

**OFFICIAL AGENTS FOR THE SALE OF INDIAN
OFFICIAL PUBLICATIONS.**

In England.

CONSTABLE & Co., 10 Orange Street, Leicester Square, London, W.C.
GREIDLAY & Co., 54, Parliament Street, London, S.W.
HENRY S. KING & Co., 65, Cornhill, London, E.C., and 9, Pall Mall, London.
P. S. KING & SON, 2 & 4, Great Smith Street, Westminster, London, S.W.
KEGAN PAUL, TRENCH, TRUBNER & Co., 68-74, Carter Lane, London, E.C., and
25, Museum Street, London, W.C.
BERNARD QUARITCH, 11, Grafton Street, New Bond Street, London, W.
T. FISHER UNWIN, Limited, 1 Adelphi Terrace, London, W.C.
W. THACKER & Co., 2, Creed Lane, London, E.C.
LURAC & Co., 46, Great Russel Street, London, W.C.
B. H. BLACKWELL, 50 & 51, Broad Street, Oxford.
DEIGHTON BELL & Co., Ltd., Cambridge.
Messrs. WILLIAM WESLEY & SON, 28, Essex Street, Strand, London

On the Continent of Europe.

ERNEST LEROUX, 28, Rue Bonaparte, Paris.
MARTINUS NIJHOFF, The Hague, Holland.

In India.

HIGGINBOTHAM & Co., Madras.
V. KALYANABAMA IYER & Co., Madras.
P. R. RAMA IYER & Co., Madras.
Messrs. VAS & Co. Madras
M. R. RY. E. M. GOPALAKRISHNA KONE, Madras.
N. B. MATHUR, Nasir Khand Hind Press, Allahabad.
Messrs. A. H. WHEELER & Co., Allahabad, Calcutta and Bombay.
THACKER, SPINK & Co., Calcutta and Simla
W. NEWMAN & Co., Calcutta.
S^r K. LAHIBI & Co., Calcutta.
R. CAMBEAY & Co., Calcutta.
THE ASSOCIATION PRESS, Calcutta.
THACKER & Co., Ltd., Bombay.
D. B. TARAPOREVALA, Sons & Co., Bombay.
SUNDBE PANDURANG (RAMNATH SUNDBE), Bombay.
GOPAL NARAYAN & Co., Booksellers, &c., Bombay.
Mrs. RADHARAJ ATHARAM SAGOON, Bookseller, &c., Bombay.
RAMCHANDRA GOVIND & SON, Booksellers, &c., Bombay.
BOMBAY TRACT & BOOK SOCIETY, Bombay.
SUPERINTENDENT, GOVERNMENT PRINTING, Bombay, Poona.
MANAGER, NYAYASHRAYA, Poona.
THE PROPRIETOR OF THE NEW KITABKHANA, Poona.
Messrs. KARSANDAS NARANDAS & SONS, Booksellers and Publishers, Surat.
Messrs. RAMA KRISHNA & SONS, Lahore.
MANAGER, the "HITAVADA," Nagpur.

Department of Agriculture, Bombay.

BULLETIN No. 93 OF 1919.

PALM GUL MANUFACTURE
IN THE
BOMBAY PRESIDENCY
(Principally Date Palm).

BY

V. G. GOKHALE, L.AG.,
Deputy Director of Agriculture, Konkan.



POONA :

PRINTED AT THE YERAVDA PRISON PRESS.

1920.

45752

CONTENTS.

	Page
PART I.—INTRODUCTION.	
	1-2
PART II.—A BRIEF ACCOUNT OF THE EARLIER ATTEMPTS AT GUL-MAKING FROM PALMS.	
Mr. Gonehalli's enquiries in 1910	3
Date Palm Gul-making by the Parsis	3
Mr. Sorabji Patel of Tadgaon's bringing it to the notice of the Agricultural Department in 1914	3
Manjri Farm's Trials, 1913-14 and 1914-15	3-4
Mr. P. C. Patil's Preliminary Tests of 1915	4-6
Bombay Government's sanction to allow the palms to be tapped free of tax for sugar manufacture.	6
PART III.—COMPREHENSIVE FINAL EXPERIMENTS WITH DATE PALM.	
Experiments in 1915-16	7-8
A First Hand Study of the Bengal Industry	8-12
Experiments of 1916-17	12-13
Experiments of 1917-18	13-14
Experiments of 1918-19	14
Statistical Results of all the Four Years' Experiments	16-18
Financial Results—	
Receipts	18
Expenditure.—Labour, Fuel, Pots, Tools and accessories, Furnace and Boiling pans, Preservatives, Supervision, Rent of trees, Total cost per tree.	18-19
Profit	19-20
Relations of the Excise Department with the Industry	20-21
Experiments with—	
(1) The Various Preservative Treatments	21-27
(2) Improving the Colour of Gul	28-32
Conclusions and Recommendations	32-34
Acknowledgments	34-35
PART IV.—DESCRIPTION OF THE DETAILED PROCESS OF TAPPING THE JUICE AND MAKING GUL FROM DATE PALM.	
Tapping	36-41
Boiling	41-48

**PART V.—GUL-MAKING FROM BRAB OR FAN PALM IN THE
BOMBAY PRESIDENCY.**

Page

44

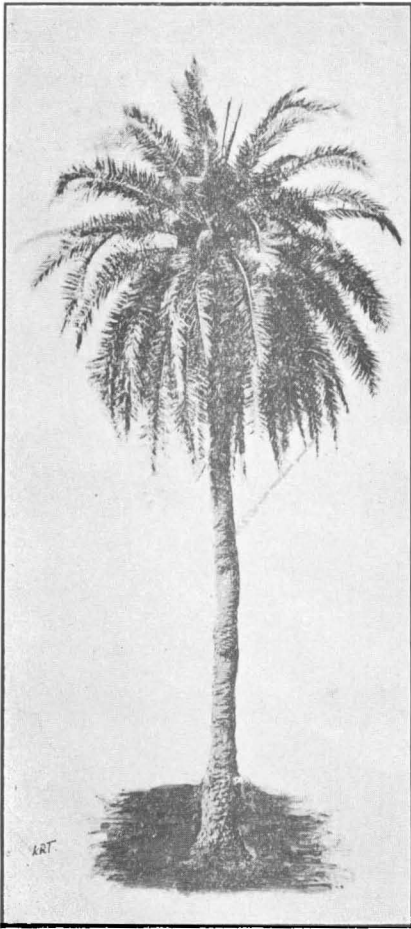
Appendices.

- I.—Notes on Gul-making from Brab, Coconut and *Bheris* Palms by Mr. P. C. Patil, when officiating as Extra Deputy Director of Agriculture, Konkan. 45-49
- II.—Observations by Mr. P. C. Patil on the Quantity per tree, Chemical composition, Deterioration in keeping, effect of different preservatives of the juices and guls of palms. 50-55
- III.—Daily output of juice and gul obtained from Date Palm at Tadgaon during the tapping seasons of 1917-18 and 1918-19. 56, 66

Illustrations.

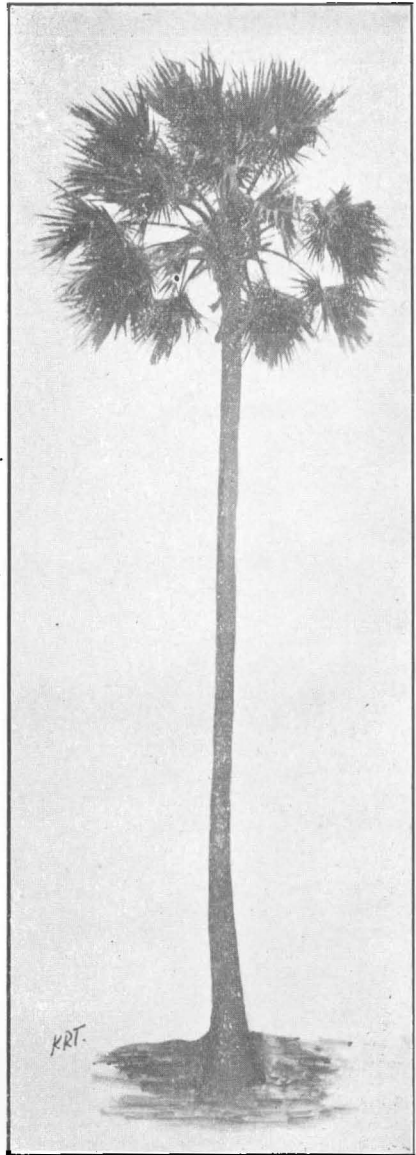
- Plate I A and I B.—The four kinds of sugar yielding palms of the Bombay Presidency. Opposite 1st page
- Plate II.—Tapping articles used in Bengal and Thana ... Facing p. 36
- Plate III.—Cleaning of the stem of Date Palm being the first operation in tapping. Between pp. 36 & 37
- Plate IV.—Making of the incisions for the juice yielding surface in the Thana and the Bengal systems. Between pp. 38 & 39
- Plate V.—The two methods of tying pots in the Thana and the Bengal systems. The juice yielding surface as it appears after cutting the first and the second steps in the Bengal method. Between pp. 38 & 39 after Plate IV
- Plate VI.—The appearances of the juice yielding surfaces in the Thana and the Bengal systems as they are seen at the end of the tapping season. Between pp. 38 & 39 after Plate V
- Plate VII.—The two ways of carrying juice from the groves to the boiling place, and The method of smoking the pots in the Bengal system. Between pp. 40 & 41
- Plate VIII A.—The Bengal oven and pan for boiling date juice into gul ... Between pp. 40 & 41
- Plate VIII B.—The Coimbatore ovens for boiling Fan Palm juice ... Between pp. 40 & 41 after Plate VIII A.
- Plate IX.—The Poona furnace ... Between pp. 42 & 43

PLATE I A.



1—DATE PALM.

Shindi. (Marathi) Khajuri
(Gujarathi).
(*Phoenix Sylvestris*).



2—BARB, PALMIRA OR FAN PALM.

Tad (Marathi).
(*Bovassus Fluheli formis*).

Palm Gul Manufacture in the Bombay Presidency.

PART I.

Introduction.

Palms, as a source of sugar, though very largely and regularly exploited in parts of Bengal, Burma, Madras and Ceylon, are not generally known as such in the Bombay Presidency.

In Bombay, there occur four kinds of such sugar yielding palms on a fairly considerable scale; they are:—

- (1) *Mad* or *Naral* (Marathi) or the cocoanut. *Cocos nucifera*.
- (2) The *Tad* (Marathi) or the fan, the palmyra or the brab palm. *Borassus flabeliformis*.
- (3) The *Shindi* (Marathi) or the *Khajuri* (Gujarati) or the wild date palm. *Phoenix sylvestris*.
- (4) The *Bherli* or *Sur Mad* (Marathi) or *Kitul* (Ceylon). *Caryota Urens*.

All of these except the third are mostly confined to the Konkan, *i.e.*, that part of the Bombay Presidency stretching along the West Coast between the Arabian Sea and the Western Ghats and comprising the four districts of Thana, Kolaba, Ratnagiri and Kanara. The remaining kind of palm—the wild date is found distributed almost throughout the Presidency as the main source of obtaining a mild alcoholic drink going under the name of *toddy*.

Out of all the four kinds met with in the Konkan, cocoanut is the most commonly occurring in all the four districts where it is regularly cultivated for its valuable product of nuts and kopra; it is also considered and used as a source of toddy in preference to any other palm. The *Bherli* or the *Sur Mad* occurs only as a wild growth in the forests of Kanara and to some extent in those of the Alibag and Roha talukas and Nagothna Peta of the Kolaba District and as stray plants in the gardens or house yards in all the four districts of the Konkan more or less; these are very scantily used as a source of toddy by the jungle tribes where there is no other source available; they are not however so plentiful and accessible as to be used for gul-making on any profitable scale.

The remaining two, *viz.*, the brab and the date palm, occur abundantly and wild in the trap Konkan, that is to say, in the Thana and the Kolaba Districts. They are so plentiful in some parts that they cannot but catch the eye of the new comer interested in plants and the plant industries. Out of these two, the date palm appears to be a more fastidious plant and is, therefore, mostly concentrated in a few well marked localities, principally the Umbergaon Peta and to a less extent mixed with brab palms in the Salsette taluka of the Thana District, where conditions may be particularly favourable to their growth; while the brab is found scattered throughout all the talukas of the two districts, whether coastal or inland. The

dictionary of the Economic Products of India by Watt states (pp. 498 to 500) that "the tree is found by tens of thousands in the coast subdivisions". The flat plains of sticky clay soil (*Manat*) seem to afford the brab palm as congenial a home as the slopes and tops of hills with well drained coarser shallow soils.

One who is attracted by this catching feature of the country is naturally inclined to ask whether this nature's gift is being turned to the fullest advantage within man's knowledge. A part of them is being used for furnishing toddy as a drink to the poorer inhabitants who consider it to be a sustaining food and which yields some revenue to the State; but the proportion used for this purpose is only small considering the total number of trees. Thus in the case of the date palm, it is estimated* that there are not less than five lakhs of date trees in the Umbergaon Peta of which only sixty thousand (half the number in alternate years) are used for the purposes of toddy drawing, while in the case of brab, out of the several tens of thousands, only about 8,000 were tapped for this purpose throughout the Thana District; all the rest are going to waste excepting that their leaves are used for thatching or making mats, ropes or brooms.

This loss of a source of wealth is too considerable to be ignored and should naturally stimulate one to investigate into the possibilities of turning it to an economic advantage.

Now to those who know anything about these palms, it is a well known fact that they yield a juice, which at some time is highly sweet like sugarcane juice, a very few people in Western India also know that it can, with special precautions, be turned into good *gul*. The average chemical composition of the sweet unfermented juices of these palms in Konkan as given below points to the conclusion that it ought to be possible to make sugar or *gul* out of them though not perhaps as easily as with sugarcane:—

	Date Juice.†	Palm Juice.‡
	Per cent.	Per cent.
Water	Not determined.	81.09
Cane sugar	9.50	13.89
Non-crystalizable sugar	1.38	1.36

To those who will have seen, read or heard of these palms in Madras, Bengal or Burma, it will be known that *gul* and even sugar manufacture from these palms is as common an industry there as rice or sugarcane cultivation.

Gul or sugar making would thus appeal to be the first and easiest possibility for investigation.

* Para. 3 of Mr. Clifford, Assistant Collector of Excise's report to the Collector of Thana of 8th September 1915 printed as an accompaniment to G. O. No. 2930, dated 13th March 1916.

† Average sample taken at Sanjan (District Thana) in January 1915.

‡ The composition represents only one sample taken during July 1919 at Bassein, District Thana.

PART II.

A BRIEF ACCOUNT OF THE EARLIER ATTEMPTS AT GUL-
MAKING FROM PALMS IN THE KONKAN.*Mr. Gonehalli's enquiries in 1910.*

The question of investigating the possibilities of gul-making from these palms first attracted the notice of Mr. V. H. Gonehalli, the then Divisional Inspector of Agriculture, Konkan, in the year 1910. He made enquiries as regards the magnitude and the importance of the problem and obtained from the Madras Presidency samples of gul and some data.

Date Palm Gul-making by the Parsis.

In the Umbergaon Peta of the Thana District some of the Parsi families occasionally prepare gul from the date palm juice, as a fancy article, which, it is considered, requires too extraordinary care, skill and expense to be done by every one.

*Mr. Sorabji Patel of Tadgaon's bringing it to the notice
of the Agricultural Department early in 1914.*

The question had also attracted the attention of an enterprising Parsi land-lord one Mr. Sorabji B. Patel of Tadgaon, Peta Umbergaon, District Thana, who owns a large number of date palms on his estate. He obtained from the Director of Agriculture the available literature on the subject and on reading the Memoir on the "Date Sugar Industry in Bengal" by Annett and others brought to the notice of the Director of Agriculture the possibility of turning to advantage, by making jaggery, the thousands of trees of the date palm that are going to waste in the Umbergaon Peta and also submitted early in 1914 a petition to the Collector of Thana for being allowed to tap 1,000 trees free of Excise tax for the purpose.

Manjri Farm's Trials in 1913-14 and 1914-15.

In the meantime, some attempts at gul-making from the date palm were made on the Manjri farm in the years 1913-14 and 1914-15. The night juice from one tree was collected; special precautions to use a fresh pot scalded with hot water each time in order to obtain unfermented juice were taken. The yield of juice was profuse varying from $\frac{3}{4}$ to 2 gallons showing a Brix reading from 16 to $11\frac{1}{2}$ respectively. At this rate 140 gallons of juice had been expected in one tapping season per tree, estimated to give about 150 lbs. of gul fetching about Rs. 10 per tree. It must be remembered here, however, that these yields are under condition of plentiful irrigation. Good solid crystalline gul could be prepared, but it had a dark colour; when blankit (sodium hydrosulphite) was added to the juice a very white coloured gul was obtained.

One fact of interest that is worth noticing and recording from the Manjri farm experiments is the great difference between the sucrose content

of the trees under dry conditions and under irrigation as can be clearly seen from the figures obtained and recorded below :—

Kind of tree.	Brix reading.	Sucrose per cent.	Reducing sugars.	Purity.	Glucose ratio.
	p. c.	p. c.	p. c.	p. c.	p. c.
Tree without irrigation ...	15.74	12.16	1.25	77.2	10.3
Tree on the bank of a flowing stream.	9.75	6.86	0.91	65.2	14.3

From the above data, which are the average of many samples, it was also noticeable that the date palm juice contains from two to three per cent. of solids not sugar.

The author is indebted to Mr. Padhye of the Manjri Farm for having placed this information at his disposal.

Mr. P. C. Patil's Preliminary Tests in 1915.

Mr. P. C. Patil, immediately on coming to the Konkan Division as Deputy Director of Agriculture, was again struck by the importance of the question and with the help of a Chemical Assistant from the Agricultural Chemist's laboratory set about collecting data as to the magnitude of the possibility, the quantity and quality of juice and gul obtainable from all the four kinds of palms—cocoanut, brab, date and *bherli*, the chemical composition of their juices, the rate of their deterioration and the effect of some preservatives and the financial possibility. The results of his preliminary experiments and his enquiries in the Konkan Districts as well as in the Madras Presidency where he made a special tour for the purpose, as worked up in a report submitted by him to the Director of Agriculture may be summarised as follows :—

(1) There is a very large number of date and fan palm trees in the North Konkan which are not used for any purpose and which, therefore, offer a good scope for making gul.

(2) From the various published records and enquiries and from people having experience verified to some extent by actual observations, he came to the conclusion that the different kinds of palms may be expected to yield annually the following quantities of juice and gul fetching the value as shown in the statement.

Kind of palm.	Season of tapping in the year.	Quantity of juice in gallons estimated to be obtained per tree annually.	Percentage of total solids (representing mostly sugar) as determined by Brix Hydro-meter.	Estimated quantity of gul per tree annually.		Value of gul.
				lbs.	Rs.	
Date palm. ...	October to April	35	11	35	1 6 0	
Fan or Brab palm.	September to December and February to May.	50	10	50	2 0 0	
Cocconut ...	Throughout the year (but October to May only suitable for gul-making).	50	15	80	4 0 0	

(3) In the actual trials he made of drawing unfermented juice and making gul therefrom, he succeeded in making gul from all the four kinds of palms, but he found that date palm juice was most difficult to deal with, all possible precautions being necessary to obtain good quality of juice capable of being turned into a good quality of gul, and that the other kinds of palms are comparatively much easier.

(4) The number of trees of each kind which can be managed by one tapper and his family and the money return which can be expected therefrom has been given by him as follows:—

Kind of palm.	No. of trees that can be managed by one tapper.	Total quantity of gul that can be expected (as calculated from the statement under 2 above).	Rate per rupee of gul.	Rent of the trees that can be paid.		Net income for the whole tapping season.
				lbs.	Rs.	
Date palm ...	50 (about half the number being required to be attended to every day).	1,750	25	10	60	
Brab palm ...	25	1,250	25	5	45	
Cocconut ...	20	1,600	25	25	55	

(5) From the figures given above it is to be seen that gul-making industry from palms cannot bear to pay any tree tax to Government for supervision against illicit use of the palms under the pretext of gul-making. Mr. Paril observed that in Madras no tree tax is levied for gul-making, though free licenses from the Excise Department have to

be obtained, but he did not hear reports of any misuse being made of this privilege. In the Konkan, with the same precautions as in Madras he did not apprehend that the gul-making license would be abused.

(6) At the above prices there is almost no scope for carrying on the gul-making industry on a sole business scale. The economic condition of the tenant agriculturists in the Thana and Kolaba Districts was quite suitable to fit and to be benefited by gul-making from palms as a cottage industry.

The detailed notes which they have drawn up on the process of and the possibility for gul-making from three kinds of palms—Brab, cocconut and *bherli* (*Caryota urens*) (that about Date palm being omitted as this palm has been further worked out and a full account of the same is appearing in this publication) together with the statistical and analytical observations that they took, would be an interesting and useful record for future workers and are, therefore, published as appendices Nos. I and II.

