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Manufacturing Method of Instant Green Tea

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Introduction

In Japan green tea is an integral part of dietary life with rice as the staple food. As a major beverage it has maintained a relatively stable consumption. Meanwhile the recent trend in non-alcholic beverage consumption is toward more convenient way of drinking as illustrated by soluble coffee and soft drinks.

The way of living in Japan has been undergoing rapid modernization. Among others we live less in houses and more in apartments, and less in rural areas and more in cities. Under such situations 'convenient foods' are becoming increasingly important. Convenient foods reach consumers with all wastes having been disposed of at the processing stage.

Green tea also needed a new type of product to keep up with these changes in consumers' mode of living. Instant green tea, soluble in cold water and without wastes, might maintain consumption and develop a new use as a cold drink in addition to the traditional use as a hot drink.

Research[1] on such a product was carried out between 1959 and 1965. Commercial production started in 1962 on a very small scale. At present several kinds of products are on the market. A few more attempts at commercialization are under consideration.

Outline of manufacturing

Dried tea is ground and loaded into a percolator, where soluble solids are extracted under a continuous supply of hot water. Extracted liquid concentrated to contain about 20 percent solids is collected, and then directly vacuum dried or freeze dried into soluble tea powder which has 2 to 3 percent moisture.

Extraction

The batch slurry system[2] extractor produces a highly concentrated (fifty to sixty-fold) extract, which can be sent to the drying process immediately. The concentration of extract is directly proportional to the number of percolators used, but when it has reached a certain degree (about 20 percent for *sencha* and about 25 percent for *hojicha*) the extract becomes difficult to flow due to high viscosity and extraction efficiency is reduced. Therefore the concentration of extract must be regulated by the amount of collection so as to maintain the limit. Generally, the extract of fairly stable concentration can be obtained each time if the weight of extract approximately equivalent to that of materials charged per percolator is collected from an extraction battery consisting of four percolators (for *sencha*) or five (for *hojicha*).

Infinite care must be taken in extraction temperature, as it greatly affects the composition of extract and hence the quality of products. Tables 1 and 2 show as an example the change in tannin and soluble nitrogen content by temperatures and the results of organoleptic sensory examination. At a high temperature more tannins are extracted and pungency becomes stronger, and at a low temperature the lack of pungency is felt. According to the results of the tests the best tasting liquid was obtained when the temperature of extract to be collected was maintained at about 70°C.

Table 1. Tannin and nitrogen content and its ratio in extracts at various temperatures.

	Solble solid percent		Ratio
Temp.	Tannin	Nitrogen	
60°C	19.4%	3.6%	5.3
70	21.1	3.4	5.8
80	22.6	3.6	6.3

Table 2. Preference tests comparing paired samples*

Pairs	Number of panels	
A vs B	prefer A 10	prefer B 5
B vs C	prefer B 14	prefer C 1

* The test samples are 0.5% solution of freeze dryed powders A, B and C which are made from infusions extracted at 60°, 70° and 80°C respectively.

Dried tea sucks water and swells when charged in the percolator. So fully loaded tea leaves press and stick to one another by swelling, and blocks the flow of liquid in it. In determining the amount of charges, therefore, it is necessary to make allowance for swellings. The results of experiments show optimum rate of charges is about 50 percent (150g/1) for *sencha* and about 90 percent (170g/1) for *hojicha* of the net capacity of a percolator. Swelling rate of the former is about 250 percent and that of the latter is about 140 percent.

Hot water should be supplied upward from the bottom of the percolator in case of *sencha* as its swelling rate is high, and it should be flowed down from the top in case of *hojicha* as it is apt to float.

The smaller the size of material the higher the extraction efficiency. However if fragments are mixed, space among tea leaves is closed and flow becomes difficult. Therefore fragments of smaller than 25 mesh should be eliminated. Optimum size is normally 10 to 25 mesh.

The extract, if left alone, tends to deteriorate rather easily. At room temperature deterioration is recognizable in a day. Therefore extract must be immediately sent to drying process or cooled and stored. Time-temperature stability of storage period is one day at 25°C, and three days at 8 °C would be the limit. From our studies on frozen storage at −18°C for a week it is presumed that a much longer period of storage would be possible.

Drying

High temperature drying is not desirable; for water soluble components of green tea contain very easily oxidizable components, e. g. ascorbic acid and catechins. Therefore such drying methods as vacuum drying, freeze drying and spray drying are considered suitable. But as spray drying requires large mechanical equipment in order to improve solubility by enlarging grain size of granules[3], no research was carried out.

In vacuum drying pre-treatment of mixing foam into extract is necessary in order to improve drying efficiency. This treatment can increase efficiency by 2.5 times. It can also increase solubility in water by further thinning thickness of particles of dried powder. During our experiment it was not recognized that oxidation would be accelerated by mixing of foam. Drying conditions are as follows. Traying is at the rate of 10 grams of extract per 100 sq cm of tray surface. The dryer is operated under a vacuum of 5 to 1 mm Hg with the temperature of tray bottom maintained at about 70 to 50°C. As drying progresses, the temperature of the product will more nearly approach that of the tray. Therefore heat should be reduced towards the end of the drying period so that the extract temperature may not exceed 50°C. Under these conditions drying is finished in 60 minutes. Powder of about 4 percent moisture is obtained.

