

CERTAIN ASPECTS OF TEA MANUFACTURE

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(1) GENERAL CONDITIONS.

Officers of the Biochemical division have often been called upon to visit factories and to advise on manufacture during the last two years, and I should like to make a few remarks on this aspect of our work.

In the first place transport of the leaf into the factory appears to be one of the greatest difficulties which many Mid and Low-Country estates have to contend with, owing to the wide distribution of their divisions, and any improvement in this respect would be a great aid to them. Temperature conditions at such elevation demand that the leaf should be brought to the factory as quickly as possible to prevent heating of the leaf.

On the whole factory accommodation and equipment is better at higher elevations than at lower elevations, and it is not unusual to meet in the Low-Country with factories deficient of any fan arrangement at all, and forced to contend with conditions which fortunately we know little about Up-country. Although modern factories may not be absolutely essential for good teamaking, my firm opinion is that a good factory is a great asset, provided it is intelligently run.

There has been an advance in recent years in factory control, and although the benefit of this may not always be immediately apparent it will eventually be found of inestimable value. A few pertinent well-kept records do without doubt engender an interest in the system of manufacture and the more they are studied the more one gains from them. The collection of records is not an end in itself, it is only a guide to the proper working of the factory and very useful when it becomes necessary to alter the manufacture in some way to meet the changing market requirements.

There appears to be a certain rivalry between estates as to the prices obtained but I regret to say that there is a deplorable lack of mutual study of each others' methods throughout the Island. Again and again on visiting factories when I enquire as to how the manufacture differs from that of the neighbouring factories, I am told that it is not known, even when some of these may be attaining considerable success. It would be a great help to all if it became a habit to study each others' methods of manufacture by occasional visits

during which various problems could be discussed in the factory. Such co-operation would greatly help if well-kept records were also available.

Too often one is asked to visit a factory and to report on the manufacture as a result of the study of one day's manufacture although conditions during that day might be quite different from those usually existing. It is sometimes possible to suggest alterations as a result of such a visit, but in many instances improvement cannot be obtained by attention to one item in the manufacture since a change in one process may affect the procedure at some other stage.

I cannot, therefore, urge too strongly that every effort should be made to determine the details of the manufacture and to ascertain as clearly as possible what is the complaint. In this way it is often possible to determine what line of action to follow in investigating the trouble, and the details available indicate possible sources of trouble. I tried to overcome this difficulty by having a list of printed questions to be filled in before I visited the factories but found that in many cases these were indifferently completed by the clerk or some subordinate, so that the information was often more misleading than helpful. I am sure that you will all realise how important it is to have every information available if the full benefit of any visit is to be obtained, since it is so easy to be misled by the manufacture on one particular day.

In spite of the fact that Ceylon is supposed to maintain a standard of fine plucking, this is not the universal practice, and frequently the leaf seen on the tats has been coarse, stalky and very uneven, making for poor withering. There is room for great improvement in this respect, and it is hoped that restriction of crop when it comes will help to improve this state of affairs. If a factory must adopt coarse plucking it ought to realise this when grading their teas, and that it is not feasible to turn out such a high percentage of B.O.P. for example with a coarse pluck as with a fine pluck. In spite of this the tendency appears to be to gauge the success of manufacture by the percentage B.O.P. turned out. This may be excusable at a time when teas are selling well and with a fine quality tea, but not when there is no demand for anything but a tea with some stand-out characteristic. Every estate cannot turn out stand-out teas but nearly every estate can turn out a certain percentage of really fine tea provided they do not mix it with too much of the coarse leaf in their pluck.

The introduction of controlled withering systems in recent years has supplied estates with a means of controlling their manufacture to a great extent. Such systems have not always been entirely successful, and there is unfortunately a good deal of ignorance as to the manner in which these systems should be worked, thus leading to bad results. I cannot stop to enter into details, as I have dealt fairly comprehensively with this in Bulletin No. 9, but I should like to mention one or two common faults not referred to there. The first of these is that the factory which claims to use its fans the least is not necessarily the one that does the least harm with the fans and warm air. Very often a good deal of damage is done by these factories since low fan hours means somewhat drastic withering conditions for a short period. The most successful on the other hand are those that use their fans for long periods with little warm air so that the wither is continuous and not carried out spasmodically.

