The Preparation & Vulcanisation of Plantation Para Rubber

By B. J. Eaton, F.I.C., F.C.S.,
Agricultural Chemist, F.M.S.

Assisted by

J. Grantham, B.A. (Cantab.)
Late Assistant Agricultural Chemist.

And

F. W. F. Day,
Assistant Agricultural Chemist.

Price One Dollar.

Kuala Lumpur, Federated Malay States,
April, 1918.

Printed at the Malayan Supply Co's Press, Kuala Lumpur.
THE PREPARATION & VULCANISATION OF PLANTATION PARA RUBBER

BY

B. J. EATON, F.I.C., F.C.S.,
Agricultural Chemist, F.M.S.

ASSISTED BY

J. GRANTHAM, B.A. (Cantab.)
Late Assistant Agricultural Chemist.

AND

F. W. F. DAY,
Assistant Agricultural Chemist.

Kuala Lumpur, Federated Malay States,
April, 1918.
The researches on the variability of plantation Para rubber published in this bulletin contain the results of work carried out by the Agricultural Chemist and his assistants covering a period of about 3½ years.

Many of these results have been published in the Agricultural Bulletin, F.M.S., and some of the strictly scientific parts of the researches have been published in the Journal of the Society of Chemical Industry.

It has been considered desirable, however, to collect all the material and this bulletin contains many new experiments hitherto unpublished. These new experiments complete the investigations on a number of side issues or contributory factors in connection with estate, factory practice, which affect the variability of Para rubber and have thrown further light on a number of problems which were hitherto somewhat obscured.

It may be pointed out here that the researches on variability of Para rubber conducted by the chemical division of the Agricultural Department are fundamental in nature and are the earliest and most complete work carried out on this important problem. The value of these researches has been recognised already by many of the leading rubber manufacturers in Great Britain, America and France and by other scientific workers engaged in the investigation of the problem.

It is also probable that one direct and important result of these researches will be the preparation of a new type of rubber (slab), which has been shown to possess superior properties to the first grades, *viz.* smoked sheet and pale crepe, now being prepared on estates in Malaya and other eastern tropical countries.

This, however, is not likely to eventuate until the end of the war, on account of the fact that all rubber manufacturers are working, at present, at high pressure in connection with material for war purposes.
The problem of organic vulcanisation accelerators discovered and utilised since about 1914, has been one of the most important developments of the rubber industry, since the original discovery of vulcanisation. These researches, which were carried out independently and at first without any knowledge of the existence and use of such accelerators, have demonstrated that valuable vulcanisation accelerators are present in Hevea latex and can also be formed by special treatment of the coagulum, as indicated in this bulletin.

The chemical nature of the accelerating substances present in Hevea latex or formed subsequently in the coagulum, has not yet been determined, but their probable nature is indicated. Much research, in connection with the specific action of these accelerators on the mechanism of vulcanisation still remains to be carried out.

The researches contained in this bulletin demonstrate beyond doubt the value to the rubber industry of this country, of the action of the Government in the inauguration of the experimental vulcanising factory and laboratory at the Agricultural Department and the value of conducting researches of this nature in the country of origin of the product.

L. LEWTON-BRAIN.

April, 1918.
THE PREPARATION AND VULCANISATION
OF PLANTATION PARA RUBBER.

VARIABILITY; ITS CAUSE AND CONTRIBUTORY FACTORS.

Introductory.

Since about 1906 when the advent of plantation Para rubber from *Hevea brasiliensis* on the various markets of the world became an important factor in the world's production of rubber, considerable controversy has taken place among planters, manufacturers, rubber chemists and other scientific officials connected with the industry on the comparative value of the product from the cultivated tree and from the tree indigenous to South America.

