Cuba, British Guiana and Hawaii, and in India and Java in the Old World. The numerous cultivated varieties are dis­tinguished mainly by the colour of the internodes, whether yellow, red or purple, or striped, and by the height of the culm. Apart from the sugar-cane and the beet, which are dealt with in detail below, a brief reference need only be made here to maple sugar, palm sugar and sorghum sugar.

*Maple Sugar.—*This is derived from the sap of the rock or sugar maple *(Acer saccharinum),* a large tree growing in Canada and the United States.

The sap is collected in spring, just before the foliage develops, and is procured by making a notch or boring a hole in the stem of thc tree about 3 ft. from the ground. A tree may yield 3 gallons of juice a day and continue flowing for six weeks; but on an average only about 4 lb of sugar are obtained from each tree, 4 to 6 gallons of sap giving 1 lb of sugar. The sap is purified and concentrated in a simple manner, the whole work being carried on by farmers, who themselves use much of the product for domestic and culinary purposes.

*Palm Sugar.*—That which comes into the European market as Jaggery or *khaur* is obtained from the sap of several palms, the wild date *(Phoenix sylvestris),* the palmyra *(Borassus flabellifer),* the coco-nut *(Cocos nucifera),* the gomuti *(Arenga saccharifera)* and others. The principal source is *Phoenix sylvestris,* which is cultivated in a portion of the Ganges valley to the north of Calcutta. The trees are ready to yield sap when five years old; at eight years they are mature, and continue to give an annual supply till they reach thirty years. The collection of the sap (toddy) begins about the end of October and continues, during the cool season, till the middle of February. The sap is drawn on from the upper growing portion of the stem, and altogether an average tree will run in a season 350 lb of toddy, from which about 35 lb of raw sugar—jaggery —is made by simple and rude processes. Jaggery production is entirely in native hands, and the greater part of the amount made is consumed locally; it only occasionally reaches the European market.

*Sorghum Sugar.—*The stem of the Guinea corn or sorghum *(Sorghum saccharatum)* has long been known in China as a source of sugar.. The sorghum is hardier than the sugar-cane; it comes to maturity in a season; and it retains its maximum sugar content a considerable time, giving opportunity for leisurely harvesting. The sugar is obtained by the same method as cane sugar.

*Cane Sugar Manufacture.—*The value of sugar-canes at a given plantation or central factory would at first sight appear *Commercial* to vary directly as the amount of saccharine contained in the juice expressed from them varies*,* and if canes with juice indicating 9° Beaumé be made a basis of value or worth, say at 10s. per ton, then canes with juice indicating in degrees Beaumé 10° 9° 8° 7° 6°

and containing in

sugar. . . . 18∙05% 16∙23% 14∙42% 12∙61% 10∙8o%

would be worth per

ton . . . . 11/11/4 10/- 8/101/2 7/91/4 6/8

But this is not an accurate statement of the commercial value of sugar-canes—that is, of their value for the production of sugar to the planter or manufacturer—because a properly equipped and balanced factory, capable of making 100 tons of sugar per day, for 100 days’ crop, from canes giving juice of 90 B., or say 10,000 tons of sugar, at an aggregate expenditure for manufacture *(i.e.* the annual cost of running the factory) of £3 per ton, or £30,000 per annum, will not be able to make as much sugar per day with canes giving juice of 8° B., and will make still less if they yield juice of only 6° B. In practice, the expenses of upkeep for the year and of manufacturing thc crop remain the same whether the canes are rich or poor and whether the crop is good or bad, the power of the factory being limited by its power of evaporation. For example, a factory able to evaporate 622 tons of water in 24 hours could treat 1000 tons of canes yielding juice of 9° B., and make therefrom 100 tons of sugar in that time; but this same factory, if supplied with canes giving juice of 6°B.,could not treat more than 935 tons of canes in 24 hours, and would only make therefrom 62∙2 tons of sugar.

