THE YESTERDAY, TODAY AND TOMORROW OF TEA MANUFACTURE

D. Kirtisinghe

The consumption of tea as a beverage dates back at least three to four thousand years in South East China and its origin has in all probability been lost in antiquity. There are, however, several Chinese legends which relate to the discovery of tea. One such narrative relates that the Emperor Shen Nung who reigned about 2737 BC accidently discovered tea as a result of some wild tea leaves falling into his pot of boiling drinking water.

Europe's entire requirement of tea was met by China up to the early 1830's. Then, as a result of trading difficulties with China and after the British East India Company lost its monopoly of trade with Canton in 1833, the Governor General Lord Bentinck appointed a committee in Calcutta to examine the feasibility of opening up tea plantations in India. Experiments were carried out at the Calcutta Botanic Gardens with seed imported from China, but eventually these imported varieties were discarded and the industry built up from seeds of indigenous plants. Teas from these plantations came up for sale in London in 1839 and were the first Indian teas to be exported. A few tea plants came to Ceylon from China in 1834 and from Assam in 1839, and were planted for experimental purposes at the Royal Botanical Gardens at Peradeniya. The first commercial plantings, however, are credited to James Taylor who planted a few acres of tea at Loolecondera estate in 1867 from seed imported from Assam and so founded the industry in Ceylon. When the Coffee Rust Disease destroyed the coffee plantations in 1869 there were only 200 acres of tea in Ceylon but this was to constitute the nucleus of a new industry.

Despite the acreage being opened out both in Ceylon and in India, China continued to dominate the world market as the chief tea-producing country, reaching a peak export figure of 300 million lb of tea in 1886. Exports dwindled rapidly thereafter to 200 million lb in 1900, a 100 million lb in 1930 and down to negligible figures thereafter.

The terminal bud and two leaves of the tea shoot are harvested and processed in a manner which varies according to whether the product required is black, green or powder, or in small quantities as brick ooloong or scented tea. In Burma, pickle tea locally known as leppet-so, is consumed even as a vegetable in commercial quantities.

The preparation of black tea

In principle, the basic operations carried out in black tea manufacture today are similar to those carried out by the Chinese several hundred years ago, except perhaps for a certain degree of mechanization which has been found necessary in order to convert what was perhaps once a cottage industry for villagers into a commercial-scale undertaking.

The Chinese set about their manufacture by withering the young tea shoots by exposure to sun and air till the leaf became flaccid after which it was handled till the leaves turned red. The fermentation process was then allowed to proceed in a cool place for up to six hours to enable the development of the tea aroma. Fermentation was followed by a drying operation wherein the fermented leaf was semi-dried

by heating on an iron pan. The product was re-rolled on a tray and the panning and rolling operations were alternated till the leaf became crisp. It was then given a slow final drying over a charcoal fire for several hours. The tea manufactured in the villages was then sent to central collection points where it was graded, blended and packed for export.

The village techniques of manufacture which took over three days to complete proved to be too slow and arduous in the Assam plantations. The first step taken to simplify operation was to spread the leaf thinly on trays and to wither it overnight. It was then rolled by hand, fermented and given a preliminary drying over a hot pan followed by the final drying on trays over a charcoal fire. These simplifications obviated the need for the alternate panning and rolling of the leaf and shortened the manufacturing process — which took three days to complete by the Chinese methods — to approximately a day.

The bottleneck in the manufacturing process was undoubtedly the operation of hand rolling withered leaf and it naturally followed that several attempts were made at mechanizing this operation. The most noteworthy of these attempts is accredited to Williams Jackson who introduced a cross-action roller in 1873. In this unit the table and roller jacket moved at right angles to each other in a to and fro motion while pressure was applied on the leaf by means of an adjustable lid on top of the roller jacket. Four years later Jackson replaced this model with his famous double action ' Rapid ' Roller which employed for the first time, the principle of a jacket which revolved relative to the table, almost in the form it is known today.

Simultaneously with the development of the mechanical roller, attempts were also been made to mechanize the tea-drying operation. The first firing machines consisted of several trays stacked one above the other. Heat was supplied by means of a charcoal fire directly below and these units had to depend on natural convection for air movement through the trays on which the teas were being dried. As time went on there was keen competition between Jackson and Davidsons and several improvements were added such as the incorporation of suction fans, directly-fired stoves and mechanically-operated trays. Soon after the turn of this century, endless-chain pressure driers were in production and the driers we know today are refinements of these early ECP driers designed to economize on fuel and ensure even firing.

In the days of the early Assam plantings, made tea was graded with the help of hand sieves but this was soon mechanized after Jackson's invention of a mechanized sifter in 1875. This invention was followed a short while later with the invention by Reid of a mechanized tea breaker.