Appendix No. I gives notes on gul-making from brab palm in Madras and its possibility in the Konkan, from cocconut palm in the Konkan and from *bherli* (*kitul*—Ceylon) in Ceylon.

Appendix No. II gives :—

(a) Quantities of juice obtained in the Thana District from the brab and the Date palms.

(b) Chemical composition of the Date palm juice and its rate of deterioration in keeping.

(c) The effect of various preservatives as tested on the cocconut and Date palm juice.

(d) Composition of guls of date and brab palms.

Bombay Government's sanction to allow the Palms to be tapped free of tax for sugar manufacture.

When Mr. Patil was proceeding with his investigation, the Commissioner of Excise himself also raised the question of the possibility of gul-making with the Director of Agriculture. Mr. Patil's report was accordingly forwarded by the Director of Agriculture to the Commissioner of Excise in reply to his enquiry and stated that if the Excise Department could see its way to permit the use of sweet toddy for the purpose of gul-making free of charge, the Agricultural Department will do its best to develop the industry. At the recommendation of the Commissioner of Excise, Bombay Government subsequently in March 1916 sanctioned the exemption from payment of tree tax of trees to be tapped for sweet toddy for the manufacture of sugar under a license from the Excise Department.

PART III.

COMPREHENSIVE FINAL EXPERIMENTS WITH DATE PALM.

Experiments in 1915-16.

On the authority of the Government Orders referred to at the end of the last part, Mr. Sorabji Patel's petition asking for permission to tap 1000 Date palm trees free of tax for gul manufacture was granted, and Mr. Sorabji being further encouraged by the results of Mr. Patil's investigation, undertook an experiment of gul manufacture on a business scale with 1,000 date palm trees in the tapping season commencing from October 1915. The trees commenced to yield juice from the 13th of December 1915 and were continued to be tapped till the 8th of April 1916, when the output of juice was so small that it was uneconomic to attempt collection of juice any more, and so the business was closed for the season. The method of operating the trees was that locally adopted with the modification however that the periods of tapping the juice and resting the plants were made much shorter, namely, three to four days' tapping followed by five to six days rest, approximating in this respect somewhat to the Bengal system. The pots were lined as was required by the license and special care was taken to manipulate the cuts as cleanly as possible. Mostly the night juice was collected. It was boiled in big sugarcane juice boiling pans of the Poona type on the Poona type of furnace.

The total quantities of juice and gul of different qualities obtained by him throughout the whole season are set out in the table hereafter, giving these results for all the four years he has been proceeding with his experiments.

Mr. Sorabji's first adventure was not without difficulties. His tappers were quite new, unaccustomed and moreover unwilling to take the extra trouble and care required in manipulating the cuts to the required degree of cleanliness; that they were not allowed to drink fresh toddy as is their practice in drawing fermented toddy put them out so much that Mr. Sorabji had to provide them with their drink by issuing for the purpose domestic consumption license of ten trees for twenty tappers; his inexperience in gul-making was another disadvantage, the departmental gul-maker, who was supplied, being unable to negotiate with the juice which had already more or less fermented. As a consequence of all this, the quality of the product was very poor consisting of a large portion of sticky molasses, for which there was no demand and he found great difficulty in disposing of it and suffered a good deal of loss financially.

This experiment on a comprehensive and full season scale was keenly watched, helped and kept under close study by the Agricultural Department in order to get full data and experience of the detailed working and practical difficulties with a view to evolving the appropriate methods for successful gul-making. At the same time some experimental work was also done, which with its results is mentioned below.

The use of formalin to obtain sweet and unfermented juice fit for gul-making.—It was noticed by the author that for reasons explained above the juice, excepting that drawn on the first day after a rest, was, on no occasion, entirely unfermented. As a remedy against this 3 cubic centimeters of 10 per cent. formalin per pot was tried on a fairly large scale on

the first, second and third days of a tapping period ; the juice obtained on all the days was quite clear and unfermented and produced good hard solid and granular gul. The same quantity of formalin was added for the day drippings and it was surprising to find that while the juice collected was almost free from fermentation and produced hard solid gul, that collected in freshly limed pots at the same time for comparison was highly fermented and gave very sticky liquid molasses. For the sake of curiosity, during one night formalin was added to the pots which were in long use, unwashed, untreated, for drawing ordinary toddy with the result that sweet unfermented juice yielding hard solid gul was obtained. Juice kept for three days with the above quantity of formalin added remained without any apparent change. The cost of formalin at the above rate works out for a whole season at six annas per tree at the retail rate of Rs. 1-8-0 per lb. of 40 per cent. formalin. This experiment was, however, conducted too late to be of use in that season.

Fuel Requirements.—Tests to determine the quantity of fuel required for boiling the juice into gul were taken with the result that about 500 lbs. of light fuel was required to boil 100 gallons of unfermented juice on the Poona type of gul boiling furnace.

It would be seen on the whole that the results of the first year's work on a full practical scale were not very encouraging.

A first hand study of the Bengal Industry.

A perusal of the Memoir on the Date Palm Sugar Industry in Bengal by Annett and others (Memoir of the Department of Agriculture in India, Chemical Series, Vol. II, No. 6 of March 1913) gave however a much brighter, smoother and more satisfactory view of this long established industry there than what was experienced in the first attempt in Bombay and it was therefore thought that many of the difficulties would be solved and much useful practical knowledge would be gained by a first hand personal study on the spot of the methods in vogue there. The author accordingly went to Bengal for the purpose in the month of December 1916.

The magnitude and the importance of this industry in Bengal is considerable, there being about a lakh of acres under Date trees. The practice of making gul and also unrefined sugar from the date palm is of a very old standing the methods and processes in which have been reduced to a routine just as any other agricultural crop of the tract.

The special important and distinctive features of successfully dealing with the plant for gul manufacture there were found to be as follows :—

(1) *Season of Tapping.*—The season of tapping the tree is nearly the same as in Bombay ; but in Bengal the operations have to be stopped by the end of March as rains begin to fall from that time, while in Thana the weather continues to be dry till the end of May and the operations can safely be prolonged till the middle of May at any rate.

(2) *Method of Operation.*—The method of operating on the trees differs fundamentally from that in Bombay. The Bombay cut is small and narrow and elongated, 2 to 3 inches wide and of about the same depth at the top and sloping below towards the surface of the trunk, occupying a length of about 6 to 7 inches, and presents the shape of an open mouth with the tongue projecting downwards. The Bengal cut

on the other hand extends over a larger surface of about 8 inches in width horizontally, reaching a length of 8 to 9 inches vertically by the end of the tapping season, and much shallower, never penetrating deeper than $1\frac{1}{2}$ inches into the stem. The shape of the cut is like that of the position of the two eyes having their lower sides straight and converging to a point in the form of an obtuse angle; the depth of each cut is slanting, commencing at the surface at the top and reaching $\frac{3}{4}$ th inch at the base. When one such cut is spent in the course of about a fortnight, another is cut out about $\frac{3}{4}$ th inch higher up thus giving an appearance of successive steps at a distance of about $\frac{3}{4}$ th inch between each; whereas in Bombay the same cut is renovated by thinly slicing off the bottom tongue like surface, lower and lower and deeper and deeper each time. The Bengal method thus admits of a cleaner and quicker manipulation of the cut and appears to cause less damage to the trees than the Bombay method which involves an injury to the deeper tissues of the plant, and owing to its many corners and angles does not admit of a thorough removal of the ferments. It might also be supposed that the sap deeper in the tree, *i.e.*, nearer the tender growing parts as obtained in the Thana method may be less sweet and may contain more reducing sugars which are more susceptible to fermentation. A correct idea of the two systems and the differences between them can be had from the illustration (Plate No. VI). In Bengal more care is exercised in cleaning the cut surface of the foam and the ferments contained in it, while in the Thana method of extracting toddy juice no such precaution is necessary or exercised.

(3) *Periods of alternate Tapping and Rest.*—The most important feature of the Bengal process of tapping which enables the tappers there to draw sweeter and less fermented juice fit for gul-making is its more frequent and shorter periods of rest followed by very short periods of tapping juice. Thus in Bengal trees are manipulated for collecting juice for only two or three days successively followed by a period of rest of three to four days, as against a long period of 15 days or more of tapping juice followed by a similarly long rest in the Bombay practice. Resting the tree, *i.e.*, leaving it unoperated soon stops the flow of juice, dries up the surface and thus cuts off the food and moisture required by the ferments, which must in their absence die out in the course of a few days. The juice drawn after this period on a fresh stimulation to the tree by scraping is thus sweet and not so liable to fermentation; there is always some juice flowing on the second day and even on the third in the case of some heavy yielding plants as a remnant of the first day's stimulation, and the ferments do not seem to re-establish themselves to a seriously harmful extent by this time so that it is also possible to get a fairly good quantity and quality of juice on the second and sometimes on the third days of tapping after a rest. The Thana method of continuous tapping for long periods on the other hand continuously affords favourable conditions for the unrestricted development and perpetuation of the ferments which do not allow the drawing of sweet unfermented juice except probably on the first one or two days of such a period.

(4) *Preservatives.*—Washing and smoking every day of the pots used for collecting juice is the only preservative treatment employed; this simple and inexpensive remedy appears to be sufficiently effective in checking fermentation during the time the juice is being collected at night and up to the time its boiling is commenced the next morning.

Annett and others during the course of their experiments* and investigations have experimentally proved the beneficial effect of smoking and also found that formalin is far more beneficial inasmuch as it enables the collection of day drippings in an unfermented state fit for gul making, which has never been possible in the smoked pots. In the latest publication on the subject by the same author it has been proved that liming of the pots is even a better and cheaper remedy than formalin.

(5) *Boiling and Manufacture of Gul.*—Each tapper boils his own quantity on a small furnace in one, two or more earthenware pans of about 10 gallons capacity. There is nothing special about the process of boiling; scum is removed as it rises and frothing is allayed by stirring with a ladle or a palm leaf partially inserted in the boiling liquid also controls it. The bubbles which appear in the pans mark the different stages of concentration; the treacle (*Guria*) bubbles indicate that the process is nearly complete. The pan is struck off the fire only by the eye. For the last ten minutes or so it is boiled on a slow fire. The temperature of the concentrate at the time of removing it from the fire was found to be 113° C.

Cooling and Crystallization.—After the pans are removed from the fire they are kept about 10 minutes for cooling. A handful of specially prepared and finely pulverised gul locally called *Beej* (seed) is added to the contents of the pan while it is cooling and the whole well stirred. The particles of this *gul* serve as nuclei for crystallization. The contents of the pan are finally ladled out into earthen pots or jars where they solidify into good crystalline gul hard or soft according to the quality of juice. The gul remains stored and is sold in these same pots. The gul made acquires a characteristically dark colour in keeping, which Annett ascribes to the presence of alkaline potassium bicarbonate and suggests that some sort of cheap acid such as lemon juice or tamarind extract may correct the defect.

(6) *Fuel.*—For every maund of gul made about 6½ maunds of fuel is required. The fuel mostly employed for the boiling process is *sundri* wood (*Heritiera littoralis*) which forms the principal part of the wild tree vegetation of the Sundarbans. Tur or jute stalks, dead palm wood or the wood of any other trees available are also used.

(7) *Age of the tree at which tapping is commenced.*—In Bengal tapping of date trees is commenced at the sixth year, when they are of sufficient height (about eighteen inches clear stem) above ground to admit of easy manipulation. In Thana, tapping is not begun until 10th or 12th year and until a clear trunk five to six feet high is obtained.

(8) *Frequency of the years of tapping.*—In Bengal date trees are tapped successively year after year, while in the Thana method of tapping the same for toddy purposes, the same tree is not tapped oftener than once in alternate years, as it is considered that the trees will be damaged very soon if tapped every year. This may be taken as a proof of the Bengal method of operating the tree being less harmful to the life of the plant; if it is so, it would be a distinct advantage to follow the Bengal method, as it will mean more outturn of gul from a given number of trees.

*Memoirs of the Department of Agriculture in India, Chemical Series, Vol. II, No. 6 of March 1919.

(9) *Care of the trees.*—Unlike Thana, the cultivation of the trees is well attended to in Bengal, the trees being generally planted regularly in rows and intercultivation given to the plantation; this must help a good deal in obtaining the flow of juice every year.

(10) *Climatic advantages favourable for drawing unfermented juice in Bengal.*—Bengal being situated in a more northerly latitude than Thana, the mean monthly temperatures during the tapping season are less by five to eight degrees Fahrenheit, which may act to some extent in checking fermentation. This disadvantage need not, however, be supposed to be of great significance, as actual experience in Thana has shown that a good quality of gul can be made, provided other necessary precautions for controlling fermentation are attended to.

(11) *Outturn of juice and gul.*—Owing to the short stay of the author in Bengal these could not be ascertained by actual tests for the whole season. In some tests that were actually taken in the third week of December at the time of his visit, one lot of 100 trees yielded 15 gallons of juice and another of 320 trees 48 gallons for the morning collections. Other cases that were enquired into nearly came to the same. The Brix readings of the juice at the same time varied between 11 and 15. This works out at $22\frac{1}{2}$ gallons for the whole season of 5 months; but it would not be correct to suppose that the flow of the juice would be constant throughout the season as has been done in the above calculation. Annett's computation of 17 gallons of juice and $21\frac{1}{2}$ lbs. of gul per tree per season every year may, therefore, be accepted as representing a fair average yield throughout the Date sugar districts of Bengal.

(12) *Price fetched by the Bengal gul and disposal of the produce.*—The price per *kaccha* maund (60 lbs.) of gul was Rs. 1-12-0 in December of 1916 and it has never exceeded Rs. 2-8-0 in the past; this means one tree on an average never gave more return than 14 annas per tree, but 12 annas per tree may be taken as an average. The gul made from date is sold for consumption as such in the households or to sugar factories, which manufacture unrefined sugar by country methods. It does not keep well during the monsoon and is, therefore, mostly disposed of before its commencement.

(13) *The number of trees that can be managed by one tapper.*—It was noticed by the author that in one case 320 trees and in another 240 trees were managed by one tapper with the help of a boy. The latter figure was found to represent the general practice. This shows that the efficiency for work of the Bengal tapper is far greater than that of the tapper in Bombay, whose utmost capacity is not more than 60 trees each, of course without any additional assistance. The reasons for this appear to be as follows:—The wider, shallower cuts, and the particular fashion of operation facilitates the use of a more efficient tapping tool (*daws*) having a larger sweep of action (about four inches), as against a small chisel-like tool half an inch in width used in Bombay; secondly, in Bengal, in the short period of tapping, only one-sixth of the total number of the trees has to be cut daily whereas in the longer periods of tapping in Thana half the number has to be thinly chiselled out daily; and lastly, the Bengal tapper with his little wooden peg driven on the palm by the side of the tapping surface to suspend the pot used for collecting juice, saves an appreciable amount of time which is required by the Thana tapper in tying the pot to the tree with rope.

(14) *Financial aspect.*—One tapper with the help of a boy has been said to deal with 240 trees. This number of trees at an average of 12 annas each as calculated under the heading 'prices fetched' above will bring a return of Rs. 280 at an out-of-pocket expenditure as follows, the labour required being the tapper's and that of his boy:—

Fuel	... Rs. 20
Pots and pans	... Rs. 10
Tapping tools	... Re. 1
Ropes and jute	... Rs. 2
Rent of trees to the owner at one anna each	... Rs. 15
Total	... Rs. 48

Thus the tapper and his boy get a return of Rs. 132 for their six months labour; but when the labour is to be paid for it costs as follows:—

One tapper for the season at Rs. 3 per 20 trees	... Rs. 36	0	0
One boy	... Rs. 15	0	0
Food and clothes for above	... Rs. 30	0	0
Ploughing and weeding between the trees	... Rs. 10	0	0
Total	... Rs. 91	0	0

and still leaves a net profit of Rs. 41 or a little over 2½ annas per tree.

(15) *Relations of the Excise Department with the gul-making industry*—It was a matter of surprise that no one handling the juice for gul manufacture in Bengal ever thinks of using it as an intoxicant drink. On the other hand they deplore any fermentation in the juice, for it means so much loss in quantity and quality of gul. There are no excise restrictions of any kind, no permission to be obtained, no licenses to be issued, no taxes to be levied on trees to be tapped for gul manufacture. Some responsible officers of the Excise Department of Bengal, who were consulted, said that no cases have ever been noticed by their department where fermented toddy is made and used under the garb of sweet toddy even in localities where there are trees tapped for both purposes side by side. The author's impression was that the people seemed to be less addicted to drinking in Bengal than Madras or Bombay, which is corroborated by the comparative figures of the Excise Revenue in these provinces.

Experiments in 1916-17.

In Thana in the meanwhile, Mr. Sorabji who was encouraged with hopes of better prospects as a result of the Bengal visit undertook the experiment a second time with 300 date trees. He was however late in starting even this year, his trees beginning to yield juice from 1st January 1917. The important change he was induced to adopt from the experience of the methods followed the first year was the shortening of the period of tapping the juice to only two days at a time followed by a rest of four days; his tappers also got somewhat used and reconciled to better care and cleanliness in operating the cuts; liming of the pots was regularly followed as

required by the conditions of the license. As a result of all this a larger quantity of juice and good crystalline gul and a lesser quantity of molasses were obtained. Owing to the general increase in the prices of sugarcane gul, his product of date gul also fetched a good price of about 2 lbs per rupee and all the output could easily be sold. The detailed statistical results of the whole season's working are set out along with all the four years' results in the statement hereafter.

Experiments in 1917-18.

Being furnished with full and first hand information about the practices successfully carried out in Bengal, the Bombay Agricultural Department also undertook an experiment on a comprehensive and full season scale in the season commencing in October of 1917. Two expert Bengal tappers were imported for the purpose. The work was carried on at Tadgaon, Petha Umbargaon of the Thana District, where Mr. Sorabji, the pioneer worker, kindly placed 500 of his trees at the disposal of the Department. Side by side he continued his experiment a third time with 100 trees with a view of setting up a competition between the Bengal and his own tappers with the very desirable aim of course of making both, especially the latter, to exert their best energy to get a good quality and quantity of juice.

The methods followed in the departmental experiments were entirely a copy of those of Bengal in all respects except boiling which was done in large pans on a Poona type of furnace. Mr. Sorabji followed the local method of incision but the shorter periods of tapping and rest of Bengal which were found to be absolutely necessary from the previous two years' experience.

The Bengal tappers commenced to prepare their trees in October so that they commenced to yield juice from 16th November. Smoking of the pots was the preservative treatment adopted as in Bengal and clear unfermented sweet juice was obtained. The Bengal tappers, however, felt generally not very comfortable being strange to the language and habits of living and new to climate. Latterly they caught malaria and they wrote to their Bengal employer through whose kindness they were secured and got him to press for their early return; they had, therefore, to be allowed to go back on 14th January 1918. Their expert services could not thus be available for a whole working season. In the meantime, however, provision was made to initiate three or four local tappers into the Bengal process of manipulating the tree; they could not, however, master it thoroughly and the work done after the Bengal tappers left was very rough and indifferent. The work, however, was continued till the end of April when the yield of juice became unconomically low, as well as that in Mr. Sorabji's experiments. All through, clear juice was, however, being obtained which produced a hard solid granular gul which could be turned into blocks as those of sugarcane gul.

Mr. Sorabji commenced a little later, his trees beginning to yield by 5th December 1917. For some days in the beginning he resorted to lining as required by a condition in his license; but after finding in the departmental experiments that smoking of the pots was simple, inexpensive and equally or perhaps more efficient than lining he obtained permission to resort to the former which he continued throughout the season. Owing to the competitive spirit set up as referred to above combined with the offer of Mr. Sorabji to pay the tappers by so much (nine pies in this case) per

gallon of sweet unfermented juice drawn by each, he obtained nearly one and half times as much juice as by the Bengal method; but looking to the figure of Brix reading or the proportion of gul to juice, these are much lower than in the Bengal method, which may indicate that in stimulating the plant to give more juice its sugar-content is decreased or the tappers might have added some water to show a larger output and get better payment. The quality of his gul was a little inferior.

The statistical results of both the experiments are detailed in the combined statement of all the four years' results to follow. All the gul made could be easily sold at good prices.

Thus it is that suitable and appropriate methods of dealing with the date palm—rather the most difficult one of all the palms—for the purpose of gul manufacture, have been evolved so as to make it a complete success so far as the technical part at any rate is concerned.

Experiments in 1918-19.

Mr. Sorabji continued his concern for a fourth year in the season commencing from October of 1918, in which he tapped 600 trees; the trees began to yield juice from the 13th of December 1918 and his factory was closed down by the end of April 1919. This year he even went further in reducing the period of tapping to one day followed by two days rest, but some juice that invariably flows on the second day after freshly cutting the surface was thus a loss and his small total outturn of the season may have been due to this cause. He adopted smoking of the pots as his preservative treatment and made a satisfactory product as in the previous year. The long drought of 1918 is also supposed to be a possible cause for the reduced yield of the year as compared to that of the previous one.