The other fault often overlooked is the damage done by the dryer when it becomes empty and the loft fans are running. It is very rarely that any cognisance is taken of the altered conditions when the dryer runs empty, although the temperature of the hot air to the lofts may rise from 120-220°F and continue so for an indefinite period. The air supply to the withering lofts should therefore be watched very carefully when the dryers are either being heated up, or empty if scorched leaf is to be avoided. It is now generally admitted that withering is one of the most important processes in tea manufacture, and yet it is often the least satisfactorily performed operation. As I intend to deal with this later I will now pass with the comment that a proper wither is not always obtained on estates and is the cause of a good deal of trouble.

The success or otherwise in rolling depends to a large extent on the nature of the wither, and when the tea is stated to be flaky or hard it will be found that the origin of the trouble is the wither of the leaf. I do not mean to imply that rolling can be carelessly done or cannot modify the nature of the tea according to the way pressure is applied and so on, but that most of the trouble met with in rolling has been due to improper withering of the leaf, and the non-realisation of the difference produced in the twisting capacity of a pluck by various degrees of wither. In spite of everything, convenience of working seems to be too often the criterion of when leaf is taken for rolling, and as long as factories do this trouble will be experienced in rolling.

Another fault connected with the rollers is the lack of proper co-ordination between the feeding of the rollers and the capacity of the dryers. This should be easily arranged so that the range of fermentation, i.e., the period between firing the first dhoos sent to the dryers and the last is reduced as short as possible, unless the factory is very short of dryers. This range should preferably not be much more than 90 minutes and one of the most successful factories I know of aims at less than 60 minutes. The way in which this trouble arises is shown by the following example, where 3 rollers out of 4 were charged together with 600-700 pounds of withered leaf and the firing had to be carried out on one firing machine capable of turning out 80-90 pounds of made tea per hour. The result was that the dhoos took 3-4 hours to be fired and the teas were poor. If two rollers were charged at a time each batch could be fired in a very much shorter period, and rolling could become continuous, although the range would be still high.

Again one meets with overcharging of the rollers especially when amalgamating the charge of two rollers into one. This results in a mass of leaf which gets little or no rolling, and also makes for high temperature conditions. If a record of the weight of dhoos is kept it is easy to ascertain when the bulk of several rollers is reduced to the proportion fit for a lesser number of rollers.

More attention than ever is given to the conditions of fermentation, but unmarked dhoos are still seen and these no doubt do get mixed at times. In some factories firing of the dhoos is worked to a fixed programme according to the temperature of the rolling room with great success. The actual period of fermentation is very variable from estate to estate, one estate will get outstanding results with a short period of fermentation, while another estate is getting just as remarkable results with a long period, and it appears impossible to stipulate any optimum period of fermentation.

The question of tea firing in factories has occupied a good deal of time, and as this has been fairly thoroughly dealt with in recent publications, I do not propose to deal with it today. It is a great satisfaction to me that the attention focussed on this part of the manufacture has awakened interest in the efficiency of dryers by the engineers, that a greater understanding of this process is developing and that improvements in the dryers themselves are almost certain to be produced. A good deal of the trouble met with on tea estates has been connected with the drying of the tea, and further there is

no doubt but that greater economy without loss of efficiency can be obtained at this stage.

Finally it seems to me that greater attention could be given to maintenance and cleanliness in many factories, especially in the withering lofts, drying room and grading room floors to prevent sand getting into the teas. The roll breakers are also too often in a bad condition as regards the tightness of the mesh, and I regret to say of low efficiency owing to closing of the mesh by stale leaf.

(ii) THE IMPORTANCE OF MOISTURE IN TEA

In my address to you at the last Conference I pointed out that the range of variation in the moisture associated with the leaf coming in to the factory was very high, and that this variation was an important factor in tea manufacture. Subsequent investigations here at St. Coombs and in other factories support this contention and show that the removal of this moisture is of the greatest importance for successful tea manufacture.

The determination of the dry weight of the leaf received in the factory during the day shows a high variation from weighing to weighing, which is not surprising in view of the variable weather conditions during the day. The manner in which this variation in moisture content affects the manufacture is seen when the weight of water evaporated per unit of dry tea produced is considered. Thus on one day the following differences were obtained in the weight of water evaporated during manufacture to produce a pound of dry tea.

		Lb.
Morning leaf	...	3.70
Noon leaf	...	3.12
Evening leaf	...	4.00

The variation in moisture content is almost entirely due to more or less surface moisture as a result of rain, no rain or dew at the time of plucking, and since it is so variable during the day it means that conditions of manufacture may be very different for the different weighings.

The actual moisture of the leaf has been determined each day for a whole year and without entering into details it may be said that the range of variation is very high. The lowest figure recorded was 67.5 per cent while the highest figure was 84.7 per cent moisture, i.e., a little more than 2 pounds of water had to be evaporated to produce a pound of dry matter in one instance and 5.4 pounds in the other.

