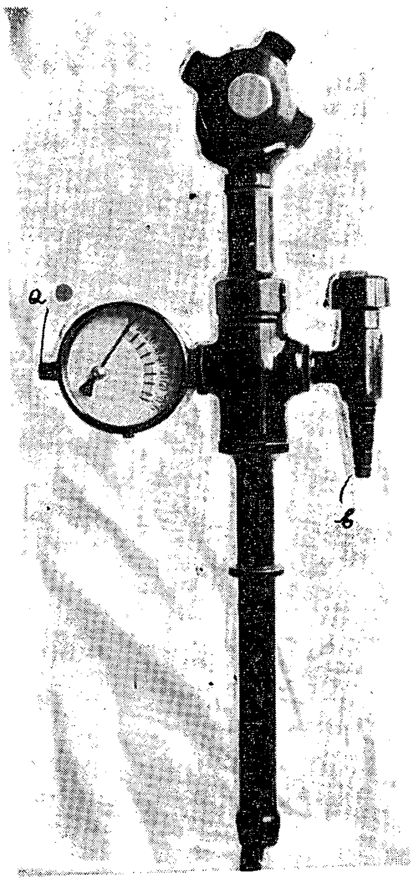


Fig. 3. Metalic Aspirator made in France.

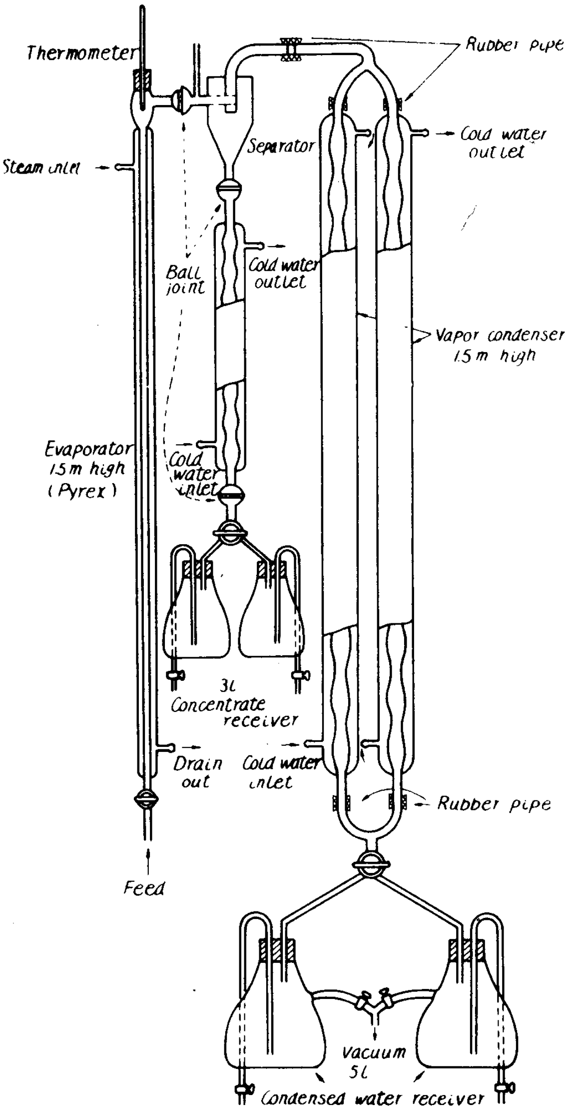


Fig. 4. Improved All-Glass Laboratory Scale Evaporator.

Table 4. Concentration of Some Juice by Our Improved Laboratory Scale Evaporator

Conditions of Concentration : Vacuum, 21-28 mmHg ; Temp., 33-37°C ; Working time, 34 min.

	Juice volume ml	Total sugar (as invert) g/100 ml	Reducing sugar (as glucose) g/100 ml	Total acid (as malic) g/100 ml	Ballg. (15°C) deg.
Befor	3,000	10.74	6.92	0.17	12.45
After	640	47.78	30.50	0.77	48.10

structural flexibility in the unit, have been reduced to a half. The manufacture of each section of apparatus has been simplified, and no trouble in setting the apparatus has occurred.

A detailed sketch of the improved glass evaporator is shown in Figure 4. An example of several tests made in this apparatus is reported in Table 4.

Summary

Red concentrated grape juices were experimentally prepared from the *Concord* grapes produced in Miyagi Prefecture with the processes of cold-press or hot-press, recovery of its aroma by the flash deordorizer, concentration of the stripped juice by our improved glass vacuum evaporator, removal of argols from the concentrate, and addition of the recovered aroma to the concentrate.

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