Another cultivator near the place of the above experiments a Koli (one of the tapper class) by caste, owning some 500 date trees of his own, being stimulated by the results of Mr. Sorabji's experiments obtained permission from the Excise Department and tapped 500 trees in the year 1917-18 and 1918-19. The method of two days tapping followed by three days rest was adopted by him. His product was, however, much inferior to that of Mr. Sorabji's experiments; a visit to his manufactory gave the author an impression that he must not have been regularly liming his pots, and his boiling was also defective. He thought himself too wise to look into and follow the details of his more successful neighbour.

STATISTICAL RESULTS.

The statistical data obtained from the full season experiments carried on a

Year.	Name of Experimentor.	Total No. of trees dealt with in each year.	Date of trees commencing to yield their juice for the first time.	Date of closing the season's work.	Method of tapping and rest followed.	Total quantity of juice obtained.	
						Night drippings.	Day drippings.
						Gallons.	Gallons.
1915-16	Mr. Sorabji's experiment at Tadgaon.	1,000	13-12-1915	8-4-1916	3 to 4 days tapping followed by an equal period of rest.	11,051	1,664
1916-17	Do. ...	300	1-1-1917	16-5-1917	2 days tapping followed by 4 days rest.	4,195	837
1917-18	Do. ...	400	5-12-1917	30-4-1918	Do. ...	11,966	Not taken.
1917-18	The author's experiment...	Equivalent to 300	16-11-1917	30-4-1918	2 to 3 days tapping followed by 3 to 4 days rest.	5,572½	Not taken.
1918-19	Mr. Sorabji's experiment at Tadgaon.	600	13-12-1918	30-4-1919	One day's tapping followed by 2 days rest.	9,436	Not taken.

NOTE.—The prices fetched by Date Gul in the various years were 15 to

Results.

comprehensive scale in all the four years are detailed in the following statement : -

Average Brix reading of the juice.	Total quantity of product made.		Any circumstances affecting the quantity or quality of the product.	Average result per tree per year.			
	Solid granular Gul.	Semi-liquid molasses.		Outturn of juice.	Outturn of Gul.	Rate fetched by the Gul.	Value realised for Gul.
	lbs.	lbs.		gallons	lbs.		Rs. a. p.
12 to 14, rarely 15.	5,804	{ 9,746 2,972 }	The tapping could have been commenced about a month earlier and continued for 2 weeks more, had the trees been more carefully handled. Owing to the longer period of tapping and inexperience of tappers juice was spoiled resulting into a large quantity of molasses.	12.6	18	Solid Gul @ 16 lbs and molasses at 20 lbs. per Rupee.	1 0 0
Not available.	5,514	1,855	It would have been better had the working been started a month earlier.	16.16	23.6	Solid Gul @ Rs. 2-8 per md. of 28 lbs. and molasses @ Rs. 1-4 per md. of 28 lbs.	1 13 0
11 to 12½, mostly 11½, for the first month 13 to 14.	13,831		Every working as smooth as possible	29.9	34.5	Solid Gul @ Rs. 3 per md.	3 11 9
13 to 14, mostly the latter.	6,959½		Tapping indifferent after the Bengal tappers left on 14th January. About half the number of trees were brought under operation after Bengal tappers left.	18.6	23	Solid Gul @ Rs. 3-2-0.	2 3 6
Not taken.	11,863		Preceding rainy season droughty. Tapping period shortened too much.	15.7	19.8	Solid Gul @ Rs. 3-8-0 per md.	2 7 0

20 per cent. lower than by an equal quality of Cane Gul.

Taking into account the results of all the years and making allowance for all the circumstances recorded in the foregoing statement it would seem that 17 gallons of juice and 22 lbs of gul per tree per year are what can be expected from the Date trees in the wild condition as they are in the North Konkan. The daily outturns of juice and gul which also furnish data for knowing the variations at different times of the season are given in Appendix III.

Financial Results.

RECEIPTS.

The outturn of 17 gallons of juice or 22 lbs. of gul per tree per year, as arrived at above, at the normal (pre-war) rates of gul at 16 lbs. per rupee would fetch a money value of Rs. 1-6-0 per tree per annum.

EXPENDITURE.

Now turning to the head of cost, the several items involved are discussed below :—

Labour.—According to the Thana practice one tapper can handle not more than 60 trees. For the purpose of drawing fermented toddy the usual practice is to pay from Rs. 35 to Rs. 40 for the whole season. In the case of gul-making Mr. Sorabji obtained them at the same rate out of his own tenants, but Rs. 10 more might be allowed for the extra care the tapper has to take. The same man can attend to boiling, or when the man is doing the business for himself his wife can help him in this.

Fuel.—In gul-making from palms the item of fuel is of great significance unlike sugarcane gul for which the megass and trash from the cane are usually sufficient and is therefore next in importance to labour. It has been found by actual tests recorded elsewhere above that 5 lbs. of light fuel is required for every gallon of juice; at this rate each tree with the average output of 20 gallons of juice would require 100 lbs. of fuel for a full season. Heavy wood fuel is not as good to regulate the fire especially at the latter stages of boiling the liquid into gul as light fuel such as stalks of crops, tree leaves, branch and brush wood and under-growth. It has been found that the leaves from the Date trees themselves provide only a small fraction of 15 lbs. annually. The remaining quantity has to be provided from some other sources. There are no crops in the palm growing tract of Konkan, yielding woody stalks except very small areas under *tur*; the landlords own some woodlands which carry brushwood but it is mostly required for rabbit-burning; there are not many trees in private lands which can be cut down and used for fuel. Log fuel selling at Rs. 3-8-0 per Khandi of 784 lbs. at the forest depots in the Thana district, and adding to this the charges for carrying and preparing it in a suitable form for burning in the furnace, the fuel for each tree would cost not less than annas eight.

Pots for drawing the juice and storing gul, ropes, &c.—In a season as many pots as the number of trees to be tapped for collecting juice, allowing for breakage, and a sufficient number to hold about equal number of maunds of gul are required; the charge on this account would come to not more than two annas per tree.

Tools and Accessories.—This is a small item and may be taken to cost not more than Rs. 2 for the equipment of each tapper.

Furnace and boiling pans.—To deal with the quantity on an home industry scale of one tapper, whether earthen pans which would have to be renewed oftener or iron pans which would last longer are used, the charge would not exceed Rs. 3 annually.

Preservatives.—The cost of liming per tree throughout the season would come to about six pies per tree. If smoking of the pots is adopted the cost is negligible.

Supervision.—On the small scale of cottage industry this need not be considered, but if the industry is possible on a large business scale, one twenty-rupee supervisor would be needed for every 1,000 trees for seven months, which works out at Re. 0-2-3 per tree per season.

Rent of trees.—All the Date trees are owned by landlords and the cottager tenants or any business man cannot have their use free; at present Date trees are fetching to their owners at about half an anna per tree per year for the purposes of cutting their leaves for mats, ropes and broom making; of course only a small fraction of the total number of trees is utilised for this purpose. In Bengal one to two annas and in Madras for palmyra palms two annas per tree are the usual rates given for gul-making purpose. Thus in Bombay the owner of Date trees cannot be expected to let them out for less than two annas per tree per season.

Total cost per tree.—From the above data the expenditure per tree under the two conditions where labour is hired and where labour is one's own as in the case of the cottage industry, works out as follows:—

Name of item.	Expenditure per tree.					
	Where labour is hired.			Where labour is one's own.		
	Rs.	a.	p.	Rs.	a.	p.
Labour at 60 trees per tapper as in the Thana present practice.	0	13	8	0	0	0
Fuel	0	8	0	0	8	0
Pots and ropes, and preservatives	0	2	6	0	2	6
Furnace and boiling pans	0	0	9	0	0	6
Tools and accessories	0	0	6	0	0	6
Rent of trees	0	2	0	0	2	0
Supervision	0	2	0	0	0	0
Total	1	13	0	0	13	6

PROFIT.

At the normal rates of gul it would thus be seen that it is a losing concern to conduct it on a large business scale with hired labour. The only chance of making a profit with hired labour lies in the circumstance of a

higher price for gul than 16 lbs. to the rupee and that too after the tapper's efficiency has reached that of the Bengal tapper, without an increase of wages, by which the labour cost may be reduced to 5 annas per tree.

But to the tenant agriculturists it would leave a margin of Re 0-8-6 per tree or Rs. 31-14-0 for the whole tapping season as a subsidiary income for his seven months' labour at the present rate of his efficiency; but if by adopting Bengal methods he can reach (and there is no reason why he cannot) somewhere near the Bengal efficiency of tackling with three to four time the number of trees the Thana tenant's return for his labour would increase to about Rs. 100 to 120 per tapping season, out of which he may have to pay the boy helper, if he has not the additional assistance forthcoming in his own family.

Relations of the Excise Department with the Industry.

Date juice is an easily fermentable juice, and it might be argued that the Excise interests will suffer if an improper use of the juice is made under the license of gul-making, that therefore Excise control is necessary and that the cost for the same should be raised by a tree tax. Just how much effective minimum of supervision will cost, is a very difficult matter for the author to estimate, but if it is to be on a scale as provided at Mr. Sorabji's and the other farmer's trial concerns consisting of one Sub-Inspector and two peons stationed at the spot all the time throughout the season at a cost of about Rs. 500 and two such establishments for the two places within a distance of three miles, it is indeed very high, and out of the question. Moreover from the figures of the financial situation of gul-making detailed in the foregoing statement it could be glaringly seen that the industry can bear absolutely no charge on this account.

In Bengal there is no Excise supervision at all; there is no Excise tax, no permission to be granted, no licenses to be issued; in Madras permission of the Excise Department had to be obtained and licenses to be issued but free of any tax. It has been noted above (page 12) that in Bengal the absence of Excise control has not been abused. As regards Madras, Mr. Chadwick, Director of Agriculture, Madras, informed the Director of Agriculture, Bombay, about the Excise control in that Presidency in the year 1914 as follows:—

“ In Coimbatore and Kishna districts licenses free of charge are issued by the Abkari Department for trees from which sweet juice only is to be drawn. In Tinnevely the people are at liberty to tap any tree they like for sweet juice. During the tapping season extra Abkari officials are sent down into the areas and they can have any pot brought down from the tree to be tested for acidity with litmus paper—a test which all the people know. In order to check the petty oppression which might result from such a system, extra picked Assistant Inspectors are also posted to inspect promptly any cases of extortion by the subordinates. I know the tract well myself and for the last ten years or so there have been very few complaints.”

It is understood that even the issuing of licenses has been latterly dispensed with.

In the Thana District and especially in the Date growing tract the tenant's addiction to drinking toddy is no doubt great, but it would not be right to suppose that under the fear of surprise inspections, there will be an abuse on any appreciable scale so as to affect the Excise interests; the

Excise supervision during the experimental period was so rigid as not to give any idea as to what extent the abuse would have taken place by only occasional surprise supervision as could be afforded by the usual Excise staff.

No tax should therefore be levied for the reasons explained above. But in the initial stages of this new departure, the obtaining of permission and issuing of licenses under certain conditions should be adopted keeping only an occasional and surprise inspection by the existing Excise staff.

Experiments with Various Preservative Treatments and Improving the Colour of Gul.

1. PRESERVATIVE TREATMENTS.

Palm juice, and especially Date palm juice, is so easily liable to fermentation that unless some preservative treatment of the juice is adopted it is impossible to draw unfermented juice required to make good hard cry talline gul. A short period of tapping not exceeding two or three days followed by a rest of three to four days as practised in Bengal and cleaning the tapped surface of all ferments are the first essentials, then it is equally necessary to see that the pots used for collecting the juice and the juice itself while in the process of being collected in pots is prevented from fermenting. In Bengal smoking of the pots has been found effective and is in vogue during all the long period gul-making is practised. For palmyra juice in Madras liming is the common remedy resorted to. Formalin is also known in scientific circles and recommended as an effective preservative for Date juice by Annett and others in their first Memoir on the subject of Date palm. All these were, therefore, tested and compared by chemical methods in collaboration with Mr. V. G. Patwardhan, a Chemical Assistant kindly deputed by the Agricultural Chemist to the Government of Bombay during the period of the comprehensive experiment by the Department in the year 1917-18. The results obtained are given in the following statement.

[For Statement see page 22.]

Results showing the preservative effect of the various treatments of pots used for collecting juice of Date palm for Gul-manufacture.

Jiran juice (i.e. first day's collection after resting the plant.)						Dokat juice (i.e., second day's collection after a resting period.)					
No. of trees.	Brix reading of juice.	Temperature of juice at the time of Brix reading. Degrees C.	Alkalinity in terms of grammes of sulphuric acid per 100 c.c. of juice with phenolphthalein.	Acidity in terms of grammes of caustic potash per 100 c.c. of juice with phenolphthalein.	Colour of juice in respect to fermentation.	No. of trees.	Brix reading of juice.	Temperature of juice at the time of Brix reading. Degrees C.	Alkalinity in terms of grammes of sulphuric acid per 100 c.c. of juice of phenolphthalein.	Acidity in terms of grammes of caustic potash per 100 c.c. of juice with phenolphthalein.	Colour of juice in respect to fermentation.

NEW POTS.

(Bengal method of tapping.)

5-2-1918.					6-2-1918.						
828	16.5	10	0.114	Not determined.	Clear.	323	14	15	0.124	0.024	Dull.
269	14	10	0.124		Dull.	269	10.5	15	0.143	0.034	Dull.
283	15.5	10	0.095		Dull.	283	13.5	14	0.124	0.024	Clear.
325	14	10	0.124		Dull.	325	11.5	14	0.124	0.019	Dull.
231	18.5	12	0.105		Clear.	231	17.5	15	0.114	0.039	Dull

(Bengal-cum-Thana Method of tapping.)

5-2-1918.					6-2-1918.						
159	12.5	10	0.095	Not determined.	Dull.	159	15	13	0.190	0.029	Clear.
154	16	10	0.095		Dull.	154	15.5	13	0.085	0.024	Dull.
97	Not sufficient juice.	11	0.119		Clear.	97	13	13	0.114	0.024	Dull.
158	14.5	10	0.076		Dull.	158	13.5	12	0.143	0.019	Dull
127	16	10	0.100		Clear.	127	14.5	12	0.105	0.010	Dull

(Bengal Method of tapping.)

9-2-1918.					10-2-1918.						
116	15	12	0.095	0.019	Clear.	116	15	16	0.076	0.048	Clear.
48	15.5	13	0.095	0.029	Clear.	48	Not sufficient juice.	18	0.066	0.029	Clear.
47	14	13	0.104	0.019	Clear.	47	14.5	17	0.057	0.034	Clear.
122	11	13	0.086	0.019	Clear.	122	11	18	0.057	0.034	Clear.
120	11.5	13	0.124	0.024	Clear.	120	11.5	16	0.095	0.034	Clear
Average.			0.103	0.022		Average.			0.107	0.028	

Jiran juice (i.e. first day's collection after resting the plant).					Dokat juice (i.e., second day's collection after a resting period).						
No. of trees.	Brix reading of juice.	Temperature of juice at the time of Brix reading. Degrees C.	Alkalinity in terms of grammes of sulphuric acid per 100 c. c. of juice with phenolphthalein.	Acidity in terms of grammes of caustic potash per 100 c. c. of juice with phenolphthalein.	Colour of juice in respect to fermentation.	No. of trees.	Brix reading of juice.	Temperature of juice at the time of Brix reading. Degrees C.	Alkalinity in terms of grammes of sulphuric acid per 100 c. c. of juice with phenolphthalein.	Acidity in terms of grammes of caustic potash per 100 c. c. of juice with phenolphthalein.	Colour of juice in respect to fermentation.

SMOKED POTS.

(Bengal Method of tapping.)

5-2-1918.					6-2-1918.						
823	16	11	0.095	Not determined.	Clear.	323	15	15	0.104	0.029	Clear.
269	14	10	0.133		Clear.	269	11	15	0.134	0.034	Dull.
233	15	11	0.143		Clear.	233	13.5	14	0.133	0.048	Clear.
325	14	11	0.114		Clear.	325	12	14	0.104	0.015	Dull.
231	Not sufficient juice to take the reading.	16	0.095		Clear.	231	16.5	16	0.114	0.024	Dull.

(Bengal-cum-Thana Method of tapping.)

5-2-1918.					6-2-1918.						
159	12.5	10	0.081	Not determined.	Clear.	159	15	13	0.100	0.038	Clear.
154	16.5	11	0.035		Clear.	154	15	13	0.100	0.038	Clear.
97	Not sufficient juice.	11	0.100		Clear.	97	13.5	13	0.133	0.019	Dull.
158	14.5	11	0.091		Clear.	158	13.5	13	0.152	0.029	Dull.
127	16	11	0.114		Clear.	127	14	13	0.095	0.029	Dull.

(Bengal Method of tapping.)

9-2-1918.					10-2-1918.						
116	14.5	13	0.104	0.033	Clear.	116	16	17	0.057	0.044	Dull.
48	15.5	14	0.085	0.033	Clear.	48	16.5	17	0.057	0.053	Clear.
47	Not sufficient juice.	15	0.095	0.029	Clear.	47	16.5	18	0.067	0.053	Clear.
122	11.5	14	0.090	0.072	Dull.	122	11	17	0.047	0.048	Clear.
120	11	14	0.095	0.019	Clear.	120	12.5	17	0.067	0.039	Clear.
Average.			0.101	0.037		Average.			0.097	0.036	

Jiran juice (i.e., first day's collection after resting the plant).						Dokat juice (i.e., second day's collection after a resting period).					
No. of trees.	Brix reading of juice.	Temperature of juice at the time of Brix reading. Degrees C.	Alkalinity in terms of grammes of sulphuric acid per 100 c. c. of juice with phenolphthalein.	Acidity in terms of grammes of caustic potash per 100 c. c. of juice with phenolphthalein.	Colour of juice in respect to fermentation.	No. of trees.	Brix reading of juice.	Temperature of juice at the time of Brix reading. Degrees C.	Alkalinity in terms of grammes of sulphuric acid per 100 c. c. of juice with phenolphthalein.	Acidity in terms of grammes of caustic potash per 100 c. c. of juice with phenolphthalein.	Colour of juice in respect to fermentation.

LIMED POTS.

(Bengal Method of tapping.)

5-2-1918.						6-2-1918.					
261	12.5	10	0.114	Not determined.	Clear.	261	11	13	0.113	0.014	Dull.
260	12.5	10	0.152		Clear.	260	16	14	0.143	0.010	Dull.

(Bengal-cum-Thana Method of tapping.)

5-2-1918.						6-2-1918.					
186	14	9	0.085	Not determined.	Dull.	186	13.5	11	0.095	0.019	Dull.
187	13	9	0.095		Dull.	187	13	12	0.133	0.014	Dull.

(Bengal Method of tapping.)

9-2-1918.						10-2-1918.					
25	15	12	0.104	0.019	Dull.	25	15.5	16	0.085	0.034	Whitish.
53	13.5	12	0.105	0.019	Dull.	53	14.5	15	0.081	0.038	Dull.
Average.			0.109	0.019		Average.			0.108	0.021	

FORMALINED POTS.

(Bengal Method of tapping.)

5-2-1918.						6-2-1918.					
263	16	10	0.091	Not determined.	Clear.	263	No juice obtained.				
264	14.5	10	0.143		Clear.	264	11.5	14	0.162	0.029	Dull.

(Bengal-cum-Thana Method of tapping.)

192	11	10	0.102	Not determined.	Clear.	192	12	12	0.105	0.024	Dull.
193	15	9	0.095		Clear.	193	15	12	0.114	0.020	Clear.

(Bengal Method of tapping.)

9-2-1918.						10-2-1918.						
24	12.5	12	0.109	0.024	Clear.	24	11.5	16	0.085	0.034	Dull.	
22	15	12	0.104	0.038	Clear.	22	Not sufficient juice.		18	0.047	0.033	Clear.
Average.			0.107	0.031		Average.			0.102	0.030		

**KEEPING QUALITY OF THE JUICE DRAWN IN DIFFERENT POTS TREATED
IN DIFFERENT WAYS.**

Changes in the juice collected on 6-2-1919 in the morning.

Time.	Brix reading of juice.	Temperature of juice at the time of Brix reading. Degrees C.	Alkalinity in terms of grammes of sulphuric acid per 100 c. c. of juice with phenolphthalein.	Acidity in terms of grammes of caustic potash per 100 c. c. of juice with phenolphthalein.	Colour of juice in respect to fermentation.	Time.	Brix reading of juice.	Temperature of juice at the time of Brix reading. Degrees C.	Alkalinity in terms of grammes of sulphuric acid per 100 c. c. of juice with phenolphthalein.	Acidity in terms of grammes of caustic potash per 100 c. c. of juice with phenolphthalein.	Colour of juice in respect to fermentation.
New pots.						Smoked pots.					
6th Feb. 11 a.m.	14.5	14	0.114	Not determined.	Clear.	6th Feb. 11 a.m.	14.5	16	0.109	Not determined.	Clear.
2-30 p.m.	14.5	19	0.114		Whitish.	2-30 p.m.	14	19	0.104		Clear.
6 p.m.	14.5	20	0.104		Whitish toddy smell.	6 p.m.	14.5	21	0.095		Whitish.
7th Feb. 11 a.m.	14.5	17	Nil.		0.209	Whitish toddy smell fermented.	7th Feb. 11 a.m.	14	17		Nil.
Limed pots.						Formalined pots (6 drops to a pot).					
6th Feb. 11 a.m.	13.5	13	0.133	Not determined.	Turbid.	6th Feb. 11 a.m.	11.5	18	0.095	Not determined.	Clear.
2-30 p.m.	13.5	20	0.124		Whitish.	2-30 p.m.	11.5	18	0.095		Whitish.
6 p.m.	13.5	20	0.095		Whitish toddy smell.	6 p.m.	11.5	20	0.095		Whitish.
7th Feb. 11 a.m.	13.5	17	Nil.		0.130	Whitish toddy smell fermented.	7th Feb. 11 a.m.	11.5	15		Nil.