This means that considerably more work must be done on the last to produce a pound of tea, and should indicate very clearly one difference between tea manufacture with wet leaf in wet weather as compared with dry leaf in dry weather.

Although the highest figures are obtained during the wet months, it is not unusual to meet with high figures in the middle of the drier months. What I want to impress on you is the direct way in which this variation in moisture affects the manufacture.

Suppose we take the leaf which contained 57.5 per cent moisture and withered this down to 55 per cent. The withered leaf would then contain 41 per cent moisture. The leaf which contained 84.7 per cent moisture would contain between 71 and 72 per cent moisture. I do not think much thought is necessary to show that this will have a very marked effect on the later processes of manufacture.

It may be counted that such poorly withered leaf is not met with in practice, but it was not many weeks ago that I visited an estate where the out-turn of made tea on withered leaf varied between 24.8 and 48.5 per cent equivalent to 76-77 and 53-55 per cent moisture in the withered leaf. This is not the only instance but it is illustrative of the extreme conditions met with.

What sort of variation is found in factories where controlled withering is feasible and the leaf is withered until it is considered ready by sense of touch, smell and appearance? This has been found by determining the actual moisture content of the withered leaf each day for a year. In terms of the quantity of moisture evaporated in drying per pound of dry tea turned out the range for the year was 0.71-1.53, i.e., the variation in moisture content of the withered leaf was between 60 and 42 per cent. The variation is therefore very high and I have yet to be convinced that this record obtained by careful measurement is not representative of conditions throughout the Island.

Again the variation in the moisture content of the withered leaf of different roller charges is quite high, and although the average out-turn of made tea for the day may appear satisfactory the conditions may have been very bad. Two sets with an out-turn of 40 and 60 will give an average out-turn of 50, but a proper wither was not obtained in either of them. This is a state of affairs often met with when morning, noon and evening leaf are considered. The morning leaf gets the hardest wither, and the evening leaf the lightest, the average appearing more or less satisfactory.

It is thus clear that in general practice leaf containing very variable quantities of moisture is taken for manufacture, and that this affects the subsequent processes of manufacture as follows:—

- (1). *Rolling*.—If the leaf is not properly withered it will not twist easily, and it is not possible to standardise the method of rolling. Separation of dhools will be affected, and flaky tea is liable to be produced.
- (2). *Fermentation*.—This will be irregular because the sap concentration will vary according to the moisture present in the leaf, since the speed of chemical reactions depends to a certain extent on the concentration of the reactants. There can therefore be no uniformity of the fermentation until evenly withered leaf is obtained. Dr. Shaw of the Scientific Department in South India goes even further and stipulates that the leaf should be withered so as to give the same concentration of tannin in the sap each time. This is based on sound reasoning but if as a first approximation we can work to a wither giving constant moisture it will be a tremendous step forward.
- (3). *Firing*.—In my opinion successful and economical firing can only be approximated to when the fermented leaf taken to the dryers contains a uniform quantity of moisture. No machine can deal satisfactorily with leaf containing 60 per cent moisture at one time and only 40 per cent at another time, and be economical. Much of the trouble experienced in drying would be eliminated if a factory can ensure a supply of uniform material to the dryer.

The first essential is therefore to obtain a uniformly withered leaf at all times if good manufacture is to follow, but the difficulty is to determine when the leaf is properly withered. It can be minimised if proper care is taken that the leaf is taken to the rollers when ready and not when the rollers are ready, and the fans are properly worked. Further, apparatus have been recently introduced to help in gauging the wither. They are not yet perfect by any means but once the idea is put into operation improvements will follow, and withering of the leaf will become precise instead of the haphazard process it is at present.

The first gauge to be marketed is that of Messrs. Avery who introduced the flat tat of 15 square feet attached to a sensitive

balance for withering a pound of green leaf in the lofts. Unfortunately few factories can accommodate the single tat arrangement, and at my suggestion they introduced a tier of smaller trays of such a size that they can be introduced and hung between the banks of tats in a loft. The present one is experimental but I have found it quite satisfactory, provided the spread of the green leaf is uniform and at the same rate as on the experimental tats. If wet leaf comes in it is advisable to take the leaf for spreading on the Avery tat from the factory tats after the surface moisture has been removed and then treat this as dry leaf. With a little practice it will be found that satisfactory results can be obtained.