Unfortunately many of the statements made and published, although they may be correct, have lacked the experimental proof which is essential, if they are to be accepted without question. Secondly, and this is to be deplored even more, much work has been published by chemists and other scientists connected with the raw rubber industry which is unsatisfactory, on account of the fact that the method of experiment has not been described and cannot therefore be subjected to that criticism to which all scientific work should be subjected by other workers engaged on the same problems. In other cases the method of experiment has unfortunately not been exact and the results and conclusions are, on this account, of little value. Several factors have contributed to this unsatisfactory state of affairs *viz.* (1) the rapid rise of the plantation rubber industry, culminating in the boom of 1910-1911 in which the profits made on rubber from plantations were so great that little interest was taken in any endeavour to improve the plantation product (2) the fact that rubber research was principally in the hands of chemists whose chief interest was financial and, on this account, such chemists could not be expected to publish their methods, whether good or otherwise, for the benefit of other workers (3) the manufacturer, from lack of scientific advice in his own factory, was unable to indicate the nature or source of any inferiority or variability in the plantation product, or, in the case of the large manufactories, possessing a testing laboratory and a scientific staff, was naturally unwilling to give information to the producer or the general public interested in the industry, since such information, which he had obtained at considerable expense, would become available to his smaller rival. This latter point is, we believe, not sufficiently appreciated by the producer,
who complains because the manufacturer will not say what he requires. Our experiments will show that the manufacturer, even with a scientific testing laboratory and staff, has been unable probably to indicate the cause of variability, since, till recently, chemical analysis and investigation of raw rubber has not enabled us to attribute differences in quality of the raw rubber to any particular constituent. It should be borne in mind also that a manufacturer who can purchase raw rubber on the market which is often classified, on account of its appearance, as second class, at a price below that classified as first grade, which fetches, on account of its appearance, top market prices, is not likely to publish such information for the benefit of the producer or any other person, especially since he has to bear the expense of upkeeping his testing staff and laboratories, in order to carry out preliminary tests on all samples to ascertain their behaviour on vulcanisation, before making up his different classes of manufactured articles. On the other hand, the expense of upkeep of such a scientific staff more than compensates him by the saving on cost effected by being able to purchase raw rubber, which, classified on the market, under present conditions, as below first grade, is equal to, and sometimes better than rubber sold on the market as first grade, for reasons which we hope to indicate in our experiments. In this connection, a remark made to one of us about a year ago by a leading planter and visiting agent in this country is of interest. This remark was to the effect, that a certain well-known manufacturing firm in England, which uses a large quantity of plantation Para rubber and find it satisfactory, has had to increase its scientific staff, from four to about twenty chemists, since commencing to use the plantation product. In the light of our experiments and results, this is not surprising. It can be easily understood, in view of the well-known conservatism of our British manufacturer, and the rubber manufacturer in particular, who was able when using Fine Hard Para, to always work under very similar conditions in the vulcanising factory, that considerable difficulties arose, when plantation Para rubber was substituted, more especially when it is realised that, till comparatively recently, and indeed even at the present time, many manufacturers do not employ chemists or other scientific officers, and, in many cases, such officers, when appointed, are often engaged entirely on routine work. They have little time for real research, which is often discouraged, while they are frequently denied entrance to the factory where the "rule of thumb" methods of that ancient institution, the factory foreman, reign supreme. These remarks apply particularly to the rubber manufacturing industry, to which until quite recently, chemical science cannot be said to have rendered great services, and empiricism has held sway. Again, in Great Britain, the emoluments and position offered to Works' chemists have been insufficient to attract suitable men, except in a few cases. Here again, as has been pointed out so frequently of late, is another illustration of one of the main causes which has contributed to the backward state of so many of our industries.

Finally, it is only comparatively recently that mechanical testing methods and testing machines for manufactured rubber have been brought to a sufficient state of perfection to be of value.
Up to the present time, the two most important sources of plantation Para rubber have been Malaya and Ceylon; more recently large areas have been planted up in the Dutch East Indian Colonies of Java and Sumatra and other centres of less importance in this respect such as French Indo-China, Borneo, Southern India and parts of Africa. The principal investigations in connection with the plantation rubber industry have been carried out in Ceylon and Malaya and considering the large amount of British capital involved and the importance of the industry to the countries concerned, this is satisfactory. Till within the last year, however, any really satisfactory investigations on the preparation of raw rubber for the market have been carried out by scientific officers for individual estates or groups of estates, and not by government institutions.

The most important work of this kind has been that carried out by the research chemists of the Rubber Growers' Association in Malaya and subsequently in Ceylon. Unfortunately, however apart from the publication of Mr. Sydney Morgan's book "The preparation of plantation Para rubber" the information obtained by these researches has naturally been available only for the estates contributing to the Rubber Growers' Association Research Fund, since the reports of the chemists are issued for private circulation only. This is unsatisfactory, although unavoidable under such a scheme, since the planter for whom the reports are made, is not in a position to criticise technical work of this description, and the methods and results are not available to other scientific officers who alone would be able to realise their value or to criticise the methods by which they are obtained. We propose, however, to return to this aspect of the subject later, in discussing the work and experimental results and conclusions of other workers.

