SOME OBSERVATIONS ON TEA IN JAPAN

R. L. Wickremasinghe

Geographically, Japan consists of four main islands—Honshu, Kyushu, Shikoku and Hokkaido. Green tea is manufactured in Honshu island, and black tea in Kyushu island. Time and distance did not permit a visit to Kyushu, and the greater part of this article, therefore, deals with green tea.

Shizuoka, described in tourist pamphlets as being 'blessed with a mild climate and scenic spots,' is the centre of tea growing in Honshu island. It is surrounded by mountains to the north and Suruga Bay to the south. The Tea Research Station (TRS) of Japan is situated in Shizuoka. The TRS has ten main laboratories dealing respectively with Physiology, Breeding, Cultivation, Disease Control, Pest Control, Soil and Manure, Green Tea, Black Tea, Chemistry and Machinery. A great deal of work is being done on breeding with a view to developing cold-resistant varieties which will withstand winter conditions. There are also different kinds of green tea which are described below.

1 — *Gyokuro or 'Pearl Dew'*

This is the finest tea in Japan and is made from hand-picked leaf. The tea is grown under complete shade, and no light is allowed to penetrate from above or from any of the four sides. Plucking is possible only once a year in spring, during early May, when the low temperature produces a green tea of the highest quality. This leaf is highly prized and sometimes fetches a price of about Rs 29 per lb of green leaf. The effect of shading on the chemical constitution of the leaf is marked. It is said that shading for a period of one month causes a threefold increase in the chlorophyll content, a marked increase in most of the amino-acids and caffeine, and a decrease in theanine and tannins. The nett result is a green tea of desirable flavour and bright colour.

2 — *Matcha tea*

This tea is also made from leaves grown under complete shade, but the finished product is a powder, and not the twisted leaf as in Gyokuro. It is used exclusively in the Japanese tea ceremony, where the green tea liquor is made by whisking in a bowl.

3 — *Sencha tea*

This is the most popular type for domestic use and is made from well-twisted, young leaves. The most suitable clone for the manufacture of Sencha tea is Yabuchita.

4 — *Kamairicha tea*

This tea is also made from young leaves, but differs from Sencha in that the first process in its manufacture is parching, and not steaming.

5 — *Bancha tea*

This is a coarse tea made from coarse leaf and stalk.

A small quantity of black tea is made in Shizuoka, but the quantity is negligible when compared to that of green tea. Different clones are preferred for each type of tea; among those commonly used for green tea are Yabuchita, Tamamidori, Asatsuyu, Miyoshi, Natsumidori, Izumi and Himemidori, whilst Benihomare more as well as Benifuji and Hachamidori are used for black tea. Green tea consumption is 16 times that of black tea, the actual figures for 1966 being 160 million lb of green tea, whilst that for black tea was 10 million lb, with coffee at 50 million lb, and cocoa 3 million lb. The present trend, however, is towards a decrease in green tea consumption and a corresponding increase in that of black tea. Both black and green tea bags are popular and the former are said to contain 75 to 80% of Ceylon tea, blended with black tea from Japan, India and East Africa. The average market price of a pack of ten tea bags is Rs 1.30.

The rate of application of nitrogen for mature tea, on an average, is 300 lb per acre per annum, but in some cases double this amount is given. Generally, 40% of this amount is applied during spring (March), followed by 40% in summer (September), whilst the remaining 20% is added in winter (December). Nitrogen is supplied as urea or sulphate of ammonia admixed with calcium superphosphate and potassium sulphate, the NPK ratio being 1 : 0.3 : 0.3. Some rape seed meal is occasionally used in spring, but not in summer. In general, tea in its first year receives only 10% of the fertilizer used for mature tea, and this amount is increased by 10% from the second year onwards so that it is only tea in its eighth year and onwards that receives the full dose of fertilizer.

In Shizuoka, four harvests are gathered per year—the first, which is considered the best, in April-May, the second in mid June, about 40 days after the first crop, the third in mid August and the final harvest in mid September. Occasionally, surface shoots are plucked in mid February too, but this is manufactured only into coarse or Bancha tea. The general method of plucking is by shears or machines, excepting when Gyokuro is being made, when hand-plucking is necessary. When using shears or mechanical pluckers, the average yield on deep cutting is about 20,000 lb of green leaf per acre, with shallow cutting this yield of green leaf is halved, whilst with hand-plucking the yield is about 4500 lb green leaf per acre. The average price of green leaf in 1967 was about 45 cents per lb, but at certain seasons the price of hand-picked green leaf for Gyokuro tea manufacture has reached Rs 29 per lb but this is, of course, exceptional. On the average, a farmer selling green leaf to the Government or Co-operative Society can earn about Rs 9000 per year per acre of tea.