The other gauge is one patented by the Colombo Commercial Co., Ltd., and which works by measuring the volume of sap in the withered leaf. The leaf is crushed, and a definite weight of it placed in the apparatus. It is then submitted to a pressure of 5,000 pounds per square inch for 5 minutes and the volume of sap squeezed out measured in a graduated tube. The amount of sap squeezed out is proportional to the moisture in the leaf, and properly withered leaf should give the same reading each day. Both sets can be seen after the meeting.

The quantity of moisture left in the dry tea is also of importance from the point of view of the storage properties of the tea and should not be lost sight of. Most estates are aware of this difficulty and have taken steps in recent years to control the moisture content of their teas, so that they do not contain too much moisture when packed. It does not necessarily follow that this is an absolute safeguard but it will reduce the risks to a minimum. It is, however, just as necessary that the teas stored in the factory have also been properly fired, otherwise deterioration will take place in the bins in spite of the fact that they may be of excellent construction. Aeration is not necessary for the growth of many moulds, so that enclosing a badly fired tea in airtight bins does not prevent the growth of moulds if the moisture conditions in the tea are suitable for them. Final firing of a tea which has gone off to a certain extent in the bins will check any further deterioration if properly carried out, but it does not cure the evil already done.

Unfortunately final firing is not properly carried out at all times according to many of the samples received by me. It is quite common to find the same quantity of moisture in the final fired tea as in the tea not final fired, and in almost every instance the tea has

been pushed through the machine quickly at a low temperature. With such low temperature as 140-150°F it will be necessary to leave the tea in the machine for about 10-15 minutes if the excess moisture in the tea is to be driven off.

I regret I cannot give definite directions for final firing, but it is very easy to check the moisture in the tea final fired and determine the most suitable conditions. If high temperatures are used for final firing then a quicker passage is necessary.

DISCUSSION

Mr. T. H. Williams said that he had listened to Dr. Evans' address with great interest, and he felt sure he was voicing the sentiments of the meeting when he said how sorry they were to lose Dr. Evans.

The first point he wished to raise was one he had already mentioned to Dr. Norris, namely that there should be more opportunities for instruction at the Institute. He referred principally to the Assistant Superintendent who on taking charge of an estate had practically no knowledge of teamaking and who consequently acquired his knowledge at the expense of the owners. Such a thing would not be allowed in any other profession. Could they imagine, for instance, a brewer getting a billet if he know nothing about making beer?

There were several points on which information was required. What happened to their tea between its leaving Ceylon and its arrival in London? Something undoubtedly happened; in some cases the tea improved and in others it deteriorated. They had practically no knowledge of the condition of any particular tea when it reached the consumer. Enquiries in London and in Colombo regarding the keeping qualities of tea produced the replies that no information was available. That, however, could not be correct as he had had conversations with gentlemen in the tea trade who had travelled through America and Canada, and they had told him that certain marks had poor keeping qualities and consequently were black listed, but he had never been told of any mark that was definitely on the black list.

He also thought that they were becoming too scientific. After all what was required was that they should make tea which would fetch good prices. He suggested that they should have informal meetings at the Institute, and that the Staff and practical planters should give lectures, the meetings to be as informal as possible. With such informal discussions he was perfectly certain that they could get to the bottom of a great many of the difficulties which had not been overcome at the present.

Dr. Norris replied to the point raised regarding instruction. He quite realised that that work should fall within the sphere of the Institute's activities. The difficulty however was the provision of accommodation for those attending the courses. He was most anxious to have short instructional courses at St. Coombs, not only in connection with manufacture but to deal with other subjects as well. The sole difficulty was one of accommodation. If a solution to the difficulty could be found, arrangements would be made for instruction of the desired type to be given.

As regards informal discussions on manufacture, he agreed that they would serve a most useful purpose. At the first opportunity he would endeavour to make arrangements for such informal discussions, but the interregnum between Dr. Evans' departure and his (Dr. Norris') return from leave would possibly cause a little delay. During the last six months members of the Staff had addressed a number of District Planters' Associations and on such occasions informal discussions had normally followed.

Dr. Evans regretted that information regarding what happened to teas in transit and storage was almost negligible. Packing teas with the correct amount of moisture would minimise any danger of the teas going off, but it was possible that some teas went off as a result of some wrong condition during manufacture.

Dr. Norris said that with regard to the question of teas going "off" in transit, he would stress the fact that Superintendents should be able to obtain further assistance through their tasters and brokers as to the direction in which deterioration had taken place. At present very little information of this nature was normally available. If such information could be obtained, it might give a clue for determining the cause.