The following table may be useful to planters and central factory owners. It shows the comparative results of working with juice of the degrees of density mentioned above, under the conditions described, for one day of 24 hours, and the real value, as raw material for manufacture, of cane giving juice of 6° B. to 10° B., with their apparent value based solely on the percentage of sugar in the juice. The canes in each case are assumed to contain 88 % of juice and 12% of fibre, and the extraction by milling to be 75 of the weight of canes—the evaporative power of the factory being equal to 622 tons per 24 hours. The factory expenses are taken at £30,000 per annum, or £3 per ton on a crop of ιo,ooo tons (the sugar to cost £8 per ton all told at the factory)—equivalent to £300 per day for the 100 working days of crop time.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Degrees Beaumé. | 6° | 7° | 8° | 9° | **1O°** |
| Tons of canes crushed per day | 935·6 | 956∙2 | 977∙4 | 1000 | 1023∙8 |
| Tons of juice ex­pressed  Tons of water evaporated | 701∙7 | 717∙2 | 733∙1 | 750 | 767∙9 |
| 622 | 622 | 622 | 622 | 622 |
| Tons of 1st Mas­secuite | 79∙7 | 95∙2 | **111**∙1 | 128 | 145∙9 |
| Tons sugar of all  classes recovered | 62∙2 | 74∙3 | 86∙7 | 100 | 114∙o |
| Total output of  sugar in 100  days. Tons | 6220 | 7430 | 8670 | 10,000 | 11,400 |
| Total value of all sugars per day at £8 per ton  Less factory ex­penses per day | £497, 6∕- | £594, 4∕- | £693. 6∕- | £800 | £912 |
| £300 | £300 | £300 | £300 | £300 |
| Leaves for canes crushed | £197, 6∕- | £294. 4∕- | £393. 6∕- | £500 | £612 |
| Real value of canes per ton | 4/23/4 | 6/2 | 8∕- | 10∕- | 11/111/2 |
| Apparent value (see preceding  Table) | 6/8 | 7/91/4 | 8/10 | 10/- | **11/11/4** |

But it is obvious that it would not pay a planter to sell canes at 4s. 2jd. a ton instead of at ιos. a ton, any more than it would pay a factory to make only 62-2 tons of sugar in 24 hours, or 6220 tons in the crop of 100 days, instead of 10,000 tons. Hence arises the imperative necessity of good cultivation by the planter, and of circumspection in the purchase and acceptance of canes on the part of the manufacturer.

Thc details of manufacture of sugar from canes and of sugar from beetroots differ, but there are five operations in the production of the sugar of commerce from either material which are common to both processes. These are:—

1. The extraction of the juice.

2. The purification or defecation of the juice.

3. The evaporation of the juice to syrup point.

4. Thc concentration and crystallization of the syrup.

5. The curing or preparation of the crystals for the market by

separating the molasses from them.

*Extraction of Juice.—*The juice is extracted from canes by squeezing them between rollers. In India at the present day there are thou­sands of small mills worked by hand, through which the peasant cultivators pass their canes two or three at a time, squeezing them a little, and extracting perhaps a fourth of their weight in juice, from which they make a substance resembling a dirty sweetmeat rather than sugar. In Barbadoes there art still many estates making good Mascabado sugar; but as the juice is extracted from the canes by windmills, and then concentrated in open kettles heated by direct fire, the financial results are disastrous, since nearly half the yield obtainable from the canes is lost. In the best organized modem cane sugar estates as much as 12 1/2 % of the weight of the canes treated is obtained in crystal sugar of high polarizing power, although in Louisiana, where cultivation and manufacture are alike most carefully and admirably carried out, the yield in sugar is only about 7 % of the weight of the canes, and sometimes, but seldom, as much as 9%. This is due to conditions of climate, which are much less favourable for the formation of saccharine in the canes than in Cuba. The protection afforded to the planters by their government, however, enables them to pursue the industry with considerable profit, notwithstanding the poor return for their labour in saleable produce. As an instance of the influence of climatic conditions combined with high cultivation the cane lands of the Sandwich Islands may be cited. Here the tropical heat is tempered by constant trade winds, there is perfect immunity from hurricanes, the soil is peculi­arly suited for cane-growing, and by the use of specially-prepared fertilizers and an ample supply of water at command for irrigation the land yields from 50 to 90 tons of canes per acre, from which from 12 to 14% of sugar is produced. To secure this marvellous return, with an annual rainfall of 26 in., as much as 52,000,000 gallons of water are pumped per 24 hours from artesian wells on one estate alone. With an inexhaustible supply of irrigation water obtainable, there is no reason why the lands in Upper Egypt, if scientifically cultivated and managed, should not yield as abundantly as those in the Sandwich Islands.