QUALITY OF THE JUICE AT DIFFERENT HOURS IN THE PROCESS OF COLLECTION
ON TREES IN ONE AND THE SAME SETTING.

Pots set at 4-30 p.m. and lowered finally at 8-30 a.m. of following day.

Time.	Brix reading of juice.	Temperature of juice at the time of Brix reading. Degrees C.	Alkalinity in terms of grammes of sulphuric acid per 100 c. c. of juice with phenolphthalein.	Acidity in terms of grammes of caustic potash per 100 c. c. of juice with phenolphthalein.	Colour of juice in respect of fermentation.	Time.	Brix reading of juice.	Temperature of juice at the time of Brix reading. Degrees C.	Alkalinity in terms of grammes of sulphuric acid per 100 c. c. of juice with phenolphthalein.	Acidity in terms of grammes of caustic potash per 100 c. c. of juice with phenolphthalein.	Colour of juice in respect to fermentation.
4-30 to 7-30 p.m.	13.5	22	0.124	0.029	Clear.	The same as for No. 1 Pot.	13.5	22	0.133	0.024	Clear.
7-30 to 10-30 p.m.	13	18	0.152	0.014	Clear.		14	18	0.124	0.014	Clear.
10-30 p.m. to 5-30 a.m.	12.5	14	0.152	0.029	Clear.		12.5	17	0.143	0.014	Clear.
5-30 to 8-30 a.m.	12.5	16	0.143	0.019	Clear.		13.5	17	0.143	0.024	Clear.

The one very interesting fact revealed by the results recorded in the foregoing statement is that fresh unfermented juice of *Phœnix sylvestris* is distinctly alkaline and somewhat acid at the same time.

As regards the effect of the various preservative treatments as measured by alkalinity and acidity of the same juice, it is to be observed that the alkalinity of the juice is the greatest and the acidity the least as could be expected in the case of the limed pots as the lime added is itself highly alkaline. But how far the small amounts of acidity and slight variations in them play a part in affecting fermentation is an undetermined point.

If the columns of colour indicating the degree of fermentation are examined it will be seen that for appearances and for all practical purposes all the treatments may be said to be alike. In this respect the set of figures given under keeping quality are particularly interesting and convincing of the above inference. In this last experiment juice in the smoked pots has actually remained unfermented longer than in the case of the other treatments.

It might be pointed out here that these tests have been carried on over only a short period out of the whole tapping season and may have fallen

on days when the weather was very clear and cold, which fact itself might have kept down fermentation equally in all the treatments and there was no chance of comparing them with the scientific precision on occasions favourable for fermentation. It is unfortunate we did not carry out tests, for a matter of experiment on day collections, which are more liable to fermentation than the night ones. The above two must be done for any complete scientific investigation of the question.

Annett, Pal and Chatterjee have also investigated this problem and published their results in a Memoir of the Department of Agriculture, in India (Chemical Series, Vol. V, No. 3, September 1918). Their conclusions may be said to agree with ours as far as the collection of night juice and the period of tapping season during which the weather is clear and sufficiently cold (*vide* results of dates 21st January to 2nd February in the statement on pages 78 to 80 of the Memoir) are concerned. We did not continue our experiment to a time during which the weather got warmed up and cloudy. But Annett and others have found out that during the warmed up time and for day collections juices which are liable to high fermentation, lime is distinctly superior to smoking (*vide* the latter part of the statement commencing from 4th February referred to above). Some pertinent extracts from the Memoir are quoted below:—

“As compared with the untreated pots it will be seen that smoking has an extremely beneficial effect. It seems to give far better results than the use of metal buckets and frequently better than those of formalin.

As compared with lime it would appear on the first glancing at the figures on pp. 78—81 that it (smoking) had given results equally good. As the weather warmed up in February however it was seen to be much inferior to lime and from general observations of many individual juices collected in limed and smoked pots there is no question as to the inferiority of the smoking process.

There is no doubt that smoke has some preservative effect on the juice and this is being discussed elsewhere,

The use of a preservative such as smoke or formalin will check the development of the living organisms. It will not, however, prevent the action of a non-living ferment such as invertase which changes cane sugar to the reducing sugar. Lime however in addition to being a good sterilizing agent for living organisms, is strongly alkaline. This alkalinity quite prevents the action of the invertase ferment.

It has been shown by other workers that lime destroys reducing sugar.”

Such are the results of the laboratory experiments. Coming however to the comprehensive tests on a practical scale smoking was the preservative treatment employed throughout the season of our full season experiment with 500 trees in the Bengal method of tapping. Mr. Sorabji who saw the simplicity, effectiveness and inexpensiveness of the treatment also adopted the same in his experiments of the year 1917-18 and 1918-19. Judging thus from the observations and actual results obtained through two seasons and on a large number of trees on a practical business scale smoking of the pots was generally considered satisfactory for all practical purposes. The juice drawn in the smoked pots remained as unfermented as and produced even a better quality of product than, in the limed pots of the previous year's experiments of Mr. Sorabji. Smoking was also found to be less laborious and expensive than liming.

2. IMPROVING THE COLOUR OF GUL.

During all the observations made on Date gul it was noticed that the colour of the gul though as bright as cane gul immediately on making, gradually changes colour in keeping, turning into dark brown in course of a fortnight or a month. Annett and others have similarly noted this fact in their work* on Date gul in Bengal. In an article in the January 1917 number of the *Agricultural Journal of India*, Mr. Annett ascribes its cause to the strongly alkaline character of fresh juice and to the fact that when alkalis are boiled with sugars black coloured decomposition products are formed; he accordingly tried making gul after acidifying the juice with some acids such as citric, sulphuric, hydrochloric acids, alum, tamarind fruit and lemon juice and was able to obtain a light coloured product.

An attempt was once made by the author in the season of 1917 to obtain a lighter coloured gul on a practical scale by putting in ripe tamarind fruit in a large pan of juice with the result that a gul of a lighter colour but of a soft sticky consistency instead of hard solid granular structure with a darker colour, was obtained.

The investigation of the question on more systematic and scientific lines was, therefore, taken up in collaboration with Mr. V. G. Patwardhan, a Chemical Assistant, kindly deputed by the Agricultural Chemist to the Government of Bombay.

To begin with several samples of Date juice were examined for alkalinity and acidity. From a number of different plants juices were separately collected under different conditions and their alkalinity and acidity were determined quantitatively. A definite amount of juice was titrated with decinormal sulphuric acid to determine the alkalinity using methyl orange as the indicator; and also another aliquot portion from the same juice was titrated with decinormal caustic potash solution to determine the acidity using phenolphthalein as the indicator. Some particular average trees were selected, and the pots with different treatments were separately attached to different trees taking all the necessary precautions to avoid any effects on the nature of the juice by other causes. The pots were attached to the trees on the evening of the previous day and the determinations of the juices collected over-night made the next morning. The juices from the same trees were taken for two continuous days and separately examined. The following scheme was adopted:—

(1) Two trees were selected to which two new pots were attached in the evening of the previous day after addition of six drops of 40 per cent. formalin to each. The analyses of the juices were done the next morning.

(2) Two trees were selected to which two new pots were attached, inside of which was given a thin coating of lime wash before attachment.

(3) Five trees were selected to which five new pots and five smoked pots were attached—two pots one new and the other smoked to every tree. From the same tree the juice was made to trickle in two pots separately by a special contrivance made for the purpose to get nearly equal amounts of juice in each pot. All these juices were separately collected and examined the next morning. This was done in both cases of trees tapped either by Bengal method or improved Thana method.

* *Memoirs of the Department of Agriculture in India, Chemical Series, Vol. II, No. 6, pp. 384, 355.*

In the Bengal method the juice of the first day's collection is known as *firan* juice and that of the second day's collection *dokat* juice. The juice of the third day's juice as *tekat* juice was not taken for experiment being too little for our purpose. The juices of different trees under similar conditions except the method of tapping, were separately collected in different lots and their determinations as to the alkalinity, &c., were done continuously for two days. Alkalinity is expressed in terms of grams of sulphuric acid per 100 c. c. of juice as determined by using methyl orange as the indicator and similarly the acidity is expressed in terms of grams of caustic potash per 100 c. c. of juice as determined by using phenolphthalein as the indicator.

All the determinations together with Brix readings, temperatures and colour of the juices are available from the last foregone statement. From the data obtained and recorded therein the date palm juice (when collected at night and tested in the morning) is not only strongly alkaline in reaction when tested with methyl orange as an indicator, but is at the same time acid in reaction, when tested with phenolphthalein as the indicator. In the case of apparently unfermented juices the average alkalinity was found to be 0.100 in terms of grams of sulphuric acid per 100 c.c. of juice and the average acidity was found to be varying from 0.010 to 0.030 or more occasionally.

The slight acidity that is present in the fresh juice changes and the juice becomes alkaline in reaction when made to boil and then tested with phenolphthalein as shown by the data in the following statement:—

Effect of boiling on the alkalinity and acidity of juice

Kind of juice.	Colour.	Alkalinity in terms of grammes of sulphuric acid per 100 c. c. of juice with methyl orange as the indicator.	Alkalinity in terms of grammes of sulphuric acid per 100 c. c. of juice with phenolphthalein as the indicator.	Acidity in terms of grammes of caustic potash per 100 c. c. of juice with phenolphthalein as the indicator.
No. I.				
Fresh juice (composite sample).	Dull.	0.119	Nil.	0.048
At scum forming (when the juice was at 70 to 80°c.)	Brownish.	0.119	0.014	Nil.
At boiling Temp. 98°c.	Brownish.	0.109	0.018	Nil.
No. II.				
Fresh juice (composite sample).	Clear.	0.095	Nil.	0.033
At boiling	Brownish.	0.095	0.018	Nil.
No. III.				
Fresh juice (composite sample).	Dull.	0.104	Nil.	0.038
At boiling ...	Brownish.	0.104	0.018	Nil.

By boiling the juice became alkaline to phenolphthalein while in the fresh condition it was acid to phenolphthalein probably due to bicarbonates changing to normal carbonates.

This suggests that there are present some alkaline bicarbonates and some alkaline salts formed of alkali metals with weak organic acids. The alkalinity may also be due to the presence of some basic nitrogenous organic compounds.

It has been found that the presence of alkaline carbonates gives a dark colour to the gul and so attempts were being made to improve the colour of the gul by neutralising the alkalinity of the juice before boiling by some organic acids in different degrees and then noting the effect on the colour of the gul prepared from it. The juices taken for various trials of gul-making were first analysed as to the amount of alkalinity and acidity present. The alkalinity of a certain sample of juice was then wholly neutralised by the addition of the required amount of citric acid before the juice was kept for boiling; but the resulting product though lighter coloured was soft and sticky and could not be turned into solid crystalline gul. So the trials were repeated with full and reduced quantities of the acid. In the beginning trials were made on a small scale using two litres of juice in every case. In every experiment the juice was divided into three or four parts—each of two litres.

One was boiled without any treatment to compare with others with different treatments of acids and to insure the correctness of result. That trial which gave the best result, was then done on a large scale. Other organic acids such as tartaric and acetic were also used. The scheme with the results obtained are as follows:—

(1) Two litres of juice with one-fourth the amount of citric acid that was necessary to neutralise the alkalinity as tested with methyl orange as the indicator:—This gave gul of fine yellow colour with very good taste and grain.

(2) Two litres of juice with one-half the amount of citric acid that was necessary to neutralise the alkalinity as tested with methyl orange as the indicator gave very bright and yellow coloured crystalline gul but rather soft and slightly acid in taste.

(3) Two litres of juice with the full amount of acid citric that was necessary to neutralise the alkalinity tested with methyl orange as the indicator gave very light yellow coloured but sticky gul with very sour taste and no grain.

(4) Two litres of juice boiled with no addition gave solid crystalline gul but rather of a darker colour.

The above results were corroborated by making various trials with the addition of different proportions of citric acid to the juice before boiling.

The net result of the trials, therefore, is that the addition of one-fourth the amount of citric acid required to neutralise the alkalinity as determined by the methyl orange test to the juice before boiling gave light coloured gul with good grain fairly comparable with Poona cane gul.

Trials were also made using tartaric and acetic acid for neutralisation in different proportions. Gul samples of juice mixed with acetic acid were rather soft and sticky with no good taste, and colour.

Gul samples from juice treated with tartaric acid were solid and crystalline. There was seen change in the colour, but it was towards deep red and brown and not towards light and bright yellow, the one which is so much liked.

The alkalinity and acidity of the samples of gul made with various treatments are given below :—

Kind of treatment.	Percentages on gul.				Alkalinity in terms of grammes of sulphuric acid per 100 grams of gul with methyl orange.	Acidity in terms of grammes of caustic potash per 100 grams of gul with phenolphthalein.
	Moisture	Ash.	Non-reducing sugars	Reducing sugars.		
Dark coloured gul prepared on a large scale by ordinary process and put in blocks.	9.30	1.55	78.35	5.50	0.763	0.387
Dark coloured gul prepared on a large scale by ordinary process and put in earthen pots.	9.33	1.80	70.75	4.60	0.477	0.339
Semi-solid gul by ordinary process.	7.35				0.572	0.290
Solid gul with no treatment (on a small scale).	5.60				0.477	0.290
Gul with one-fourth the amount of citric acid required to fully neutralise the juice.	4.95				0.658	0.200
Gul with one-half the amount of citric acid required to fully neutralise the juice.	7.05				0.763	0.677
Gul with whole amount of citric acid required to fully neutralise the juice.	3.95				0.572	0.677
Gul with no treatment ...	5.80				0.477	0.290
Gul with small amount of tartaric acid.	5.75				0.668	0.242
Gul with one-third the amount of tartaric acid	5.80				0.667	0.484
Gul with acetic acid ...	9.85				0.572	0.677

Quantity of citric acid to use on a practical scale.—It has been noted above that one-fourth the amount of acid required to neutralise the alkalinity when added to the juice gave the best quality of gul with reference to colour and crystalline consistency. Hence we take for our purpose that much amount of citric acid to be added on practical basis; calculating on the basis of neutrality of solutions we get very nearly equal to 5.4 grams of citric acid per gallon of juice to neutralise the alkalinity equivalent to one-fourth the amount. This comes to about a lb. of citric acid per 84 gallons of juice. Taking 7 per cent. as the quantity of acid present in the lemon juice it comes to almost 17 lbs. of lemon juice for 100 gallons of date palm juice. The cost of commercial citric acid is Rs. 3.8 per lb., at which rate the cost per 100 gallons of juice works out at Rs. 4.2 per lb. If lemon juice be used, 27 lemons of the average size are required to give one pound of juice; the average rate of lemons during the gul-making season is about Re. 1 per 100; at this rate 17 lbs. of lemon juice required for 100 gallons of juice

would cost Rs. 4-8 or even calculating at Re. 0-4-0 per 100 the cheapest rate throughout the whole year it would not cost less than Rs. 1-2-0. This is undoubtedly prohibitive and other articles must be investigated into. Perhaps sulphuric acid would prove cheaper. The second Memoir* on Date gul by Annett and others appeared in September 1918 after our experiments were done and in that, it is stated that with all the acid substances—sulphuric acid, citric acid, hydrochloric acid, alum, tamarind and lemon juices and the acid liquid left after souring of milk and the removal of the curds in the native fashion—that were tried, they were able to produce light coloured gul with the exception of the hydrochloric acid, that the watery extract of tamarind fruits is the cheapest and that alum is perhaps the most convenient and gives as good results as anything and that the amount of acid substance added to the juice should be such that cold juice rendered neutral to litmus paper with acid becomes just alkaline again on boiling. They do not seem to have carried on extensive trials on a practical scale and by actually making gul—the final product, as our experiments show that with the above standard of addition of acids, solid gul cannot be made though a light coloured sticky and soft product is to be had. They have not also worked out the actual quantities and cost required under which circumstances it is very difficult to say which would be the cheapest substances to use in practice. Nothing can, therefore, be distinctly stated without further investigations.

Conclusions and Recommendations.

Now finally to recapitulate all that has been said in detail so far leads to the following conclusions and recommendations with regard to the prospects and possibility of gul-making from Date palms in the Bombay Presidency with special reference to Thana District where the largest number of date trees are at present found:—

- (1) There is a very large number of Date palms in the maritime area of the Thana District which are producing no return.
- (2) These Date palms yielding a juice rich in sugar are capable of being utilised for sugar or gul manufacture and are very extensively used for the purpose in Bengal.
- (3) Though Date juice is highly liable to fermentation and to being rendered unfit for making gul it is possible to prevent and control fermentation by means within the easy reach of any ordinary man.
- (4) The most suitable season of tapping is November to the end of April.
- (5) Preventing the tapping surface, the pots. or the juice in them while being collected, from the infesting ferments in all possible ways is essential. To get the best results the periods of tapping should not exceed two to three days followed by a rest of three to four days on each occasion; all lather, &c, that will be seen should be thoroughly removed. There is not much difference between the results of Thana System and the Bengal System of making the cut in point of the quality of the juice produced but the Bengal method of a wide shallow tapping admits of the tapping operations being done more efficiently and in a clean manner.

* The Memoir of the Department of Agriculture in India, Vol. V, No. 3 of September 1918.

6. The treatments for preserving and preventing the juice from fermentation are liming, smoking of the pots and the use of formalin; liming is the most effective and also not costly and has the advantage of being noticed in any supervision that may be necessary. Smoking is, however, sufficiently effective for drawing the night juice and under normal conditions of clear and not very warm climate.

7. With the above precautions, the pots can be set from 3 o'clock in the afternoon and lowered in the morning by about 7 o'clock or so without spoiling the juice; there is no particular need to set the pots after sunset or lowering them before sunrise.

8. The boiling process is the ordinary evaporation method of any liquid; the scum should be removed and frothing allayed by a little castor oil; the only precaution to be taken is reducing the fire and heat considerably at the last stage of concentration; the striking is to be done just in the same manner as with cane gul and for unfermented qualities of juice the striking point is secured at 113 to 114° C.

9. Thus it is that good, hard, solid, granular gul can be made from the Date palm juice without much difficulty provided the precautions mentioned above are attended to.

10. The output of juice and gul per tree per season on an average may be taken to be 17 gallons of juice which will make 22 lbs. of gul, for wild growth of trees as they are found in the Thana District; where the trees are irrigated or specially cared for, an increased outturn but of a lower sugar content and a higher proportion of glucose may be expected.

11. At normal rates for cane gul, Date gul can sell at the rate of 16 lbs. per rupee and the gross return per tree would be Rs. 1-6-0; where labour is one's own, the out-of-pocket expenditure supposing that fuel has also to be bought, would be Re. 0-13-6 per tree leaving a net return of Re. 0-8-6 per tree per season for the tapper's labour. Once the product is commonly known and seen there will be no difficulty for its ready disposal.

12. One tapper of Thana at his present efficiency can manage 60 Date trees from which he can expect a net return of Rs. 31-4-0 for his labour of seven months during which he has no pressing farm work to do; if he can acquire the efficiency of the Bengal tapper, and there is no reason why he should not, he ought to be able to manage at least 200 to 240 trees and get a return of Rs. 100 to 120. It will moreover not take him away from his farm as in the other forms of labour such as carting, grass cutting, railway labour, &c., which he at present engages himself in. There is hardly any chance to make this industry pay on a business scale with hired labour unless the efficiency of Bengal tappers is reached and the prices fetched are much better than the above. Thus *this business only suits as a subsidiary cottage industry for the self-labouring farmers.*

13. Gul-making from Date palm cannot afford to pay more than Re. 0-2-0 per tree per season as the rent of trees.

14. The industry cannot afford to bear any tree tax for Excise control. From the experiences of other Provinces like Bengal and Madras, the Excise interests will not suffer if extraction of sweet juice is allowed tax free, under a license in the initial stages of the new industry.

15. As regards the inclinations of the people to adopt this new industry, those who would be wishing to go in for this on a business scale would see from the financial results recorded above that it is not worth their while to take it up. Some enterprising landlords who possess Date palms of their own and have a will to exert themselves and can command the labour from their tapper tenants may be able to make something out of it, providing prices are good. The self-labouring tenant farmers who alone can benefit by this industry, on being questioned, show that they have no clear idea of what it would mean to them; some of the more intelligent said they would take it up had it not been for the fear of the trouble that they anticipated to unnecessarily receive from the subordinate and menial officers of the Excise Department, for their lack of capital for purchasing fuel and other articles and for the difficulty of realising ready cash for the product they will make daily.