Mr. S. Howard asked for a definition of quality in tea.

Dr. Evans stated that he had no definition to give. He was entirely in the hands of the tasters who were the final arbiters in the matter.

In reply to a question regarding the necessity of fans in the withering lofts, **Dr. Evans** stated that the fans afforded a means of obtaining a proper wither of the leaf and thus ensured a proper condition for rolling at all times. He had at no time claimed that the use of fans would give quality teas.

Dr. Norris said that many people had prejudices against artificial withering and the use of fans. He suggested that in many cases it was not the use of fans that spoilt the teas but the misuse of them. Artificial withering required careful study as the methods were not particularly simple, and if improperly used, bad results undoubtedly followed.

Mr. Marsh Smith asked for information regarding the effect of the period of withering on the colour of the tea.

Dr. Evans said that the length of the period of withering was undoubtedly intimately connected with the amount of colour obtained in the liquors of made teas. He had carried out experiments during the last year to determine the effect of the period of wither on the quality and characteristics of the tea. Various withers from 44 to 45 hours had been compared but the results of those experiments had not been referred to that afternoon because they were obviously incomplete. A long slow wither had, however, quite definitely given colour, but at the same time in all his experiments that gain in colour had been associated with a definite loss of pungency, quality and flavour. He would not like to say that it was impracticable or uneconomical to give up the idea of slow withering, but at certain times of the year when there was little quality in their teas and the market demanded colour and strength, under those conditions it might be advisable to resort to longer withering in order to produce those characteristics in the tea.

Experiments had also been laid out to test not only the period of wither but also the degree of wither. At the same time he had also tried out the effect

of fermentation on leaf subjected to various periods of wither, but so far he had not obtained any very conclusive evidence one way or other as to how the length of withering affected the fermentation of the leaf.

Mr. J. P. Blackmore said that he had heard of estates firing their leaf before it was hardly fermented at all and of others which fermented for four hours. He asked whether any experiments had been carried out to determine what length of fermentation gave the best results.

Dr. Evans replied that such experiments had been carried out and were reported in the Annual Report for 1931. Since then further experiments had been carried out at St. Coombs to ascertain whether more coloury teas could be produced by long fermentation. The results showed that there was a fairly wide range of time of fermentation within which favourable reports could be obtained from different brokers. He had taken samples of tea fermented from $\frac{1}{2}$ to 24 hours and had sent them to a number of brokers. He received a series of favourable reports covering a range of 2 and 4 $\frac{1}{2}$ hours. The only conclusion he could arrive at was that teas fermented to different degrees met certain market requirements, dependent on the broker. What particular demand their teas should meet must be determined by each estate.

Mr. Scott asked whether heavy pressure in the early roll spoiled quality.

Dr. Evans replied that pressure had no effect on the quality of teas except indirectly. If hard pressure was applied to the early rolls, as much as 20-25 per cent of the leaf would be obtained in the first dhool, and thus there was a tendency to dilute the fine leaf with coarser leaf. If hard pressure is carried too far there was also discolouration of the tip and it became impossible to turn out F. B. O. P. which had been doing well during the last year.

Mr. Sydney Smith said that the suggestions made by Mr. Williams and supported by Dr. Norris were of considerable importance. He referred to the necessity for instructional work at the Institute and for informal discussions. Dr. Norris had told them that the difficulty was the provision of accommodation for those attending the course. He considered the courses and discussion to be of paramount importance and that some form of resthouse should be provided. He did not see why the provision of such accommodation should be a very expensive matter. Something on the lines of the huts at Diyatalawa camp, with cubicles, would not cost a lot of money. It was essential that those attending the course should be able to stay at St. Coombs for a night or two, they could take part in discussions or receive instruction and see what was happening. He considered that only a small expenditure was necessary for the purpose of providing accommodation but he felt sure that it would bring a good return.

Mr. R. G. Coombe said that on behalf of the Board of the Institute he welcomed the suggestion made by Mr. Sydney-Smith regarding the necessity of accommodation for visitors on St. Coombs. Those who had followed the proceedings of the Board would have noticed that on more than one occasion the question of a resthouse had appeared in their estimates but the Board after careful consideration had felt that other accommodation requirements, namely those of the Staff, were of more paramount importance, and the provision of a resthouse had reluctantly to be postponed. On behalf of the Board he could give them the assurance that the matter to which Mr. Sydney Smith had referred would receive very careful consideration. The provision of a resthouse would not be possible during the present year, but they might rest assured that it would be at the top of the list of new works for consideration of inclusion in the budget for the coming year.