All these operations saw a few refinements as the years went by and so evolved the orthodox system of tea manufacture which consisted of a 14 to 20 – hour wither on tats followed by three to five rolls in crank rollers. After a period of fermentation which ranged from 1 hr 30 min to about 4 hr depending on elevation and climatic conditions, the teas were given a single firing of 18 to 21 min under conditions of operations which ensured the moisture content of 2 to 3% in the freshly fired product and finally the teas were graded. In the last few years electrostatic stalk extractors have been added to the armoury in the grading room and this has helped to facilitate and also improve what was once a painfully slow and time-consuming operation carried out by hand.

Most factories built on conventional lines in the pre-second world war era are already handling crops far in excess of what they were intended for. While it is evident that a good many of these factories have reached the saturation point of expansion, tea fields are yet nowhere near their limit of production. This is

abundantly clear when it is considered that the average yield per acre in Ceylon is around 850 lb per annum while yields of over 8000 lb per acre have been recorded ; The need is felt to gear up the industry for anticipated crops of 10,000 lb per acre per annum in the low country and around 6000 lb at higher elevations.

It is now possible that even these futuristic crops could be handled in estate factories for a very moderate capital outlay if advantage is taken of the new machines and techniques of manufacture that have been recently introduced to put production on a continuous footing as opposed to what is now considered to be the traditional but ineffective batchwise process of orthodox manufacture.

The withering operation occupies 70 to 80 per cent of the total floor area in a conventional tea factory and yet it was among the first to feel the need for more accommodation space as yields began to increase. The Ceylon tea industry first approached this problem by replacing the hessian with nylon and other synthetic fish nets of open weave construction and this move resulted in an immediate doubling of withering capacity on the same floor area.

The introduction of the drum-withering unit was perhaps the first serious attempt at mechanizing this operation. These units did not find general acceptance by the industry and were gradually replaced by the withering trough which probably originated in the Belgian Congo and was subsequently developed to commercial scale application in its present form by Wood of Colchester, England. The design of this unit is such that it ensures a higher thermal efficiency than the conventional withering system and consequently lowers the fuel cost of the operation. In experiments carried out at St Coombs, the fuel requirement of trough operation has been found to be half that on tats and the labour requirement of trough is only a third of that on tats. Further, for the same floor area the capacity of withering troughs is approximately four times that on hessian tats. This system offers the added advantage of uniform withers and of simple operation at a negligible cost of maintenance. These units are, however, not easily adaptable for use in factories that are not conducted to the national grid and the other slight disadvantage with the withering trough is that it continues to remain a batchwise process. A more recent development included the incorporation of reversible withering fans but their usefulness is still being hotly debated. At Kakajan factory in Assam, a pair of high pressure bulking chamber fans provide air into sixteen withering troughs simultaneously and no doubt substantially lowers the capital cost of installation.

The only successful approach to a continuous withering system working on a commercial scale is the trolley withering unit found at Hanwarl factory in Assam. The green leaf is loaded into trolleys and pushed through a series of four tunnels where conditioned air is blown over the leaf from alternating directions to ensure uniformity of withers. Scales at either end of the platform are used for controlling the wither. It is possible that these units have not gained universal acceptance on account of the higher costs involved.

The crushing, tearing, curling machine, better known as the CTC roller invented by William McKercher in 1932 was probably the first serious attempt at producing a continuous tea roller. Its usefulness to the tea industry was not generally recognized till around 1952 from which time onwards it gained general acceptance in Assam and a short while later in East Africa. The same degree of success has not been observed in Ceylon with the CTC type of manufacture as has been found hitherto in Assam where about 80% of all teas are of CTC manufacture. Switching on from orthodox to CTC manufacture is not always simple as the soft withers result in hastening the fermentation process and consequently calls for close control to produce optimum results. Additional drier capacity is also required with the CTC type of manufacture to evaporate the extra moisture in the leaf.

Brooke Bond (Africa) Ltd had originally developed the Triturator for continuous processing of unwithered leaf and were by and large satisfied with the performance of this machine. This machine was taken over subsequently by Marshall's who re-designed the machine to suit the processing of withered leaf and it is expected that in time this machine would be capable of processing 2400 lb of withered leaf per hour requiring 12½ HP for its operation. Experiments are now in progress with this machine at St Coombs to determine its suitability under conditions in Ceylon.

In 1958, McTear of the Tocklai Experimental Station developed the Rotorvane which has probably made the biggest impact of all among the recent developments in the tea industry. It is manufactured in two standard sizes, 8 in and 15 in ; the capacity of the larger machine is around 6000 lb withered leaf per hour which is considered to be too high in relation to the output of most Ceylon tea factories and research has, therefore, been directed towards working out the optimum conditions of operation in Ceylon of the smaller 8 in machine whose output, depending on several factors such as the shaft speed and the type of leaf, ranges from 1200 to 2000 lb withered leaf an hour, the equivalent of about three of the largest orthodox rollers now in commercial production.