The above difficulties are, however, all surmountable, if the Agricultural Department would organise the industry in its first stages of introduction; as an encouragement and inducement it would be well to allow the removal free of charge of the scrub and under-growth from the neighbouring Government forests which would not mean any financial loss to the Forest Department but on the other hand may prove to be beneficial to the growth of the more valuable trees. In Burmah fuel for gul-making from palms is allowed to be removed free of charge from Government forests for a very long time. The effects of this practice on the timber supply was once enquired into about 9 years ago with the result that the practice was continued on the basis of the reports from Mr. W. J. Keith, I. C. S., Settlement Officer, Meiktila, and Mr. A. McKerral, Deputy Director of Agriculture, Burmah, which are published in the Bulletin No. 3 of 1910 of the Burmah Department of Agriculture.

16. It has been mentioned elsewhere that there are about five lakhs of Date trees in the Thana District; allowing one lakh for toddy purposes there are still four lakhs left which could be turned at a very moderate estimate of Re. 1 per tree, into a source of *wealth worth four lakhs annually* by the process of gul-making which has been shown to be perfectly possible by methods described so far in abstract and in detail in a separate part hereforward. It also presents a possible scope for establishing a sugar factory. The cultivation of Date trees is capable of extension in the North Konkan. There are besides other parts in the Bombay Presidency such as Surat District, along the irrigation canals of the Deccan and in the western part of the Dharwar District in which some trees though not to the same extent as the Umbergaon Peta of the Thana District could be found.

Acknowledgments.

It would be ungrateful to conclude this part without acknowledging the valuable assistance which has been rendered to the author by several persons.

The first and foremost is that of Mr. Sorabji B. Patel, a Parsi landlord of Tadgaon, Peta Umbergaon of the Thana District, who not only pointed out the possibility but took it on himself to make experiments on a practical scale with great zeal, intelligence, scientific spirit and persistence in the

earlier part of which he had also to suffer a financial loss. His thorough knowledge of the local method of tapping was of much use. In short his pioneer efforts and ready help to the Department has been greatly responsible in carrying out the experiment to a success as it has been, for which he deserves special thanks not of the author alone but of all who would be benefited by the results obtained.

The Director of Agriculture, Bengal, is to be thanked for the very good facilities he afforded to the author in studying the Date gul industry in Bengal.

Special and a deep debt of gratitude of the author is owed to Mr. E. G. MacLeod of Kotechandpur, District Jessore, Bengal, for his very kind help to the author while at Kotechandpur and more particularly for having induced two expert Bengal tappers to come to Bombay—not at all an easy job.

Dr. H. H. Mann, Agricultural Chemist to the Government of Bombay, and Mr. V. G. Patwardhan of his Laboratory who carried out the chemical investigations and gave advice from time to time have placed the author under deep obligations.

Lastly, the acknowledgments cannot be complete without mentioning the services of Mr. G. B. Pandit, Agricultural Overseer, Thana, who was in immediate charge of my experiments for a whole season.

PART IV.

DESCRIPTION OF THE DETAILED PROCESS OF TAPPING
THE JUICE AND MAKING GUL FROM DATE PALM.*Tapping.*

Tapping of Date palm can be commenced as soon as there is sufficient clean stem above ground to admit of manipulation of the tree; in Bengal it is commenced at the sixth year of the tree by which time there is a clear trunk of about 18" height. In Thana it is commenced at the 10th or 12th year, when the stem reaches a height of 5 to 6 feet as earlier commencement is considered to shorten the life of the plant and also injure the productiveness; no such disadvantage is experienced by the Bengal tappers by their own method and there does not appear any harm if the tapping is commenced earlier.

Unlike other palms from whose flower spathes the juice is extracted, it is from the stem itself nearer the growing region that juice is to be extracted in the case of the Date palm.

In the heavy rainfall tracts like the Konkan and Bengal, the dry season from October to May is the most suitable time of the year for collecting the juice; during the rainy season the juice will get largely diluted by the water from the rains and it will be very difficult if not impossible to walk about in the mud and climb the trees; besides it is probable that in the cold season the plant will be yielding most and purest juice. Thus the annual tapping should be commenced in October-November depending on the ceasing of the monsoon, no tapping being commenced as long as the weather continues to be rainy. In the previous year before the first tapping is to be done the green upper leaves are tied up like a bouquet, the lower yellow coloured ones being cut away.

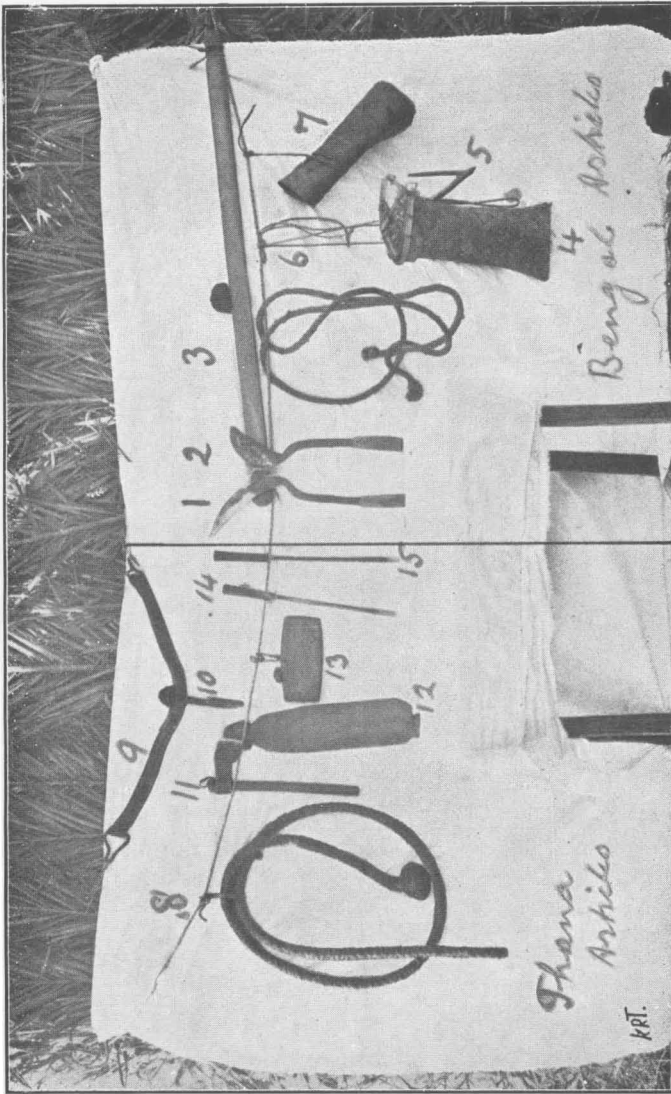
The usual articles and equipment required by a tapper of Date tree consist of:—

(1) A rope called *dora* (No. 3 in Plate II) in Bengal, 9 feet long and 1 to 1½ inch thick and in Thana called *dhaman patta* (No. 8 in Plate II) which is a round thick rope made by winding leather over a rope and having a hole and button arrangement at either ends, by which it can be loosely tied round the operator and the tree for the purposes of climbing the tree rapidly and safely.

(2) In Bengal a plaited palmyra leaf bag (*thungi*) (No. 4), about one foot deep, in which are carried the *daws*, spouts and other articles and to which are attached a wooden hook (No. 5) and two loops (No. 6) of string, the loops going round the waist of the tapper and being tied in front and the hook suspending an earthen pot (see Plate IV, Bengal method). In Thana a leather belt (No. 9) to be fastened round the climbing tapper's waist having a hook (No. 10) attached to the back and a wooden case called *takri* (No. 12) in front. The hook is meant for suspending an earthen pot, and the wooden case for keeping the tapping instrument. (The numbers mentioned above are those of Plate II.)

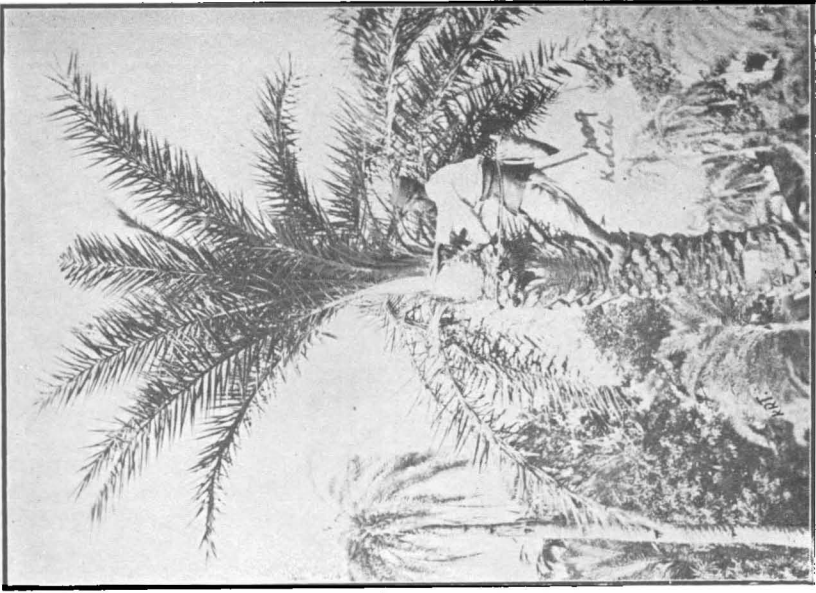
(3) In Bengal a piece of canvas or goatskin (the *kolach*) (No. 7) one foot wide to be tied on the man's back (see *kolach* in Plate III)

PLATE II

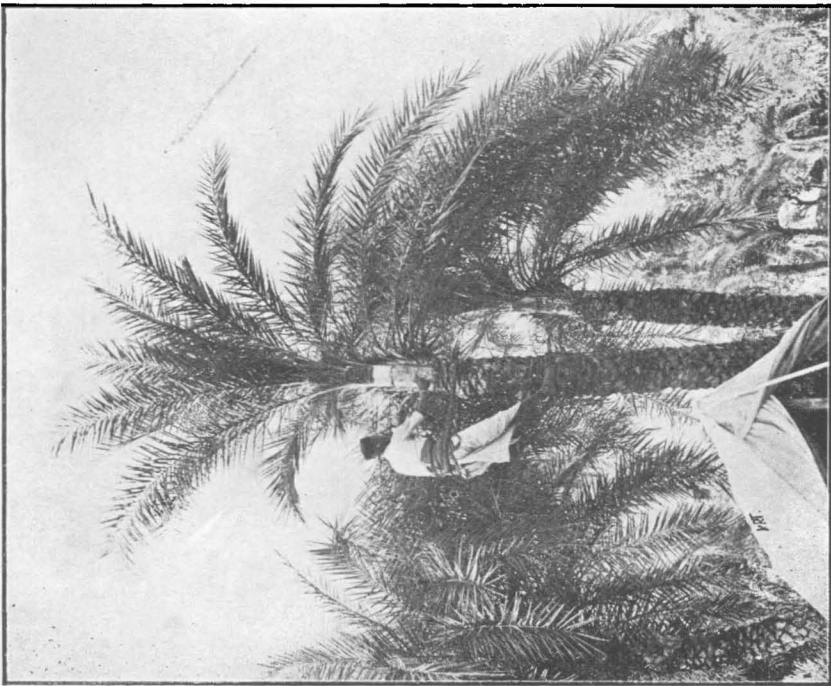


TAPPING ARTICLES.

PLATE III.



FIRST CLEANING, BENGAL METHOD.



FIRST CLEANING, THANA METHOD.

and in Thana a leather piece (*see* leather piece in Plate IV) round his waist to prevent the rubbing action of the climbing rope.

(4) Tapping tools in Bengal consist in three sickle-like tools called *daws* (Nos. 1 and 2 in Plate II) having a cutting blade of 4 inches one of them being a heavier one (No. 2) for cutting coarser parts of the tree and the rest two lighter and sharper ones (No. 1) for doing the fine work of tapping the cuts. In Thana the tapping tool is one long chisel having a wooden handle and the cutting blade $\frac{1}{2}$ inch wide, sharpened on both sides, and is called *vindhān* (Nos. 14 and 15 of Plate II).

(5) A wooden strop on which to rub on a little clay the sharp edge of the tapping tool for the purpose of sharpening.

For the purpose of climbing the trees, the tapper gets ready with all the equipment as described above, and ascends the tree by the aid of the thick rope, which he fastens loosely encircling the tree and his waist before starting to climb. Then by pressing his feet against the trunk and leaning back against the rope, raises the latter with his hand and steps upwards thus quickly reaching the summit, where supporting himself on his foot steps firmly planted against the stem and his body leaning on the thick rope, he has his arms and hands quite free for work.

In Bengal it is noticeable that trees are almost always tapped only on the east and west side. The first tapping generally takes place on the east side. If cuts on the northern or southern side are taken it is supposed that the surface to be exposed for tapping would not dry as rapidly and putrefaction may take place. In the month of October or November, then as the case may be, all the old leaves of the tree on the half side opposite to the other half surface which was tapped the previous year (this is in the case of trees which have been tapped before on previous occasions) and those higher up for a height of about 18 inches and almost extending upwards to the central growing shoot of the tree are removed with heavy *daws* in Bengal and with hatchets in Thana, the former being speedier than the latter. The leaves on the opposite side of this cleaning are not to be removed. The bases of the petioles and sheaths of the cut leaves are then carefully removed. Then with the lighter *daws* in Bengal and a chisel shaped tool in Thana the outer zone of the loose soft tissue is pared off in long slices leaving only a thin covering of it over the sap supplying inner zone which corresponds to the woody zone in the older wood of all the palms (*see* Plate III). Very great care must be taken not to expose this inner tissue at this stage, otherwise the tree is sure to rot and dry.

After this first operation, the trees are given about 8 days rest, by which time the fine covering of soft tissue gets a little hardened and begins to crack. The second operation consists in the Bengal method in removing this covering, great care being taken not to cut into the inner zone, which is now for the first time simply exposed. Then comes a period of rest of 12 to 14 days. Within about a week of this period in the Bengal method the position for fixing the bamboo spout (*see* Plate V) for collecting the juice and a wooden pin (*see* Plate V) for hanging the collecting pot just near the base of the spout are marked out; this is about one foot below the topmost edge of the cleaned and exposed surface or 6 to 7 inches higher up from the top edge of the last year's tapped surface, and on the midline of the exposed surface to be tapped. At the end of this rest, at about midway of the exposed surface are cut by the light *daws* two eye-shaped notches each about 4" long, 2" high and $\frac{1}{4}$ " deep at the base, their lower sides being straight and converging to a point as shown in the illustration (*see* Plate V).

From the converging point a narrow and shallow furrow is cut out below to a length of about 2' to lead the juice to the bamboo spout already fixed.

In the Thana Method this notch for tapping is cut out at the root of the growing shoot soon after the surface is first prepared. It is cut out by the chisel-shaped tool called *vindhān* in the form of a quadrangle, about two to three inches horizontally at the top and extending over a length of about five to six inches below; it is $\frac{1}{4}$ " deep at the top and sloping towards the outside to the surface below (see Plate V). For the next 8 or 10 days the cut notch is left to harden; what little sap exudes from it is allowed to run to waste. After 8 or 10 days the hardened part is scraped a little when it is observed that the juice is running freely.

Collection of the night or the most important juice for gul-making.—In the Bengal Method the first cutting of the notch for collecting juice is done after midday and at about 3 or 4 o'clock in the afternoon an earthenware pot is suspended under the spout over the wooden pin driven into the tree near the spout (see Plate V), and the juice which trickles down is collected. By the Thana method also the pots should be similarly set in the afternoon; however according to the local practice there is no wooden pin fixed for suspending the pots which have therefore to be tied round the tree (see Plate V); similarly instead of the bamboo spout to collect the juice from the notch in the Bengal Method the Thana tapper makes a slit crosswise at the bottom of the cut in which are inserted two pieces of Date leaves for the purpose of leading the juice into the pot (see Plate IV).

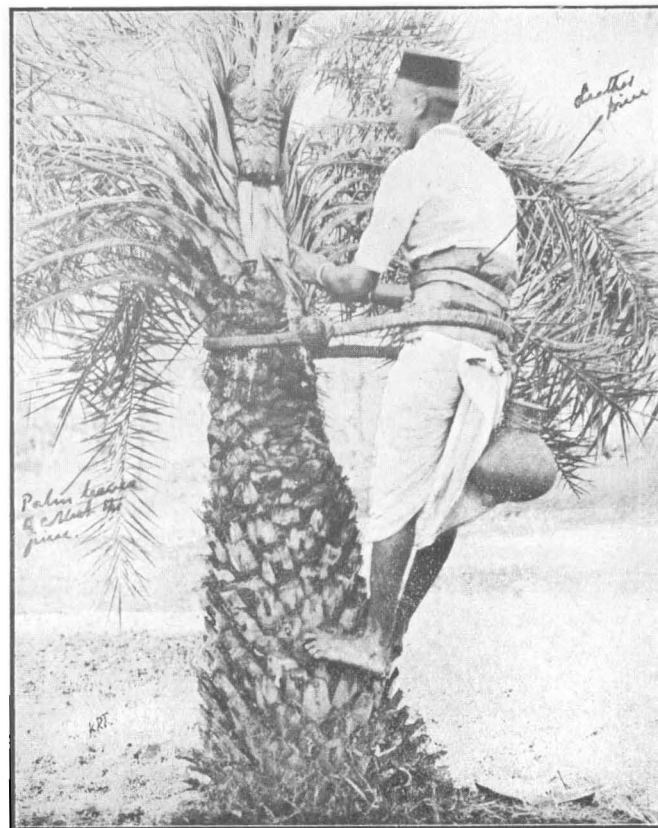
The pots are removed early next morning at 6 or 7 a.m. before the sun gets on them and the juice is kept for boiling as soon as possible.

According to the Bengal System on the following night juice is again collected generally without renewing the cut though the surface is as a rule cleaned with the hard stem of the palm leaf in which operation the lather formed by the ferments is also removed. A smaller quantity is generally obtained than on the first night. On the third evening also more juice is as a rule collected but is only small in amount and of very poor quality. Each night's juice has a distinctive name given to it. That of the first night is called *jīran* (rest), of the second night *dokat* (second cut) and of the third night *tekat* (third cut), on the fourth and fifth nights the tree is given rest and no juice is collected. In addition to resting the trees this period of rest dries and probably kills off the ferments.

In the Bombay Method of tapping for fermented toddy, the cut is renewed every day by scraping out thin slices with the chisel tool, *vindhān* which is worked from below upwards (see Plate IV). The Surat tapper thus collects the juice for about five days and then rests them for a week or so, while the Thana tapper collects the juice continuously for about one or even two months and then leaves the tree to rest for about a fortnight, no steps being taken or necessary for fermented toddy to clean the cut of the lather. But none of these methods would work for gul-making. For gul-making the juice should be collected for only two successive nights and rested for three or four days following before renewing the cut again. As the Thana renewing of the cut with the chisel is fine and thin, it may be necessary to renew the cut with the chisel even for the second night of collection. In Mr. Sorabji's experiments according to this method the second night's collections were generally more than the first after a rest. It is absolutely essential to dress the cut as clean of lather as possible.



FIRST TAPPING NOTCH, BENGAL METHOD.



FIRST TAPPING NOTCH, THANA METHOD.

In the Bengal Method, one notch is re-dressed about three to four times scraping off $\frac{1}{4}$ " more or less of thickness according to the flow of juice is less or more, respectively. After the first notch is thus spent up another eye notch is cut out about $\frac{3}{4}$ " higher up but again having its tops in the shape of the two eye-brows and its bottom forming straight converging edges as in the first notch and forming a step about $\frac{3}{4}$ " higher up the first; as this second notch or step is cut out not on the outermost surface of the tree as in the first notch, but on the already cut out sloping surface of the first notch, the outermost and the innermost edges of the second step are naturally on a deeper level of the tree by about $\frac{1}{8}$ " than those of the first step respectively. The appearance of this second step with respect to the first is shown in the illustration (see Plate V). This process of cutting out new and new steps higher and higher up goes on till the end of March by which time the tapping season in Bengal ceases, thus giving in all 8 to 10 notch steps over a height of 8' to 9' and the deepest portion being at the bottom of the highest step about $1\frac{1}{2}$ " from the original surface of tree. The appearance of the tapped surface at the end of the season will thus be seen as shown in the illustration in Plate VI. The entire exposed surface of the stem gets hardened and is to be slightly scraped every fortnight or so, by which operation the secretion of juice is stimulated.

It is not however to be supposed that the plan of tapping described above is carried out in such a regular manner in all cases. Sometimes the trees are cut for two or three days in succession, if they are found not to yield a good flow.

As a rule there is not *dokat* or *tekat* juice in November. In December *dokat* as well as *jiran* is obtained and from January *tekat* is also to be had in addition. Towards the end of January and thence till the end of the season the trees are slightly cut for *dokat* juice as well as for *jiran*, that is, they are cut on two successive evenings.