During the last two years, however, the Governments concerned in the Federated Malay States and Ceylon respectively have realised the necessity of more satisfactory investigations on this particular problem in connection with the plantation rubber industry, namely the preparation of the raw product for the market, a problem which has now become probably the most important one in connection with the industry. In the case of our own Government, on the suggestion of the senior author, supported by the Director of Agriculture, it was decided in 1912 to provide a sum for the installation of an experimental vulcanising factory and plant with the necessary testing machines and other equipment.

The senior author, while on leave in 1912, visited the works of Messrs. David Bridge and Sons, Castleton, Manchester, (the first firm, as far as we know, to construct a complete experimental plant of this description) made arrangements for the purchase of such a plant and, in addition, visited a number of the largest rubber works in Great Britain and on the Continent. A brief study of the methods of vulcanisation was made at the Netherlands' Government Rubber Testing Station in Delft, Holland where Messrs. David Bridge and Co. installed their first experimental vulcanising plant for the Netherlands' Government and at
the Königlich Material-prüfungsamt at Grosse-Lichterfelde, near Berlin, Germany. (A report on the information derived from these visits was published as a Government paper in 1913). Shortly afterwards the Ceylon Government decided to engage a research chemist under the Department of Agriculture in Ceylon to carry out investigations on the preparation of rubber, and in addition installed a vulcanisation plant at the Imperial Institute, London, where the samples prepared in Ceylon were vulcanised and tested subsequently by one of the chemists on the staff of the Institute. In 1914 a further step in this direction was made by the Netherlands East Indian Government who decided to purchase a similar experimental vulcanising plant which had been constructed by Messrs. David Bridge and Sons, and exhibited by them at the International Rubber Exhibition held at Batavia in 1914. It was realised probably that while the original station, instituted in Delft, Holland, would be of value to manufacturers in Holland, it was essential to investigate many of the problems in connection with the preparation of rubber in the country of origin of the raw material, since every detail of coagulation and subsequent treatment of the raw material could be supervised personally at an Experimental Agricultural Station by the officer in charge of the rubber testing station. In the light of our experimental results and conclusions in this bulletin, we can state emphatically how important this is, and of what great value such a combination of the work has been to us and how many more difficulties and obscurities there would be in such if the preparation of raw rubber were left to an experimenter here and the subsequent vulcanisation carried out in another place such as Europe by an officer who had little knowledge of methods of coagulation and preparation of the raw material. The information gleaned by carrying out the vulcanisation and tests on the manufactured rubber in combination with the knowledge derived from the preparation of the raw samples has been of the greatest value to us in the elucidation of the cause of variability and the factors in connection with estate factory practice contributing to this cause.

In addition to the above testing stations, an official station has now been instituted under the Bureau of Standards, in the United States of America, the work in which, so far, has consisted in testing manufactured rubber goods for the consumer and manufacturer, although this station intends later to investigate the raw material. The Königlich Material-prüfungsamt at Grosse-Lichterfelde near Berlin, which is an institution similar to our National Physical Laboratory, where materials from bridge girders and building materials to papers, yarns, fibres, oils etc. are investigated, has during recent years added a rubber testing division, in which much valuable preliminary work on methods of testing has been carried out. This institution is very fully equipped with scientific testing machines, many of which were designed by members of the institution and constructed by the well-known firm of Louis Schopper and Sons, Leipzig. Still more recently the Northern Polytechnic, London, has organised a rubber school, equipped with vulcanising plant similar to that at the Agricultural Department, F.M.S. while the Municipal School of Technology, Manchester, has had such an installation for several years for local purposes.
All the larger rubber manufactories in Great Britain, Europe and America are also now similarly equipped and among the private vulcanising laboratories, the best known are those of Dr. Schidrowitz, London, whose report to the Standardisation Committee of the Rubber Growers’ Association, containing details for the erection of a large commercial testing and experimental factory in London, is well known; of Messrs. Clayton Beadle and Stevens, London, the consulting chemists to the Rubber Growers’ Association and the laboratory of Drs. Frank and Marckwald in Berlin, consulting chemists to the German Colonial Office, who investigate rubber from the various German colonies.