In freeze drying as preparation preliminary freezing is carried out. Extract is brought to a completely frozen state by lowering temperature to about eutectic point as described later. Otherwise, the drying method is similar to that of vacuum drying. As there is no foaming more extract can be charged than in the case of vacuum drying. This method is essentially as follows: Extract is loaded at the rate of 100 grams per 100 sq cm is first freezed to the temperature of lower than −20°C approaching the eutectic point of the liquid (−23° to −26°C), and then dehydrated under a vacuum of 0.1 to 0.01 mm Hg with tray temperature maintained at about 70 to 50°C. In freeze drying the product is not allowed to thaw during drying. Drying time is 8 hours (5 hours if traying rate is 50 grams per 100 sq cm) at which time the product contains 2 to 3 percent moisture.

Among heating systems, temperatures during drying are most easily controlled by radiation heating. Furthermore, new systems including dielectric heating are being developed. In dielectric heating temperature control should be done not by the temperature of the tray but by that of the surface of dried parts (drying progresses from surface downward in any heating system). The temperature should not exceed 50°C.

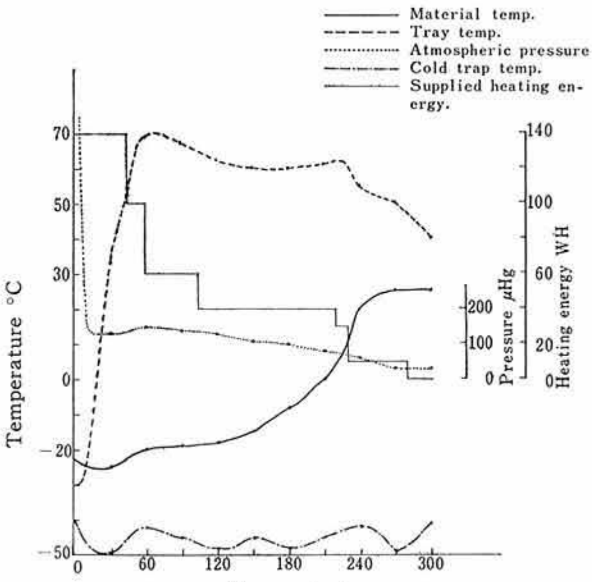


Fig. 1 One operating map of freeze drying

Compared with vacuum drying, freeze drying necessitates higher initial investment, involves higher operating costs, and hence production costs are higher. There is no appreciable difference in output per hour between the two systems if the drying tray and shelf is utilized. In vacuum drying continuous method by chain belt dryer[4] has been developed while completely continuous method is difficult in freeze drying. Freezs drying produces products of better quality with regard to the maintenance of flavor and solubility in cold water. Fig. 1 shows an example of operating map of freeze drying.

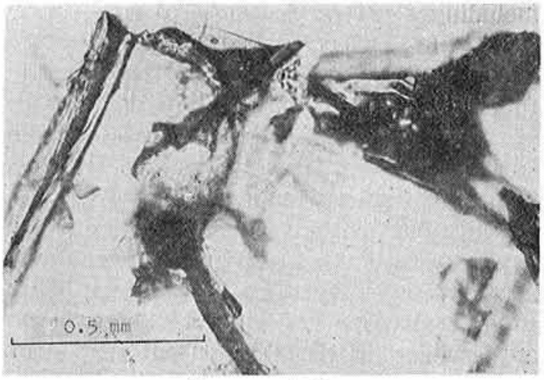
Product characteristics

In case of water soluble powder of 2 to 3 percent moisture particles are of an amorphous piece as shown in Fig. 2. They are a little thick in the case of vacuum dried product while they are small in shape and very thin in the case of freeze dried product. These differences in form seem to account for the varying solubility previously mentioned.

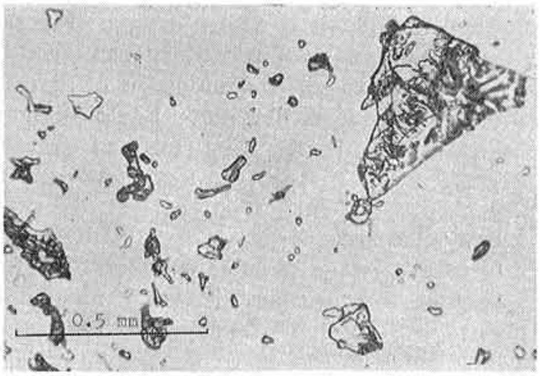
Solubility in water is excellent. It dissolves immediately in hot water without any stir. Even in cold water it dissolves completely with a few stirs.

Comparison of the quality of the reconstituted product with percolation of material tea show somewhat less flavor, but otherwise difference in taste and color of liquor is not recognizable. A cup of tea with natural strength is obtained with about 0.5 gram added to 100 ml of water.