Tasting reports from a panel of six tasters in Colombo reveal that the made tea characteristics of infusion, colour, strength and quality are all significantly superior in the rotorvaned leaf when compared with a similar sample given four orthodox rolls each of 30 min duration. The effect of Rotorvane manufacture on flavour is also very interesting. Results obtained at St Coombs indicate that flavour can be developed to the same extent if not more so as in orthodox teas. These findings are for the moment applicable only to high-grown teas and perhaps to a lesser extent to some of the better liquoring mid-growns. The problems associated with the production of a low-grown Rotorvane tea are entirely different and an entirely new set of operating conditions require to be worked out in order to meet the requirements of the Persian Gulf market where the market emphasis is more on made tea appearance than on liquoring properties.

The CTCs; Triturators and Rotorvanes demand a very high standard of leaf. In orthodox manufacture, the coarse leaf and stalk could be collected along with the big bulk and its removal in the made tea stage is relatively easy, but this is not the case with the three continuous processes outlined above.

In East Africa, Geo Williamson Trolley Fermenters and the Skip Fermenters have practically replaced the table fermenting process carried out in Ceylon. These units are labour saving devices and five to ten times as much leaf can be fermented on the trolleys as on an equivalent area by conventional means. A trough fermenter is in operation at Kakajan factory in Assam and a fermenting drum is to be found in an estate in the Nandi Hills area in Kenya. Analytical findings of the Biochemistry Division of the Tea Research Institute of Ceylon have revealed that fermenting machines as we know today would need to be re-designed almost entirely in order to produce the aroma of tea to an optimum degree and work is in progress to determine the additional features which would need to be incorporated.

A great deal of concern has been shown both in Ceylon and also overseas about the possible health hazard constituted by the consumption of teas fired in driers coupled to directly fired furnaces. Directly fired furnaces are slightly cheaper to operate but the general cost of factory maintenance rises as a result of the corrosive action of the sulphurous products to the extent where it would easily offset the initial advantage of cheap operation. Driers which would make more efficient use of hot air are being designed and it is hoped that fuel savings of up to 50% may eventually be made.

With all the enthusiasm for novel methods of manufacture, the Institute is also primarily concerned with the quality of the end product. A large amount of work is being done by the Technology Division in conjunction with the Biochemist and tea tasters to ascertain the usefulness of each machine and also to optimize their operation.

Other processing techniques

The un-oxidized green tea is produced and consumed chiefly in China, Japan and Taiwan. Green tea manufacture differs from that of black tea in the very first processing operation which consists either of steaming or of heating the leaves on a hot pan as soon as conveniently possible after plucking in order to inactivate the enzymes present. After the enzymes are destroyed the leaf is processed further by several alternate operations of rolling and panning as in the manufacture of black tea by the Chinese technique. The tea liquor has a very pale green or yellow colour and a distinctly different aroma and taste from that of black tea which, on the other hand, is totally dependent on the enzymes system present for the chemical changes which take place during the oxidization (fermenting) process.

In the processing of brick or tablet tea the raw material is either green or black made tea. Tea is steamed or moistened till it softens and then extruded under high pressure into moulds and finished off with a final drying process. These forms of tea as well as the semi-fermented oolong teas have ceased to be of commercial importance today.

A great deal of interest is currently being shown in the production of an instant 100% soluble, powder tea by trade circles as well as by the Tea Research Institute of Ceylon. The problem is being approached by several widely different angles, the only point in common being, perhaps, that all these processes have green tea leaf as the starting material.

Instant tea is manufactured in the USA, UK and other non-tea-producing countries using dried black tea as the initial product. This tea is extracted in boiling water, clarified and spray dried. At this stage, powdered milk, sugar, or even flavouring essences such as lemon are sometimes added. Tea-producing countries, however, cut out the conventional firing operation in their manufacture by making the water extract for spray drying with the fermented dhools. The TRI process aims at carrying out certain other operations of controlled oxidization, extraction and drying which are all designed to assist in the preservation and even enhancement of high-grown quality and flavour.

The future

It can be gathered from what has already been said that progress in tea manufacture is taking place on two very distinctly different lines. The first is the development of techniques and equipment for processing a black tea of superior quality meeting the present trade requirements of an orthodox tea by a continuous as opposed to the traditional batchwise process. Better quality control is being sought than is now possible with the orthodox system of manufacture at lower capital and operating cost.

Secondly, a major biochemical breakthrough by Dr R. L. Wickremasinghe has resulted in opening new pathways in the production of an ' Instant Tea' aimed at preserving and enhancing the desirable liquoring characteristics of an orthodox black tea in the soluble powder form.