It is preferred that the green leaf be manufactured into green tea as soon as possible after plucking, but this is not always practicable, and the leaf is generally stored in the factory for periods ranging from two to 24 hours. On arrival in the factory the temperature of the leaf during August is about 40°C and it is cooled by spreading on perforated metal sheets and blowing cold air through the leaf. It is necessary to blow cold air for a period of two hours to cool the leaf mass to room temperature. Thereafter, cold air is passed for 20 min. every two hours as this is found to be sufficient to maintain the leaf at room temperature. No observable physical withering occurs during this storage period. The first step in the manufacture of green tea is steaming the leaf for 20 sec. as it moves along a conveyor. This short period of steaming is sufficient to completely inactivate the polyphenol oxidase and perhaps other enzymes of the tea leaf, whilst not affecting the bright green colour of the leaf. The steamed leaf is next partially dried and rolled in batches of 110 lb in a wooden box through which a shaft with forks and sweepers rotates. Hot air is blown through this box, and after about 30 min. there is a loss of about 40% of the moisture of the leaf. The leaf is next rolled under pressure for 10 to 15 min. in a conventional roller of 30 lb capacity, the purpose of this roll being to break the leaf cells. The rolled leaf is carried from the roller by a basket

conveyor to a drum drier at 100°C, from which it is discharged after about ten minutes into a battery of twisting machines. The twisting operation lasts for about ten minutes or less, and the final stage is drying at 80°C for 15 to 20 min., when the moisture content is reduced to less than 5%. The dried leaf is allowed to cool and is then packed. The above is a description of a continuous process for green tea manufacture, and the factory would consist of 16 twisters, two driers, one roller and one steamer. Such a factory is capable of processing more than 30,000 lb of green leaf every 24 hr.

The factories which manufacture mechanical pluckers and green tea machinery are also situated in Shizuoka. At the Ochiai works, the heavy, battery-powered mechanical plucker was fitted with a bag having a capacity of 44 lb of green leaf, and this amount of leaf was obtained in ten to 15 min. This cutter could be used for 15 hr without recharging the battery, and the time required for recharging the battery was also 15 hr. In the smaller knapsack mechanical plucker, the battery charge lasted 3½ hr and required three hours for recharging, so that it was recommended that at least two of these were necessary for maximum efficiency. The machinery for manufacture of green tea is made by more than one factory, and at the Date Iron Works, it was ascertained that a complete factory for green tea manufacture would cost 500 million Yen (Rs 6.5 M). In Japan, with the average cost of green leaf at about Rs 1 per lb, the cost of production worked out at 30 cents per lb of dry green tea, whilst the average market price of green tea in 1967 was Rs 2.40 per lb, and this was retailed at Rs 7 per lb.

Apart from the main Tea Research Station at Shizuoka, a visit was also paid to the northenmost Prefectural Tea Research Station, situated in Saitama. Here the main activities were advisory work and development of cold-resistant varieties capable of withstanding the severe winter conditions. Both crossing, and to a lesser extent, irradiation methods were being tried out, and the former method has yielded an outstandingly resistant variety, known as Okumusashi. Cultivation and manufacture methods were generally similar to those in Shizuoka, but only two plucks per year were possible—one in May and the other in July. Only Sencha green tea was manufactured in Saitama, as conditions were unfavourable for Gyokuro. Laboratory investigations were mainly concerned with the transformation of chlorophyll during manufacture, and using circular paper chromatographic methods, it has been found that the chlorophyll-phaeophytin ratio plays an important part in determining the appearance of green tea. This is of interest as a similar conclusion has been reached in Ceylon with respect to the appearance of black tea (Wickremasinghe & Perera 1966).

The other laboratories visited were those of the Department of Food and Nutrition at Ochanomizu University, Tokyo University, the Food Research Institute, Kyoto University, Osaka Women's University, the Tokyo Metropolitan Agricultural Research Station, and the Takasago Perfumery Factory. At the Ochanomizu University the main investigations were concerned with the gas chromatographic analysis of tea flavour, carried out by Professor Tei Yamanishi, who is acknowledged as a world authority on the chemical analysis of volatile compounds. While visiting the laboratory, we also had the good fortune to meet Professors Bokuchava and Durmishidze, and Dr Skoboleva of the Russian school of tea biochemistry. The Food Research Institute's primary activities are the production of foods by fermentation of soya bean, and the preservation of foods by irradiation. At Kyoto University the work on tea was directed towards the mode of biosynthesis of the amino-acid, theanine, and from the discussions it emerged that the site of formation of theanine was in the roots — a conclusion which agreed with our findings which were based on radioactive tracer studies. The main point of interest at Osaka Women's University was the separation of carotenoids of plants, and here too the

discussions were most interesting and useful. The Tokyo Metropolitan Agricultural Research Station is an applied science institution, and among other investigations, is carrying out a study of the changes of chlorophyll occuring during storage of green tea. The final visit was to Takasago Perfumery Factory, where attempts are being made to produce an extract for flavouring tea, although the main product (50 tons per month) of the company is menthol, which is synthesized from citronellol obtained from Java.

The final week in Japan was spent at the Sessions of the Seventh International Congress of Biochemistry, held in Tokyo, from 19 to 25 August 1967—two papers from the Tea Research Institute of Ceylon were submitted to this Congress—the first entitled "Localization of the polyphenolase of tea" (R. L. Wickremasinghe, G. R. Roberts & B. P. M. Perera 1967) and the second "A study of the tocopherols during tea manufacture" (A S. L. Tirimanna & K. P. W. C. Perera 1967).

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