The Day Collections.—A fair amount of juice drops from the cut surface during the day. This is called "Ola". It is very poor in quality and produces only molasses. It is only collected on the *jiran* day, the molasses obtained being usually put at the bottom of the pot in which good gul from the morning collection is stored. In a recent publication Annett and others have proved that by liming the pots, even this day juice can be turned into as good gul as that from the night juice, by which the output of gul from the Date palm can be increased by about 20 per cent.

In the Thana System of making the cut after the juice begins to ooze out in the manner described above, there are no variations or stages in the process except that the cut is to be thinly chiselled off on each occasion going lower and deeper till the end of the season.

Thus in the Bengal Method, tapping occupies a larger area (see Plate VI) goes on from below upwards or follows the direction of the growth of the plant and is restricted to its surface while in the Thana Method the cut is narrow but deep (see Plate VI) proceeds from above downwards or in the opposite direction of the growth of the plant and taps juice from its interior. How much this difference affects the quality or quantity of juice or the health and longevity of the tree is yet an undetermined point. But it must be admitted that the Bengal Method admits of the use of a wider sweep (4") tools which help the tapping operations to be done quicker and in a more clean manner than the Thana Method of the narrow and deep cut with corners to be chiselled out by a tool having only $\frac{1}{2}$ " width.

In Bengal the first two or three weeks supply is very valuable, for the gul produced from it has a very pleasant smell and is most appreciated by the customers. The yield of sap is greatest in mid-winter. The sap collected on calm and cloudless nights gives gul of the best quality. Cloudy and foggy nights affect both the quality and quantity of the juice adversely. It is said that in January when the trees are in full inflorescence the sap becomes very poor in sugar though profuse in quality and as a rule does not produce good crystals.

Frequency at which Date trees can be tapped.—In Bengal trees are tapped continuously year after year, each year's tapping surface being on opposite sides and higher up above the previous year's.

In Bombay it is considered that Date trees must be rested at least in alternate years; this may perhaps be necessitated by the deep cut they make in Bombay. It should be possible and advantageous to tap the trees every year in Thana by adopting the less drastic methods of the Bengal operation.

In Bengal trees are seen tapped continuously for almost fifty years as can be told by counting the number of cuts on the trees. The average sap yielding life of a tree however is probably not much more than 25 years.

Tools for tapping.—The tools used for tapping in both the systems have already been referred to. The one used in Bengal is called *daw* and resembles a sickle with a suitable shape of the cutting edge; this is of two kinds one rather heavy for cutting coarser and harder tissues such as leaves, leaf bases and the other a lighter and shorter one for chipping softer tissues of the cut finely and accurately. The Thana tool resembles a chisel having a blade half an inch wide, the heavy cutting of leaves and leaf bases being done by a hatchet. Both these are shown in the illustration at Nos. 1, 2 and 14 on Plate II. The Bengal tool is more efficient than the Thana one but requires the Bengal System of wide and shallow cutting for its operation; it cannot suit the Thana Method. Whatever tool is used it requires much attention. They are to be daily sharpened on a piece of dry wood sprinkled over with fine sand while the tools are new but with dry potter's clay afterwards. They may even require tempering once or twice in a season. The tip in the Bengal *daw* has to be specially looked to; if too sharp and pointed it cuts into the trees and injures them and if too blunt, it tears the tissues whereas a clean cut must be obtained.

Preservative Treatments.

For the purpose of making good gul from the Date juice it is imperative to draw absolutely unfermented juice. Short periods of collecting juice followed by rest as described above brings this about to a certain extent; but this is not enough and some sort of sterilizing of the pots and preserving and preventing the juice in the pots from fermentation while being collected is equally essential.

Washing and smoking of the pots.—In Bengal daily washing and smoking of the pots is resorted to which has been found to be fairly effective amongst the various preservatives tested. The night juice collected in smoked pots is quite clear and unfermented on all occasions except on cloudy and warm nights. The smoking of the pots is done in the following manner:—The pots which are used for collecting juice are washed with water after emptying the juice and then smoked. A line of some kind of

PLATE VII.

A

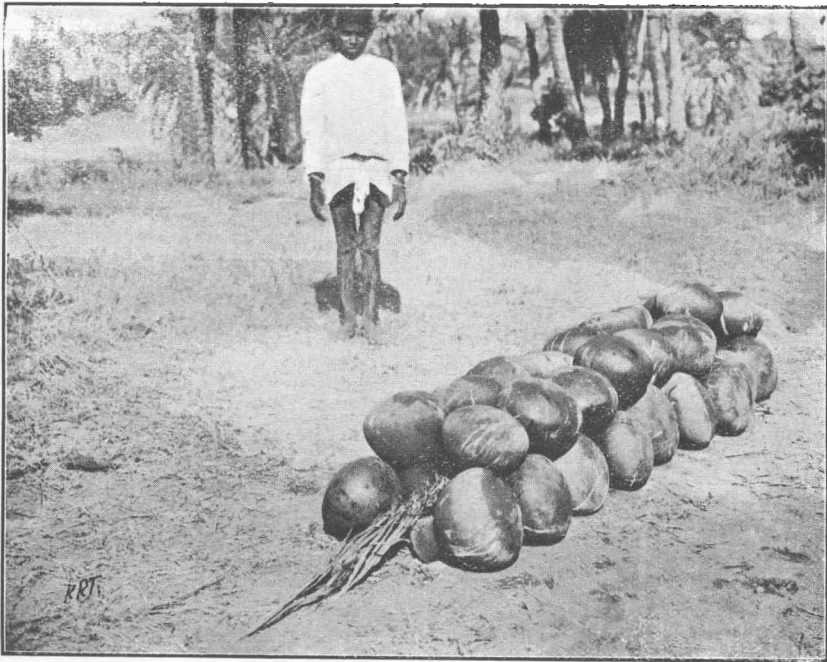


BENGAL METHOD.

THANA METHOD.

Carrying juice from the trees to the boiling place.

B



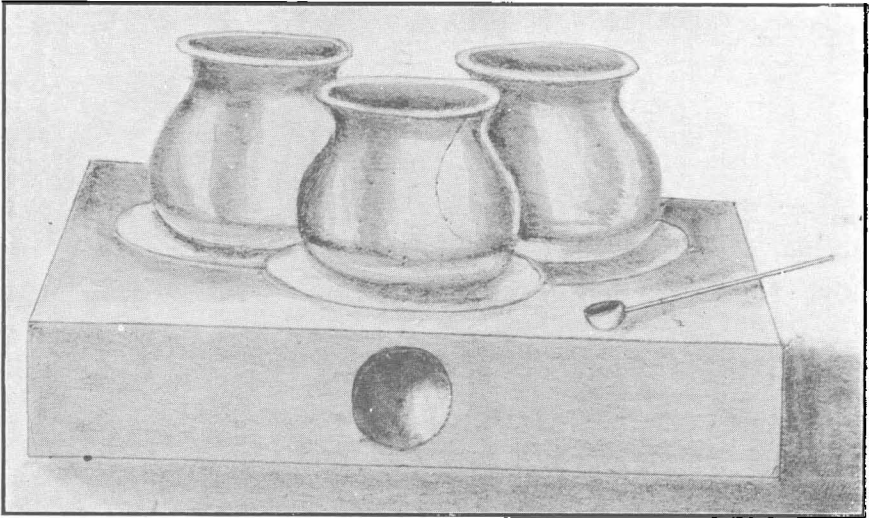
SMOKING THE POTS, BENGAL METHOD.

PLATE VIII A

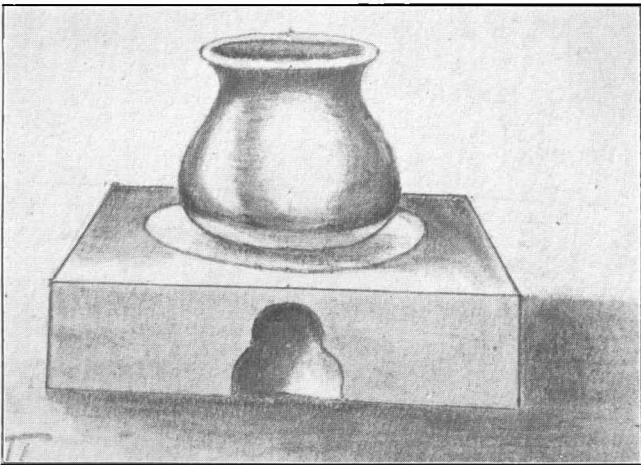


BENGAL FURNACE AND PANS FOR BOILING JUICE OF THE DATE PALM.

PLATE VIII B



COIMBATORE OVEN.



OVEN II.

rubbish such as dry palm leaves, paddy straw or stubble, *udid* bhusa or any other kind of light thin inflammable material is made on the two sides of which two lines of pots are arranged mouth to mouth, two lines being also arranged mouth downwards in the inter-spaces formed by the concavity at the necks of two adjoining pots. The whole arrangement is shown in Plate VII. When everything is ready, the rubbish is set fire to at one end from which it goes on smother-burning giving off lots of smoke which enters inside the mouths of the pots. The treatment is over in a few minutes.

Liming the Pots.—In Madras for gul-making from Palmyra palm juice, this is the practice resorted to with undoubted success. The Bombay Excise Department has enforced liming as one of the conditions of the license to be issued for the extraction of sweet juice for gul-making; good gul was accordingly made in the experiment which were carried on in Thana. In a memoir (Chemical Series, Vol V, No 3) of the Department of Agriculture in India, the authors have proved by experiments that liming of the pots has got a remarkable quality of keeping the juice from fermentation so much so that the collection of the day juice in an unfermented condition and keeping it so over night to be boiled next morning with the night juice has been possible.

Liming of the pots is done as follows:—Quick lime and water are to be mixed to make a thick cream; this cream is to be smeared round in the inside of the pots on each day before setting them on to the trees for collecting juice; if a little cream is put into the bottom of the pots and shaken it will smear round of itself but it is essential to have the liming done fresh so as to be yet wet when the juice begins to drop in the pot.

Formalin.—3 c. c. or about one tea spoonful of 10 per cent. formalin put in the pot to be used for collecting juice has also been found by the author to be very effective for keeping both night and day juices from fermentation so as to make the required quality of gul. But this at the retail rate of Rs. 1 8-0 per lb. of 40 per cent formalin works out at 6 annas for one tree for the whole season which is much costlier than smoking or liming.

Taken all other precautions, smoking is by far the simplest and cheapest at all times except warm and cloudy nights for the night collections, which are the most important. On the later occasions and when the day juice is desired to be collected liming may be done in addition.

Boiling.

When sweet unfermented juice is thus drawn, it is then to be boiled into gul. For a small cottage industry scale where the daily output is small, small ovens of the type used in Madras or in Bengal with earthenware boiling pans may be most suitable to use. In Bengal the furnace is made out of earth partly under ground and partly above ground; the earthenware pans are shallow and wide with 18" diameter and having a capacity of about 10 gallons (*see* Plate VIII A); the Madras furnace is constructed above ground and the pans are deeper (*see* Plate VIII B opposite page 46 in Appendix I). The ovens might be single or compound according to the output of juice; but if an iron pan of a sufficient size is to be used instead of several earthenware pans a single oven of suitable size would do. One important improvement to be suggested in any type and size of oven that would be used is that it should be provided with an underground air draft and an ash pit as in the Poona furnace (as shown in the illustration on Plate IX) so

that the combustion will be complete and fuel may be economized. For larger daily outputs of juice of 50 gallons and over it would be best to use suitable sizes of iron pans and the furnace of Poona type.

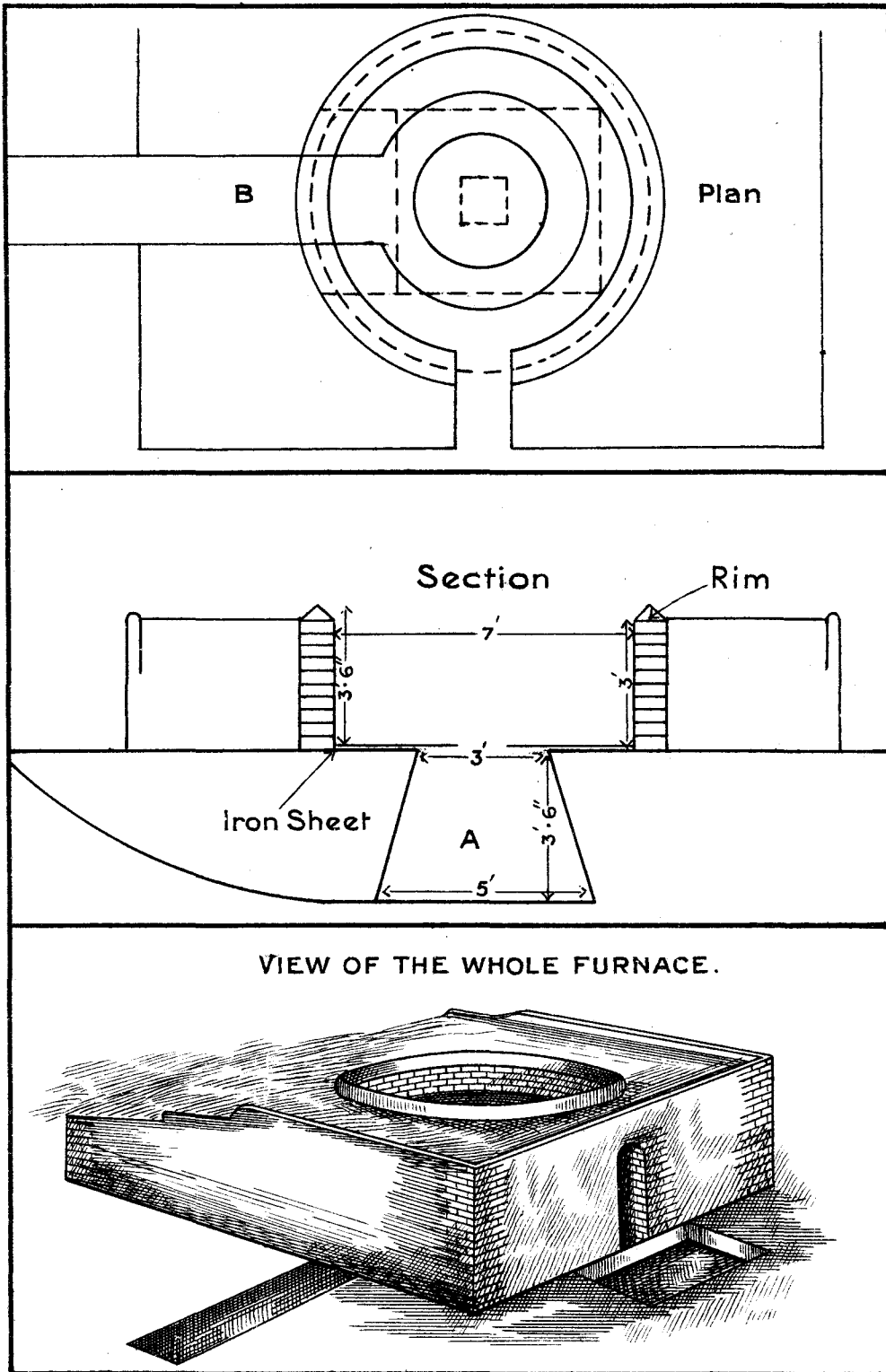
The juice should be poured into the boiling pans through some kind of strainer so that any dirt, ants, &c., may be removed. The boiling should be commenced as soon as possible, as otherwise the juice will begin to ferment and will not make good gul.

The preliminary stages of boiling have no speciality, the process consisting of simply evaporating the water from the juice as rapidly as possible. After the juice is sufficiently heated scum begins to form which should be removed with a ladle having small holes like a sieve in it to drain off the juice from the scum collected; in Madras the bowl of the ladle is made of a cocoanut shell. The amount of scum in the Date juice is however much less than that in the cane juice. Frothing is allayed in Bengal by stirring or by dried Date leaves partially inserted in the boiling liquid; in Madras when heaving up commences a few crushed castor beans are put in the boiling mass and the whole thing well stirred up. In Bengal the different stages of concentration are known by the kind of bubbles which are styled as *makarsha* (spider), *sarsifuli* (mustard flower), *baghai* (tiger) and *guria* (treacle) bubbles, the last indicating that boiling is complete. At the last stage of boiling, the fire in the oven should be considerably reduced and the boiling completed on a slow and well regulated fire accompanied by constant stirring of the juice; otherwise the concentrated mass will get rapidly charred. In Madras in some places, after two-thirds the quantity is evaporated the final boiling is done under special care by mixing the concentrates from the several pans together. The point of the completion of boiling is judged by the eye-sight in Bengal; they take some of the mass of the boiling liquid in the bowl of the ladle and if immediately on taking it out from the boiling liquid there is no settling down of the quantity in the bowl indicating probably the result of the bursting of the bubbles of the steam, the pan is taken off the fire. In Madras a little quantity of boiling syrup is taken off with wet fingers and worked up into a pill under cold water and if the pill hardens quickly, boiling may be said to have been complete. The temperature of the boiling syrup at this point is generally 113° to 114°C. On a large scale pan and furnace all the remedies for allaying frothing, reducing and regulating the fire at the last stages of boiling and striking the pan are to be the same as on the small scale described above.

In Bengal, in order to promote and hasten crystallization a starter called *beej* which is specially prepared and finely pulverised gul is added to the contents of the pan within about ten minutes while they are cooling after being removed from fire, and the whole mass is well stirred, and transferred to the earthenware pots for final solidifying in which it remains stored and is sold. In the Bombay experiments solid blocks as those of cane gul could be made.

The process of making *beej* is as follows:—As the boiling of the liquid approaches completion (the temperature at this stage was found by the author to be 109°C, while the temperature at complete boiling is 113°) a small portion is left in one of the pans (the remaining contents of the pan being poured in other pans) and rapidly boiled on a brisk fire, stirring the liquid vigorously all the while. When the liquid has reached a certain consistency (at this stage the author found the temperature to be 117°C) the pan is removed from the fire. The attendant then rubs a portion of this

POONA FURNACE



Litho. Govt. Photodupl. Office, Poona, 1919.

Scale $\frac{1}{4}$ "-1'

OFFICE OF DY. DIRECTOR.

concentrate on the side of the same pan with a piece of the palm frond vigorously but lightly up and down in the form of a streak. The streak of liquid gets more and more sticky in the beginning but finally breaks up into fine white sugary crystals. These fine crystals are mixed with the rest of the mass which is also vigorously stirred until it is rendered into friable crystalline stuff.

In Bengal a hard cake-like preparation called *patali* is made from **Date** gul. For this purpose the syrup has to be treated in the same manner as for *beej* making. In fact any excess quantity of the liquid which may not be required for *beej* making is poured out when still hot on to a flat basket, whose surface has been wetted with water to prevent the solidifying mass from sticking. This very soon solidifies into a hard cake-like mass and receives the name of *patali*.

PART V.

GUL-MAKING FROM BRAB OR FAN PALM IN THE
BOMBAY PRESIDENCY.

It has been said in Part I that the Brab or Fan palm is almost confined to the districts of Thana and Kolaba in the Bombay Presidency, but in those two districts there is a very large number of not less than 10 lakhs or so scattered almost all over the districts, being however more crowded in thick groves in the maritime talukas of Dahanu, Bassein, Salsette of the Thana District and Uran Peta of the Kolaba District. Excepting a very small portion of a few thousands used for fermented toddy all the rest are turned to no advantage, and afford a scope for investigating the gul-making possibilities.

In the Madras Presidency, gul-making from this palm is carried on, on an extensive scale, as a cottage industry subsidiary to farming and has a very old standing. The methods of tapping the juice and making gul followed there have been studied by Mr. P. C. Patil in a visit to that Province in the year 1915, his description of which along with the few tests he took in Konkan appears in the Appendix I.

In order to investigate its actual economics under Bombay conditions, it is necessary, however, to carry out comprehensive experiments as done in the case of Date palm extending over one full season at least in the palm growing tract of the Bombay Presidency itself. It has not yet been possible to do this for want of staff, but will be taken as soon as the same is available.

APPENDICES.

APPENDIX I.

NOTES ON GUL-MAKING FROM BRAB, COCOANUT AND BHERLI (*caryota urens*)
 PALMS BY MR. P. C. PATIL WHEN OFFICIATING AS EXTRA DEPUTY
 DIRECTOR OF AGRICULTURE, KONKAN.

*Brab or Palmyra Gul.**Palmyra Gul Industry in Madras.*

It is mostly in the hands of professional tappers—Shanars, Ezavas and Thandars—who are at the same time peasant cultivators and small farmers. In some cases palms belong to these men but in the majority of cases these people hire Palmyra trees from the land-lords. The tappers have to get a license from the Excise Department but it is simply formal. The application is made on one anna stamp and license is issued free of charge (for using the sweet toddy as beverage and for making jaggery). Government does not make out anything from the trees. They only get the assessment of the land and since such trees grow on poor soils as well a regular payment of assessment is a significant matter.