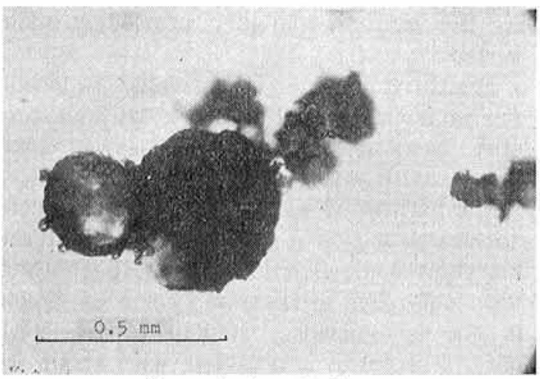
Results of analysis by gas-chromatography show that flavor components are reduced in quantity to about one-fourth of material tea but that there is no significant change in quality. Attempts are being made to recover and enrich flavor.



Vacuum drying



Freeze drying



Spray drying (Coffee)

Fig. 2 Microscopic photograph of dryed tea powder

As for storage stability powder of less than 5 percent moisture content can be stored at 25°C over a period of three months. Oxidixation of ascorbic acid is almost unrecognizable.

Instant green tea has about the same hygroscopicity as soluble coffee, dried fruit juice, etc.[5,6] Thinly spread powder absorbs 7 grams of water per 100 grams during six hours under a condition of R. H. 80 percent. Equilibrium moisture content at temperature of 25°C is about 7 percent under R. H. 40 percent and about 14 percent under R. H. 60 percent, although there is minor difference depending on drying methods and kinds of tea. When moisture content has reached about 10 percent with moisture absorption

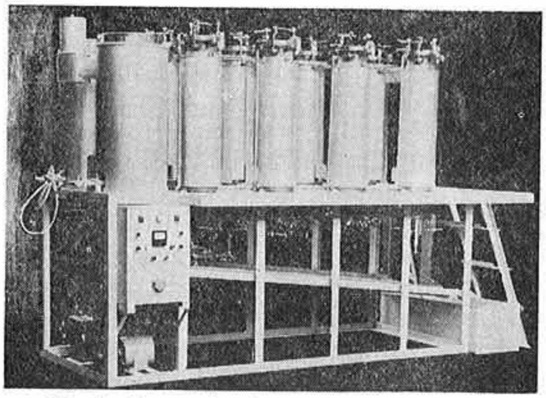


Fig. 3 Extracting battery consisting eight percolators

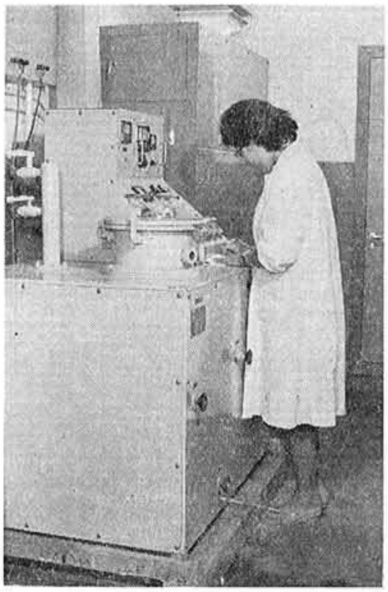


Fig. 4 Freeze dryer in our laboratory

the product begins caking and taste and physical appearance rapidly change. Therefore adequate attention should be given to containers including their orifice to prevent moisture absorption.

Footnotes:

Sencha - the most popular tea in Japan. It accounts for 80 percent of total green tea production.

Hojicha- made of larger leaves of *sencha*, or *bancha* (coarse tea) heated at 150°—180°C. It is characterized by flavor of roasting.

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A Survey on the Dextrose Industry in Japan and Its Future

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History of Japanese Dextrose Industry

We have seen remarkable progress in Japan in the manufacturing technology of dextrose by the enzymatic method of starch hydrolysis. Up to the end of 1958, almost all Japanese dextrose manufacturing palnts used the method of acid hydrolysis as used in other countries. During the latter half of 1959, dextrose manufacture was substituted by the enzymatic method very rapidly, until 100% of the dextrose industry in Japan adopted the enzymatic method by the end of 1960.

The rapid development of this industry is owed to the governmental subsidation for the purpose of the consumption of sweet potato starch. The sweet potato is a very important agricultural product in Japan from the standpoint of the farmers income. It ranks second only to rice among all agricultural products. The Japanese government supported the price of sweet potato indirectly by purchasing sweet potato starch under "The Agricultural Stabilization Act" whenever the consumption was less than the supply and price of raw potatoes fell. In 1960, the accumulation of the government stocks of surplus sweet potato starch eventually reached 350,000 tons. Since the production of sweet potato starch was expected to increase year by year, the Japanese government decided to subsidize the dextrose industry. Dextrose manufacturers are supported by government loans, by supply of sweet potato starch at a low price, by technical guidance of the government research institute, and by the promotion of consumption of dextrose that meets Japanese Agricultural Standard (JAS) Specification.

As the results of the rapid expansion of dextrose industry, the stock of sweet potato purchased under the Agricultural Stabization Act was decreased and in 1963, all the stock was used up for dextrose production.