These details are sufficient to demonstrate that the value of such work has been now realised by the governments concerned, although it is somewhat early to expect results, especially from some of the more recent government institutions, since a large amount of preliminary work on methods, which never appears, has to be carried out before the main problems can be attacked.

Before closing this foreword, we wish to make a brief statement as to the comparative value of carrying out tests of this nature at the source, that is in the country of origin of the raw material, or nearer the manufacturer, for example in Great Britain, as far as Malaya, Ceylon and other British colonies are concerned.

This will depend chiefly on the character of such an institution; if, on the one hand, it is intended to carry out tests for the market, i.e. to issue certificates of quality of raw rubber for the buyer, to enable him to purchase rubber of certain qualities or to purchase lots which behave similarly on vulcanisation, it is immaterial whether such tests are carried out in the country of origin of the rubber or near the market where the rubber is sold, provided no change occurs in the material during shipment. (It appears improbable that any change does occur, unless the rubber is kept for a long period or is damaged in any way during the voyage). If, on the other hand, such an institution is inaugurated for the purpose of investigating problems in connection with the raw material and its variability and to enable advice to be given to the producer, then, we regard it as beyond doubt essential to have such an institution in the producing country, in spite of any disadvantages in having to train native assistants to control much of the experimental work.

The combination of work in preparing vulcanised rubber from the latex, involving a knowledge of the complete history of the rubber from tree to manufactured article, enables the experimenter to trace more clearly every factor likely to cause variation. Our experiments will show that the disadvantage of having to train native assistants for the various processes of manufacture is negligible, and that, under supervision, they can be relied on entirely after a short training. A second, though minor advantage is the economy effected in employing local labour in the experimental factory. The value of carrying out such work on the spot has been realised not only by our own Government, but also by the Netherlands’ Government, which started work with a testing station in Holland and now has one in Java.
All the larger rubber manufactories in Great Britain, Europe and America are also now similarly equipped and among the private vulcanising laboratories, the best known are those of Dr. Schidrowitz, London, whose report to the Standardisation Committee of the Rubber Growers’ Association, containing details for the erection of a large commercial testing and experimental factory in London, is well known; of Messrs. Clayton Beadle and Stevens, London, the consulting chemists to the Rubber Growers’ Association and the laboratory of Drs. Frank and Marckwald in Berlin, consulting chemists to the German Colonial Office, who investigate rubber from the various German colonies.

These details are sufficient to demonstrate that the value of such work has been now realised by the governments concerned, although it is somewhat early to expect results, especially from some of the more recent government institutions, since a large amount of preliminary work on methods, which never appears, has to be carried out before the main problems can be attacked.

Before closing this foreword, we wish to make a brief statement as to the comparative value of carrying out tests of this nature at the source, that is in the country of origin of the raw material, or nearer the manufacturer, for example in Great Britain, as far as Malaya, Ceylon and other British colonies are concerned.

This will depend chiefly on the character of such an institution; if, on the one hand, it is intended to carry out tests for the market, i.e. to issue certificates of quality of raw rubber for the buyer, to enable him to purchase rubber of certain qualities or to purchase lots which behave similarly on vulcanisation, it is immaterial whether such tests are carried out in the country of origin of the rubber or near the market where the rubber is sold, provided no change occurs in the material during shipment. (It appears improbable that any change does occur, unless the rubber is kept for a long period or is damaged in any way during the voyage). If, on the other hand, such an institution is inaugurated for the purpose of investigating problems in connection with the raw material and its variability and to enable advice to be given to the producer, then, we regard it as beyond doubt essential to have such an institution in the producing country, in spite of any disadvantages in having to train native assistants to control much of the experimental work.

The combination of work in preparing vulcanised rubber from the latex, involving a knowledge of the complete history of the rubber from tree to manufactured article, enables the experimenter to trace more clearly every factor likely to cause variation. Our experiments will show that the disadvantage of having to train native assistants for the various processes of manufacture is negligible, and that, under supervision, they can be relied on entirely after a short training. A second, though minor advantage is the economy effected in employing local labour in the experimental factory. The value of carrying out such work on the spot has been realised not only by our own Government, but also by the Netherlands’ Government, which started work with a testing station in Holland and now has one in Java.