2. Towards Palghat owners of Palmyra trees get about two annas annually for every tree. (1) In one case the contract was two annas a tree. (2) In another case a man was paying Rs. 8 for 150 trees. The land and the trees were poor. Towards Tinnevely some of the owners claim about half the quantity of jaggery obtained from their trees.

3. The tapping season extends from February to May (about 90 days) There are male and female Palmyra trees. Both of these yield saccharine juice. The methods of tapping male and female trees differ. In the case of male trees the flowering shoots which look like finger growths given out by the principal stalk at the top of the tree, are to be worked out. These fingerlike shoots are bruised by rubbing between two wooden sticks (looking something like a pair of compasses). After a couple of days these are scraped with a tapping knife and their tips pared off daily. Within a week from the first operation juice begins to drop. They bring several fingers together and bend in one pot. (Bombay Method is different.)

4. The spathes of female trees have also to be worked while the nuts are very small. Only the tip ends are squeezed and beaten. The ends are pared off as in the case of male trees. As the paring approaches the thicker part of the shoot, the shoot has to be beaten all round between the nuts with the thick edge of the paring knife and the fruit near the tip removed. I have seen number of large nuts on spathes yielding juice.

5. Towards Palghat and Coimbatore, tappers climb twice a day, in the morning between 6 and 8 a.m. and in the afternoon at 5 p.m. Towards Tinnevely some climb twice and some thrice a day (especially at the close of the season).

6. In the morning the tapper gets on with a spare pot (for bringing the sweet toddy down) besides a lime pot and a brush. After he empties the juice in the spare pot, he dresses the cut by paring off a slice, limes the pot and replaces it. In the evening juice is not lowered. The cut, however, is dressed and the pot is given a shake.

7. A good tapper can look after about 20 to 25 trees working from 6 to 10 and again 5 to 7. Tapping season lasts from February to May. From the beginning of May field work compels them to give up jaggery-making. It may be remembered that from February to April end, these people have not got much work in the field and tapping Palmyra trees and making jaggery gives them remunerative employment.

Jaggery making from sweet toddy in Madras.—After once the sweet toddy is lowered (either from Palmyra or from Coconut palm) it is dealt with the same way of making jaggery. There are some local differences in the construction of the ovens on which the juice is boiled but no difference in the ovens and boiling pots is made for Coconut and Palmyra juices.

Ovens.—There are two principal types of ovens specially constructed for jaggery-making though sometimes jaggery is made in the kitchen on the ordinary *chul*. Generally jaggery ovens are built outside the cottage either in a *kacha* shed or under the shade of a tree near the cottage.

It will be seen from the sketch Plate VIII B that the oven is built in a rectangular mound 3' x 3' raised about 1½' above the ground level. There is no ash pit nor exit for smoke provided. The smoke escapes by the sides of the pots. It is a compound oven with three mouths but fed only through one common feeding hole. After a time when the juice thickens the contents are transferred to only one pot where it is finally made into jaggery.

Oven II.—At and round about Palghat single ovens are in common use. As at Coimbatore these are built in a raised mound either in a shed or under a tree. Besides feeding hole the ovens are provided with exits for smoke to escape

Here generally the boiling is not completed in one stretch. As they get juice it is boiled to a certain consistency and stored till sufficient quantity is collected when it is boiled down to jaggery.

Fuel.—Palmyra leaves and dry leaves of shed trees and waste grass is used as fuel. I do not expect that they worry about fuel. Boiling juice is a daily routine like cooking and moreover it admits of any kind of fuel, leaves, grass, waste fodder, branches, twigs, &c. The fuel has to be fed continuously in small quantities.

Utensils.—For making jaggery they use wide mouthed earthen pot (see the picture of oven attached). For removing scum the kitchen "*pali*" is used. For stirring the juice a ladle is made by putting a handle to a Coconut shell. When jaggery is nearly ready, it is stirred and rubbed with a thick end of the frond of Palmyra and when it begins to set, it is transferred to a number of moulds or empty Coconut shells.

Boiling the juice to jaggery.—I have already under the heading of ovens stated that in some parts the operation of boiling is finished in one stretch while in other places they evaporate two-thirds of the quantity and collect the comparatively thicker saccharine solution till it accumulates into a fairly large quantity and then boiled to jaggery. This finishing boiling is important and is attended to carefully. Almost everywhere in the Madras Presidency, jaggery-making is entrusted to women. The male members deliver the juice at home to their females and are then free for their field work. If there be no female in the family, the male folks will engage a woman on wages at least for the second or final boiling.

When the juice is received ants and dirt are removed by the hand and the juice slowly transferred to boiling pot. The residue, generally lime, left at the bottom is not generally taken in. After about 15 to 20 minutes, whitish scum rises to the surface which is removed and when it begins to heave up, few castor beans are crushed and put in. Oil has got remarkable effect in allaying frothing. After putting crushed castor beans the juice is well stirred. It then does not require much attention except attending the fire and occasionally removing the scum that comes up. It takes about two hours to finish boiling. As it approaches completion the fire in the oven is lowered and the contents of the pot stirred. The woman then wets her fingers in cold water and takes off a little of the syrup from the stirring frond by her thumb and feels it in cold water. If it is ready it hardens quickly. The feel is the same for cane gul and I could without difficulty strike several boilings.

When jaggery was ready, the pot was taken off the oven and kept on hot cinders and ashes. The attending woman then rubs a part of the inside of the boiling pot with the stirring frond till jaggery begins to set hard. Meanwhile the mould planks or coconut shell are washed with cold water. Before the moulds get dried the jaggery has to be transferred to these moulds. It sets there soon and in about 15 to 20 minutes perfect moulds are taken out. The moulds leave a little treacle or molasses in the holes of the plank. The percentage of jaggery to sweet toddy varies from 13 to 18. In a test at Tinnevely I got 14.5 palms of jaggery from 84 palms of sweet toddy thus giving about 17 per cent. jaggery (it is perhaps exceptionally good juice). It almost tallies with Brix reading.

One man generally attends about 25 trees and gets time to look after the field work (he generally has got few rice fields) and his wife turns the juice into jaggery and sells it. Supposing he hired 32 trees to be sure of getting juice from 25 trees throughout the season, he has to pay Rs. 4 (at annas 2 per tree). Trees yield from $\frac{1}{2}$ to 2 gallons and some fail earlier. It is therefore difficult to get average. Mr. S. Ramalingam Pillai gives 54 gallons per tree per season. Madras Bulletin No. 25 gives 48 gallons (it gives 6 maunds which means about 48 gallons).

Taking therefore 40 gallons as the average yield per tree, the man who taps 25 trees a day gets 1,000 gallons or 10,000 lbs. of sweet toddy and this at 16 per cent. yields 1,600 lbs. of jaggery. Taking the rate (at the Parry's shop) at 25 lbs. this quantity fetches about Rs. 64 for his labour. As said above he has to pay Rs. 4 to 5 to the owner of the trees. He any how makes Rs. 60.

Scope for Palmyra Industry in the Thanai District.

In the beginning of the report I have given the rough distribution of this palm and have given rough idea of the prospective business. Here I will limit myself to the yields of toddy per tree and the percentage of gul in the juice and will try to show what a family working about 25 trees can expect to make.

It is difficult to get fair average of toddy per tree in the absence of extensive trials. The soil in which the trees grow have considerable effect on the yield. The yield varies in the different seasons of the year. The sex of the tree has influence on the yield. Female trees yield more. There are two seasons in the Thanai District, Shalu (September to December) and Bharkala (February to May end), the latter being more important. In

November 1913 tests were taken by the Abkari Department and as a result they got 968 gallons of toddy from 41 trees in 31 days. The gul-making season may be reckoned from December to May (about 120 days). In Madras they get about 90 days only. (It may be remembered that they get two rainy seasons.) From the data supplied by these tests the average per tree in a season comes to 91 gallons. While conducting experiments at Bassein I took some tests and my average comes to only 53 gallons per tree per season. Excise Manual gives 90 to 111 gallons. This yield being taken for both the seasons of the year cannot be accepted for gul season. In Bengal according to the Excise Manual the yield is 43 gallons for male and 57 gallons for female trees. I, therefore, will take 50 gallons as the average yield per tree for gul-making season.

Percentage of gul.—Composite samples of fresh juice as well as samples from individual trees were tested. The reading of average (fresh) sample can be taken as 12 Brix. Gul was made several times (it is comparatively easy to make gul from Palmyra juice and we found no difficulty). The average of several trials comes to 10. The juice seems to be poorer than in Madras. Brix readings indicate the same thing. From each tree therefore about 50 lbs. of gul can be got which at 25 lbs. will fetch Rs. 2 per tree or Rs. 50 for 25 trees. If a man gets trees at 3 annas he will have to pay Rs. 4-11-0. He will thus get Rs. 45 from his subsidiary industry of making gul from Palmyra Juice.

Possibilities of Making Gul from Cocoanut Toddy in Konkan and North Kanara.

In the Konkan and North Kanara together there are about 20,729 acres of land under Cocoanut growing about 1,450,000 trees; about 25,000 of those are tapped either for toddy or for distilling arrack. In Thana, Kolaba and large part of Ratnagiri where they give regular waterings, the average yield of nuts per tree is about 60 (or when tapped, about 80 gallons of fermented toddy). In the North Kanara where cocoanut trees are not irrigated the yield of toddy is about the same but the average number of nuts is much low being 25.

The averages of toddy per tree for shops and for gul-making will necessarily be different. For shops and booths, toddy is drawn for about 120 to 150 days. Only molasses can be made in the monsoon, but it will not pay for rice farmers to make molasses. We may therefore take 50 gallons as the average per tree.

The percentage of sugar varies in different samples (the reading of Brix varies from 12 to 20. I could record 15.50, 16.40, 17.00, 15.18, 14.43, 15.93, 14.63). Taking 16 per cent as the available gul, a family working 20 trees will get 1,000 gallons (or 10,000 lbs.) juice or 1,600 lbs. gul which at 20 lbs. (it is sold at 17 lbs. in the South Kanara and Coimbatore) will fetch Rs. 80. Supposing he pays Rs. 25 for the 20 trees to the owner he makes Rs. 55 from his secondary industry.

There are a large number of professional tappers in Kanara and this industry will suit them best. In the adjoining District (South Kanara) they enjoy this privilege and the people in the North Kanara are very keen on this industry.

Cocoanut gul industry seems to suit Kanara alone. In the Konkan where the yield of nuts is better it is not profitable to go in for gulmaking.

In the several Districts of Madras, gul is made from cocoanut sweet toddy. In my tour I could see this industry at and near Coimbatore. The industry is pursued by tapper class who side by side cultivate some lands as well. They pay about a rupee to the land-lord (Mr. Vellingiri of Vellaikner gets Rs. 480 a year for 400 trees. Mr. Raju of Coimbatore gets Rs. 25 besides 175 cocoanuts for his 39 trees). As a rule trees are tapped for two years and then allowed to bear nuts for two years alternately. In my trials at Coimbatore I got 16.4 and 17.8 gul and gul could be sold at 16 lbs. a rupee. The process of making gul is exactly the same as described under Palmyra gul in Madras.

Jaggery-making from Kitul (Bherli Mad, Caryota urens) in Ceylon.

In Ceylon these trees are numerous. It is said they might occupy over 3,000 acres. They are tapped both for toddy and for making jaggery and sweets. Large quantity of this jaggery is consumed in Ceylon and some exported out of the island.

Toddy.—The spathe has to be worked before it bursts and thin slices trimmed morning and evening. For toddy they use the same chatties without adding anything or smoking those.

Jaggery-making.—The process for trimming is the same as for toddy. They however put some bark of "Ball" (*Veteria accuminata*) leaves of Aukenda (*Acronychia laurifolia*) to prevent fermentation. The average quantity of juice from a tree per day is one gallon. The percentage of solids (or for rough purposes jaggery) is about 11 per cent. Tapping season of Kitul lasts for eight months. They therefore make about 260 lbs. of jaggery from each tree. The percentage of gul in Kitul juice in Bombay is about the same as in Ceylon (Brix reading being 14).

The process of making gul is easy. They simply boil the fresh juice till a syrup of right consistency is got when the boiling pot is taken off the fire. When jaggery becomes sufficiently cool it is put in shells to make small moulds.

We have not got much scope for Kitul-gul. We have got a few thousand trees in Nagothna Petha, Alibag and Roha Talukas. These are tapped for toddy. It is however worth-while trying the vegetable preservatives in making gul from Palmyra and Date. I have written to the Forest and Botanical Departments about it and if these be available in our Presidency, I will try these sometime.

APPENDIX II.

OBSERVATIONS BY MR. P. C. PATIL ON THE QUANTITY PER TREE,
CHEMICAL COMPOSITION, DETERIORATION IN KEEPING, EFFECT
OF DIFFERENT PRESERVATIVES, OF THE JUICES AND
GULS OF PALMS.

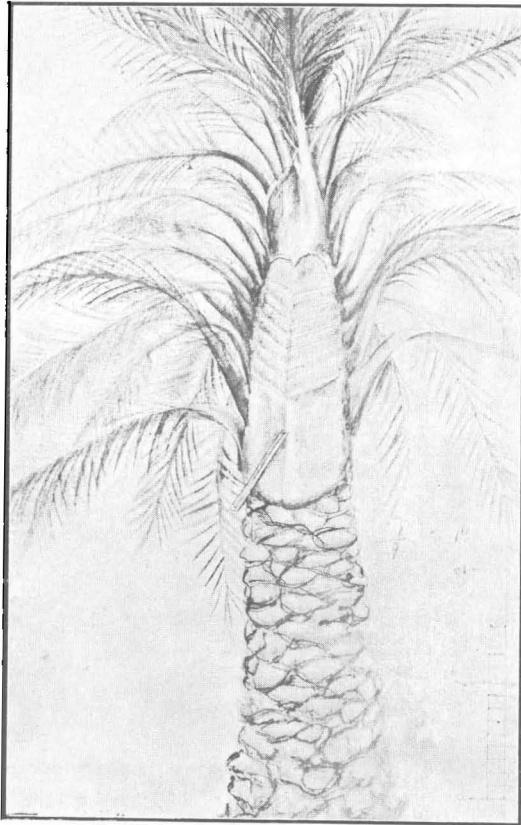
A.

*Quantities of juice obtained from Palmyra per tree during one night
(12 hours).*

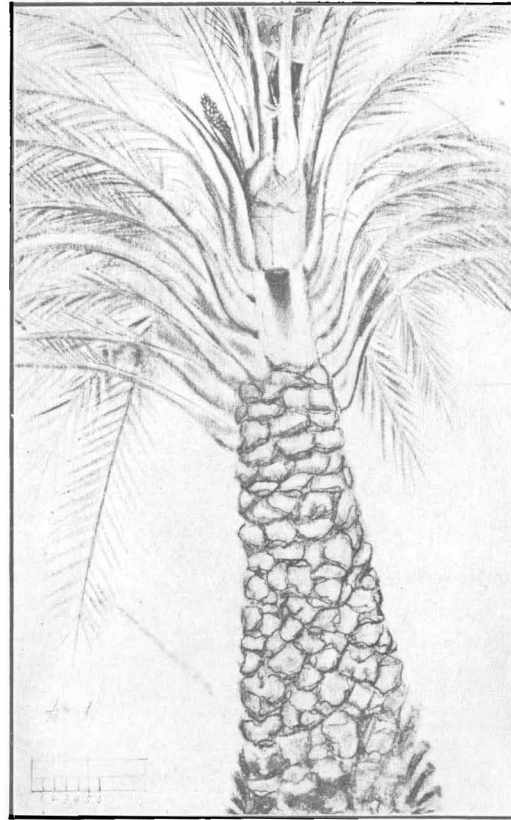
Observations taken - Dassein, 6th and 7th March 1915.

Mark on the tree.	Mark on the pot.	Quantity in lbs.	Brix reading corrected for temperature.	Mark on the tree.	Mark on the pot.	Quantity in lbs.	Brix reading corrected for temperature.
1	2	3	4	5	6	7	8
1 {	a	3.5	10.58	1 {	a	4	10.58
	b	2.5	10.58		b	2	10.58
2	a	2.5	13.09	2 {	a	1	
					b	2.5	
3 {	a	2	12.08	3 {	a	3	
	b	3.5	15.59		b	3	
5 {	a	2	11.58	4 {	a	2.5	11.08
	b	2	12.59		b	4	10.08
6 {	a	2	10.58	5 {	a	2.5	11.58
	b	3.5			b	3	10.58
7 {	a	1.5		6 {	a	2	9.58
	b	2.5	10.58		b	3	10.58
8 {	a	3	11.08	7 {	a	3	11.58
	b	1.5			b	2	10.58
9	a	3	13.59	8	a	2.5	13.58
8 Trees.	14 Pots.	35 lbs.	Percentage of gul by actual trial.	9 Trees.	15 Pots.	40 lbs.	Percentage of gul by actual trial.

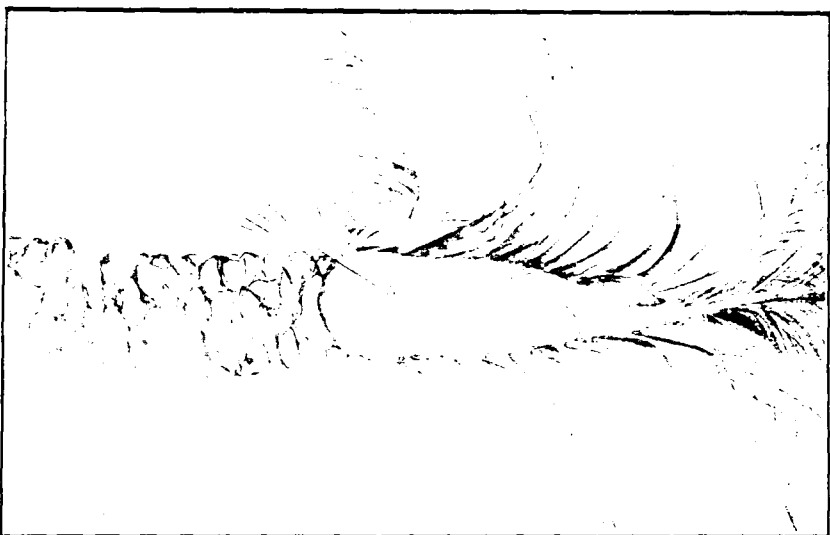
This works out at about 4.4 lbs. per tree per day or 53 gallons per season of 120 days.



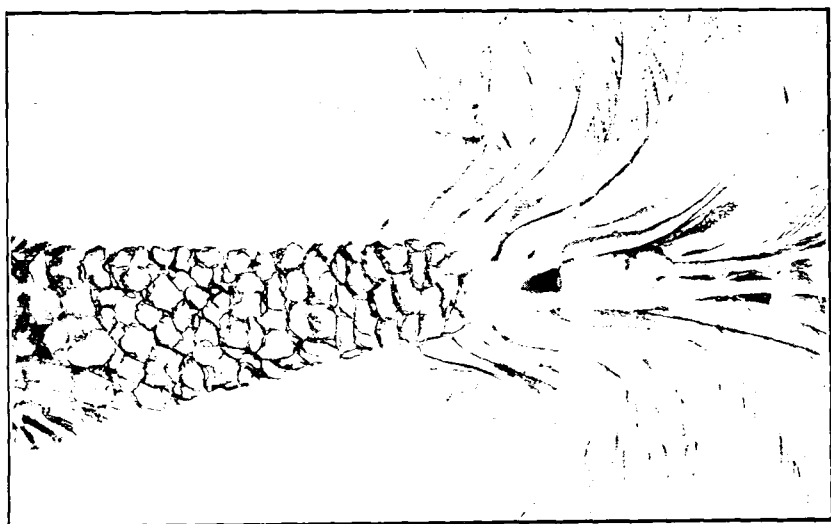
APPEARANCE OF THE TAPPED SURFACE SHOWING SEVERAL STEPS AS WILL BE OBTAINED AT THE END OF THE SEASON IN THE BENGAL METHOD.



APPEARANCE OF THE CUT AT THE END OF THE SEASON IN THE THANA METHOD.



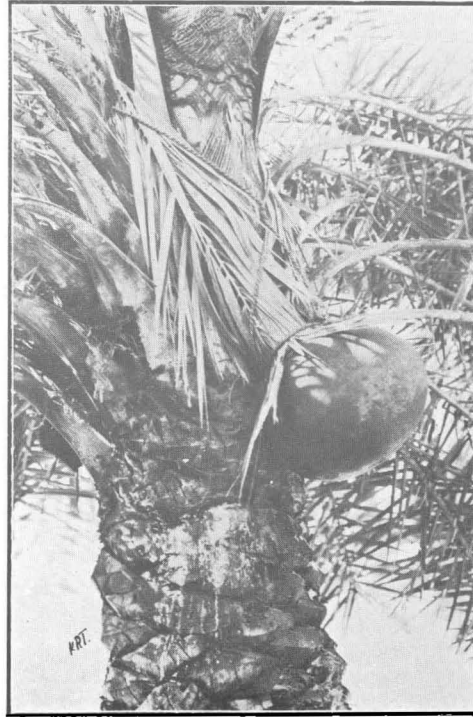
APPEARANCE OF THE TYPED STAGE SHOW-
ING SEVERAL STEPS AS WILL BE OBTAINED AT
THE END OF THE SEASON IN THE
BENGAL METHOD.



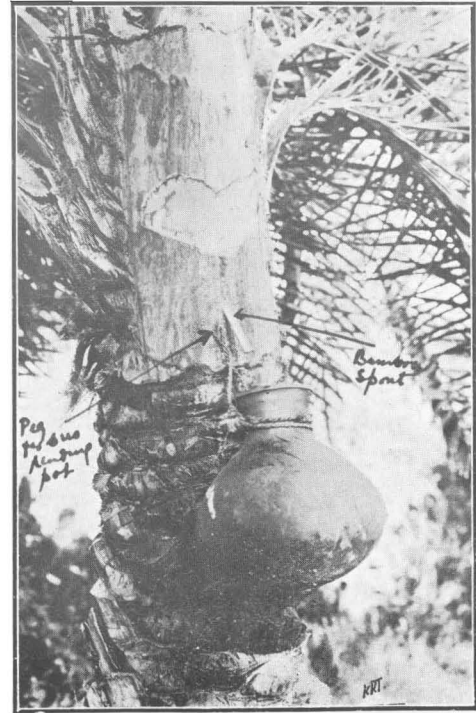
APPEARANCE OF THE CULM AT THE END OF THE
SEASON IN THE JAVA METHOD.



BENGAL METHOD SHOWING THE APPEAR-
ANCE AFTER THE SECOND STEP IS CUT OUT.



TYING OF THE POT, THANA METHOD.



BENGAL METHOD FIRST NOTCH READY.
(also showing the simple and speedy
method of suspending the pot).

*Quantity of Juice obtained from Date Palms per tree during night
(12 hours).*

Lot A.		Lot B.					Lot C.			
Mark on the trees.	Quantity in lbs.	Mark on the trees.	1st night.	2nd night.	3rd night.	4th night.	Mark on the trees.	1st night.	2nd night.	3rd night.
1	2	3	4	5	6	7	8	9	10	11
			lbs.	lbs.	lbs.	lbs.		lbs.	lbs.	lbs.
1	3	1	5	2.5	3.3	0.8	1	5	5	4.2
2	1.5	2	3.75	2.1	5		2	4.2	5	3.3
3	1.5	3	4.2	2.5	4.2	3	3	4.5	3.3	4.2
4	3	4	3.75	5.5	3	3.3	4	5	5	5.8
5	2	5	4.5	0.8	1.25	0.8	5	7.5	5	5.8
6	2	6	3	3	5.5	6.7	6	5	3.3	5
7	2	7	3.5	4.5	7.5	8.5	7	6.5	5.8	5
8	1.5	8	5	5	0.4	4.2	8	7.5	6.5	6.5
9	3	9	5	3.3	3	3				
10	1	10	3.3	4	2.5	3.75				
11	2									
12	1									
13	0.5									
14	2									
15	2									
	28 lbs.		40.80 lbs.	33.2 lbs.	35.65 lbs.	34.05 lbs.		45.20 lbs.	38.9 lbs.	39.80 lbs.

It can be said therefore that $15+40+24=79$ Date palms yielded 295.60 lbs. of juice. The average per tree during one night (*i.e.*, for morning collection) comes to 4.3 lbs., or 38.7 gallons per season of 90 days.

Comparative Quantities of Date Juice obtained during day time (i.e., for evening collection) and night time (i.e., for morning collection).

Sanjan (Thana).

90 per cent. during night time. } For details see the
10 per cent. during day time. } table below:—

Mark on the trees.	Morning collection.	Evening collection.
	lbs.	lbs.
1	5	1.25
2	3.75	0.25
3	4.2	0.50
4	3.75	0.8
5	4.5	1.7
6	3	0
7	3.3	0.25
8	5	0.8
9	5	0.4
10	3.3	0.8
	48.80	6.75

B.

Chemical Composition of the Date palm juice.

Analysis of the Date palm juice for crystalline and non-crystalline sugars, acidity, &c., and its rate of deterioration in keeping:—

	Acidity in terms of KOH grms. per 100 c.c.	Brix reading corrected for temperature.	Refractometer corrected for temperature.	Sugars.	
				Crystal-lizable. per cent.	Non-crystal-lizable. per cent.
Average sample juice taken at 8 a.m.	0.0663	12.86	13.70	9.00	1.80
Average sample taken at 6 a.m.	0.030	12.90	13.80	9.80	1.30
Do. do. ...	0.050	11.58	13.20	9.13	1.27
Do. do. ...	0.051	10.22	10.64	8.10	1.80
Day collections average sample taken at 6-30 p.m.	0.3009	13.30	13.80	4.91	5.00

Rate of deterioration as shown by the same sample of juice kept for four days :—

Date.	Time.	Brix reading corrected to 170 c.	Acidity in KOH grms. per 100 lbs. juice.
30-1-1915	9 a.m.	10.58	0.0357
"	1 p.m.	10.47	0.0561
"	5 p.m.	10.20	0.1122
"	9 p.m.	10.15	0.2703
31-1-1915	9 a.m.	9.65	0.3825
"	1 p.m.	9.00	0.4335
"	5 p.m.	8.35	0.4590
"	9 p.m.	8.00	0.4845
1-2-1915	9 a.m.	7.20	0.6375
"	1 p.m.	6.80	0.7140
"	5 p.m.	5.70	0.8160
"	9 p.m.	5.00	0.8415
2-2-1915	9 a.m.	4.00	0.8926
"	1 p.m.	3.50	0.9384
"	5 p.m.	3.00	0.9843
"	9 p.m.	2.90	1.012

Date Juice.

	Acidity in terms of KOH grms. per 100 c. c.	Brix reading corrected for temperature.	Refractometer corrected for temperature.	Sugars.	
				Crystallizable per cent.	Non-crystallizable per cent.
Night collections taken in new baked pots and tested in the morning at 7 a.m.	0.0357	10.58	10.30	7.50	1.38
Average sample taken at 7 a.m. in pots that were limed.	Neutral.	9.45	10.70	6.28	1.21

D.

COMPOSITION OF THE SAMPLES OF GUL FROM DATE AND BRAB PALM JUICE.

Date Palm.

	(1) p.c.	(2) p.c.
Moisture	8.44	8.40
Ash	2.80	3.27
Chlorine	0.65	1.12
Non-crystallizable sugar	8.00	8.16
Crystallizable sugar	75.01	73.73
Acidity (Grms. KOH per 100 grms. of gul)	0.26	0.26

Brab Palm.

	(1) p.c.	(2) p.c.
Moisture	5.2	8.1
Ash	1.2	2.3
Chlorine	1.0	1.4
Non-crystallizable sugar	4.0	9.7
Crystallizable sugar	83.8	76.1
Acidity (Grms. KOH per 100 grms. of gul)	0.25	.61

APPENDIX III.

DAILY OUT-PUT OF JUICE AND GUL OBTAINED FROM DATE PALM AT TADGAON
(PETA UMBERGAON, DISTRICT THANA) DURING THE TAPPING
SEASONS OF 1917-18 AND 1918-19.

Experiments of 1917-18 by Mr. Sorabji's modified Thana Method of tapping with 400 date trees :—

Date.	Quantity of juice obtained in gallons.		Brix reading.	Quantity of gul obtained in lbs.	Quality of gul.
	Morning.	Evening.			
5-12-1917	10		17	17	Soft, brownish.
6-12-1917	16		16	22	Sticky.
7-12-1917	19		Not available.	25½	"
8-12-1917	22		15	28½	"
9-12-1917	24		15	32	"
10-12-1917	24		Not available.	32	"
11-12-1917	23		"	28	Solid to some extent.
12-12-1917	26		"	31½	Sticky.
13-12-1917	28		15½	32	"
14-12-1917	25		16	35	Solidified.
15-12-1917	33		15	43	Sticky.
16-12-1917	36		14½	50	Not available.
17-12-1917	45		Not available.	55	"
18-12-1917	34		"	43	"
19-12-1917	47		"	57	"
20-12-1917	38		"	45	"
21-12-1917	44		"	53	"
22-12-1917	47		"	56½	"
23-12-1917	55		"	65	"
24-12-1917	44		"	55	"
25-12-1917	49		"	56	"
26-12-1917	43		"	60	"

No collections were taken.

APPENDIX III—*contd.*

Date.	Quantity of juice obtained in gallons.		Brix reading.	Quantity of gul obtained in lbs.	Quality of gul.
	Morning.	Evening.			
27-12-1917	48		Not available.	58	Not available.
28-12-1917	68		14	80	Soft.
29-12-1917	71		14	82	"
30-12-1917	64		16	80	"
31-12-1917	65		13½	77	"
1-1-1918	81		15	97	Sticky.
2-1-1918	77		15	77	Soft.
3-1-1918	79		16	97	"
4-1-1918	86		13	102	"
5-1-1918	84		Not available.	99	Sticky, soft.
6-1-1918	81		14	92	Hard.
7-1-1918	82		Not available.	95	Soft.
8-1-1918	87		"	100	"
9-1-1918	91		"	108	Hard.
10-1-1918	93		12½	116	Soft.
11-1-1918	87		14	114	"
12-1-1918	90		13	106	Sticky, soft.
13-1-1918	96		13	120	Sticky.
14-1-1918	92		Not available.	106	Soft.
15-1-1918	94		"	120	"
16-1-1918	96		12	112	"
17-1-1918	85		13½	106	"
18-1-1918	99		13½	115	"
19-1-1918	95		14½	114	"
20-1-1918	100		13½	125	"
21-1-1918	108		Not available.	125	"
22-1-1918	103		"	115	"
23-1-1918	101		"	115	"
24-1-1918	109		"	114	Good gul, hard.

No collections were taken.

APPENDIX III—*contd.*

Date.	Quantity of juice obtained in gallons.		Brix reading.	Quantity of gnl obtained in lbs.	Quality of gul.	
	Morning.	Evening				
25-1-1918	93		12	112	Good gul hard.	
26-1-1918	109		Not available.	119	Not available.	
27-1-1918	95		"	125	"	
28-1-1918	120		"	134	"	
29-1-1918	112		12½	130	"	
30-1-1918	116		Not available.	125	"	
31-1-1918	106		"	119	"	
1-2-1918	112		"	120	Hard.	
2-2-1918	113		"	129	"	
3-2-1918	106		"	115	"	
4-2-1918	110		12½	135	"	
5-2-1918	113		Not available.	127	"	
6-2-1918	82	No collections taken.	"	110	"	
7-2-1918	97		"	102	"	
8-2-1918	107		"	121	"	
9-2-1918	113		"	122	"	
10-2-1918	107		"	12½	132	"
11-2-1918	108		"	12	118	"
12-2-1918	92		"	12½	121	"
13-2-1918	99		"	11½	118	"
14-2-1918	104		"	11	120	"
15-2-1918	114		"	11	125	"
16-2-1918	99	"	13	124	"	
17-2-1918	95	"	11	100	"	
18-2-1918	82	"	12½	100	"	
19-2-1918	98	"	11	108	Soft.	
20-2-1918	93	"	12½	116	Good.	
21-2-1918	101	"	11½	111	"	
22-2-1918	97	"	13½	125	"	

30

APPENDIX III—contd.

Date.	Quantity of juice obtained in gallons.		Brix reading.	Quantity of gal obtained in lbs.	Quality of gal.
	Morning.	Evening.			
23-2-1918	108		13½	118	Good.
24-2-1918	88		11½	107	"
25-2-1918	106		11	115	Soft.
26-2-1918	97		11	130	"
27-2-1918	98		11½	115	"
28-2-1918	103		11	130	"
1-3-1918	110		10½	115	Not available.
2-3-1918	88		11½	112	"
3-3-1918	83		10	95	"
4-3-1918	88		11½	104	"
5-3-1918	100		Not available.	120	"
6-3-1918	102		"	118	"
7-3-1918	90		11	109	"
8-3-1918	110		Not available.	129	"
9-3-1918	93		"	110	"
10-3-1918	82		"	97	"
11-3-1918	95		"	110	"
12-3-1918	90		"	101	"
13-3-1918	99		"	120	"
14-3-1918	97		"	117½	"
15-3-1918	92		11½	110	"
16-3-1918	102		11½	122½	"
17-3-1918	103		11½	120	"
18-3-1918	96		10	115	"
19-3-1918	105		11½	112	"
20-3-1918	105		11½	113	"
21-3-1918	95		11½	106	"
22-3-1918	97		11½	109	"
23-3-1918	95		11½	111	"

No collections taken.

APPENDIX III—contd.

Date.	Quantity of juice obtained in gallons.		Brix reading.	Quantity of gul obtained in lbs.	Quality of gul.
	Morning.	Evening.			
24-3-1918	68		Not available.	99	Not available.
25-3-1918	104		"	120	"
26-3-1918	108		"	123	"
27-3-1918	100		"	112	"
28-3-1918	96		"	106	"
29-3-1918			"	Not available.	"
30-3-1918			"	"	"
31-3-1918			"	"	"
1-4-1918			"	"	"
2-4-1918	66		"	78	"
3-4-1918	98		"	110	"
4-4-1918	78		"	90	"
5-4-1918	88		"	102	"
6-4-1918	104		"	113	"
7-4-1918	82		"	91	"
8-4-1918	100		"	109	"
9-4-1918	101		"	107	"
10-4-1918	96		"	104	"
11-4-1918	110		"	116	"
12-4-1918	103		"	106	"
13-4-1918	86		"	95	"
14-4-1918	94		"	98	"
15-4-1918	92		"	100	"
16-4-1918	80		"	85	"
17-4-1918	98		"	103	"
18-4-1918	92		"	97	"
19-4-1918	87		"	91	"
20-4-1918	89		"	95	"
21-4-1918	96		"	100	"

Work closed for
Shimga
Holidays.

No collections taken.

APPENDIX III—contd.

Date.	Quantity of juice obtained in gallons.		Erix reading.	Quantity of gul obtained in lbs.	Quality of gul.
	Morning.	Evening.			
22-4-1918	59		Not available	55	Not available.
23-4-1918	90		"	94	"
24-4-1918	67	No collections taken.	"	71	"
25-4-1918	70		"	74	"
26-4-1918	64		"	68	"
27-4-1918	67		"	70	"
28-4-1918	48		"	52	"
29-4-1918	76		"	80	"
30-4-1918	48		"	54	"

QUANTITY OF JUICE AND GUL DAILY OBTAINED FROM 100 TREES OF
DATE PALM BY MR. SORABJI PATEL OF TADGAON, PETA
UMBERGAON, DISTRICT THANA, IN THE SEASON 1918-19.

13-12-1918	28	No collections taken.	Not available.	45	Not available.
14-12-1918	39		"	61	"
15-12-1918	37		"	59	"
16-12-1918	47		"	71	"
17-12-1918	36		"	63	"
18-12-1918	37		"	58	"
19-12-1918	45		"	75	"
20-12-1918	52		"	78	"
21-12-1918	52		"	82	"
22-12-1918	51		"	78	"
23-12-1918	52		"	82	"
24-12-1918	59		"	87	"
25-12-1918	54		"	84	"
26-12-1918	53		"	90½	"
27-12-1918	60	"	82	"	

APPENDIX III—contd.

Date.	Quantity of juice obtained in gallons.		Brix reading.	Quantity of gul obtained in lbs.	Quality of gul.
	Morning.	Evening.			
28-12-1918	70		Not available.	96	Not available.
29-12-1918	59		"	85	"
30-12-1918	64		"	89	"
31-12-1918	59		"	84	"
1-1-1919	65		"	93	"
2-1-1919	66		"	94	"
3-1-1919	64		"	86	"
4-1-1919	59		"	78	"
5-1-1919	75		"	98	"
6-1-1919	77		"	100	"
7-1-1919	59	No collections taken.	"	94	"
8-1-1919	83		"	110	"
9-1-1919	75		"	103	"
10-1-1919	73		"	100	"
11-1-1919	81		"	106	"
12-1-1919	87		"	109	"
13-1-1919	85		"	116	"
14-1-1919	96		"	124	"
15-1-1919	86		"	140	"
16-1-1919	85		"	105	"
17-1-1919	101		"	136	"
18-1-1919	84		"	104	"
19-1-1919	89		"	110	"
20-1-1919	92		"	113	"
21-1-1919	97		"	119	"
22-1-1919	92		"	112	"
23-1-1919	93		"	112	"
24-1-1919	95		"	114	"
25-1-1919	93		"	112	"

APPENDIX III—contd.

Date.	Quantity of juice obtained in gallons.		Brix reading.	Quantity of gal obtained in lbs.	Quality of gal.
	Morning.	Evening.			
26-1-1919	91		Not available.	110	Not available.
27-1-1919	95		"	119	"
28-1-1919	88		"	110	"
29-1-1919	Not available.		"	Not available.	"
30-1-1919	102		"	125	"
31-1-1919	93		"	116	"
1-2-1919	82		"	104	"
2-2-1919	102		"	129	"
3-2-1919	102		"	130	"
4-2-1919	93		"	117	"
5-2-1919	92		"	116	"
6-2-1919	102		"	126	"
7-2-1919	85		"	105	"
8-2-1919	88		"	112	"
9-2-1919	101		"	125	"
10-2-1919	91		"	108	"
11-2-1919	92		"	116	"
12-2-1919	97		"	119	"
13-2-1919	87		"	102	"
14-2-1919	93		"	117	"
15-2-1919	95		"	112	"
16-2-1919	75		"	94	"
17-2-1919	91		"	113	"
18-2-1919	99		"	120	"
19-2-1919	75		"	95	"
20-2-1919	94		"	114	"
21-2-1919	88		"	109	"
22-2-1919	79		"	92	"
23-2-1919	97		"	120	"

No collections taken.

APPENDIX III—*contd.*

Date.	Quantity of juice obtained in gallons.		Brix reading.	Quantity of gul obtained in lbs.	Quality of gul.
	Morning.	Evening.			
24-2-1919	89		Not available.	103	Not available.
25-2-1919	70		"	83	"
26-2-1919	93		"	118	"
27-2-1919	92		"	122	"
28-2-1919	74		"	87	"
1-3-1919	89		"	119	"
2-3-1919	88		"	119	"
3-3-1919	61		"	85	"
4-3-1919	88		"	113	"
5-3-1919	84		"	110	"
6-3-1919	65		"	80	"
7-3-1919	92		"	118	"
8-3-1919	89		"	111	"
9-3-1919	60		"	76	"
10-3-1919	79		"	101	"
11-3-1919	85		"	106	"
12-3-1919	57		"	74	"
13-3-1919	72		"	94	"
14-3-1919	66		"	83	"
15-3-1919	58		"	75	"
16-3-1919	65		"	82	"
17-3-1919			"	Nil.	"
18-3-1919			"	"	"
19-3-1919			"	"	"
20-3-1919			"	"	"
21-3-1919			"	"	"
22-3-1919			"	"	"
23-3-1919	64		"	81	"
24-3-1919	53		"	53	"

No collections taken.

Work closed for
Shingga Holidays.

APPENDIX III—*contd.*

Date.	Quantity of juice obtained in gallons.		Brix reading.	Quantity of gul obtained in lbs.	Quality of gul.
	Morning.	Evening.			
25-3-1919	63		Not available.	69	Not available.
26-3-1919	47		"	53	"
27-3-1919	75		"	81	"
28-3-1919	67		"	74	"
29-3-1919	51		"	66	"
30-3-1919	76		"	83	"
31-3-1919	70		"	76	"
1-4-1919	52		"	57	"
2-4-1919	72		"	80	"
3-4-1919	68		"	79	"
4-4-1919	49		"	52	"
5-4-1919	78	No collections taken.	"	96	"
6-4-1919	68		"	76	"
7-4-1919	50		"	57	"
8-4-1919	78		"	86	"
9-4-1919	60		"	68	"
10-4-1919	50		"	57	"
11-4-1919	80		"	88	"
12-4-1919	54		"	61	"
13-4-1919	44		"	52	"
14-4-1919	67		"	75	"
15-4-1919	59		"	66	"
16-4-1919	48		"	56	"
17-4-1919	71		"	80	"
18-4-1919	53		"	61	"
19-4-1919	41		"	49	"
20-4-1919	65		"	73	"
21-4-1919	53		"	61	"
22-4-1919	45		"	53	"

CHECKED
2003-04

AA

APPENDIX III—*contd.*

Date.	Quantity of juice obtained in gallons.		Brix reading.	Quantity of gul obtained in lbs.	Quality of gul.
	Morning.	Evening.			
23-4-1919	59	No collections taken.	Not available.	67	Not available.
24-4-1919	43		"	52	"
25-4-1919	33		"	44	"
26-4-1919	57		"	73	"
27-4-1919	43		"	44	"
28-4-1919	36		"	38	"
29-4-1919	44		"	47	"
30-4-1919	33		"	35	"