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The Problem of the Molasses.

THE discussions at the last Sugar Conference held at Simla (*Curr. Sci.*, **2**, 58, 1933) and the more recent meeting of the Sugar Committee at Coimbatore (*Curr. Sci.*, **2**, 202, 1933) have borne ample testimony to the fact that the provincial Governments as also the promoters of the sugar industry are quite alive to the seriousness of the new problem which they are faced with. With the creation of a number of new factories and the increased output of white sugar, the problem of the molasses has already assumed such serious proportions that it can no longer be ignored. In fact, we may even go further and state that when the protective tariff is withdrawn and the internal as well as external competition increases with the inevitable fall in prices, the intelligent utilisation of the hitherto neglected by-product may make all the difference between success and failure in the industry.

Not many years ago, India was importing quite considerable quantities of cane molasses, chiefly from Java. The imports have now very nearly disappeared and the home production so considerably increased that several factories have already got large stocks which they could not adequately dispose of. The present (1932–33) production may be reckoned at 450,000 tons and even a conservative estimate—based on the possible output of white sugar—would suggest that the manufacturers would be faced with the problem of dealing with no less than 500,000 tons during 1933–34 and subsequent years.

The problem of the molasses is not, however, unique to India. It is an inevitable consequence of the development of the white sugar industry and all the big sugar-producing countries like Java, Cuba, Natal, Hawaii, Mauritius, Queensland and Germany have had to face it. Various methods of utilising molasses (from cane or sugar beet) have been proposed and although none of them has proved wholly satisfactory, there is yet some evidence to suggest that at least some of them hold out promise of extended application. An attempt will therefore be made to critically examine the various methods now in use and to suggest a few lines along which further enquiry could be profitably undertaken.

The composition of cane molasses varies considerably depending on the variety of cane. manuring, system of boiling the juice, method of hardening and storage of the molasses and such like. It may be reckoned, however, on an approximate basis, that an average specimen contains about 40 per cent. of cane sugar, 30 per cent. of invert sugar (as glucose), 15–20 per cent. of moisture and the rest in the form of nitrogen and minerals. The nitrogen content is generally low, being under 1·0 per cent. but some specimens have been reported to contain higher percentages. Among the mineral constituents, potash (K_2O) accounts for a large share, being 1·9–4·6 per cent., and phosphoric acid (P_2O_5) 0·16–0·54 per cent. It is generally reckoned that molasses contains about 50 per cent. of the nitrogen originally present in the cane and 60 per cent. of the potash. Cane molasses can stand a reasonable amount of storage, but prolonged keeping leads to loss of sucrose, slow, irregular increase in invert sugar and general increase in non-sugars (Browne, *Ind. Eng. Chem.*, **21**, 600, 1933). Recently, a patent has been taken for producing dry molasses by grinding the liquid product with alfalfa meal and spray-drying the mixture in a current of hot air (Amer. Pat. No. 1,897,732 of 1933), but further information regarding the cost of production and the keeping quality of the final product is needed before any opinion regarding the utility of the process can be expressed.

Among the various methods of utilising molasses those with the possibility of its consumption as food deserve the most careful consideration. It has been suggested that fancy sugar syrups can be prepared out of it, but with clean, white sugar plentifully available, it is very doubtful if there would be much demand for molasses. A similar criticism would also apply to the suggestion that it could be used for the manufacture of caramel. Anyway, the quantities consumed by such industries would be almost negligible as compared with the huge stocks of molasses that would tend to accumulate in the near future. The demand for use as animal feed would appear to fluctuate considerably, the sale of molasses bringing some useful return only when other feeds are scarce (Kerr, *Proc. 4th Congress Int. Soc. Sug. Tech.*, 1932).

The utilisation of beet molasses for the manufacture of yeast would appear to have received considerable attention in Germany. The yeast, thus prepared, is mostly taken up by the bread industry, but with the increasing knowledge of the high nutritive value of yeast, it is not unlikely that the product will soon find favour as an animal feed. Cane molasses is comparatively poor in nitrogen and buffers and tends to become more readily acid than the beet product, but this defect can be remedied by addition of suitable nitrogenous substances together with the necessary mineral salts. The yield of pressed (wet) yeast which, under favourable conditions, would be nearly as much as that of the original molasses would appear to be a useful return for the sugar and inorganic salts used up by the organisms.

In this connection it should be pointed out that the manufacture of yeast is a different process from that of fermentation to alcohol. In the former process, the yeast being the chief end product, the saccharine medium is enriched with nutrients and subjected to aeration so that practically no alcohol is formed. It is not necessary that typical fermentation yeasts (*Saccharomyces*) should be used for the manufacture: even pseudo-yeasts like *Mycoderma*, *Torulae* and *Sarcinae* which do not produce more than traces of alcohol, may be used for the purpose: in fact some of the latter would appear to be efficient than the fermenting yeast in converting a given weight of sugar into its body material. The use of pseudo-yeasts has a further advantage in that it requires no excise control. The final product is almost exclusively the mass of the living organism which is quite nutritious and eminently suitable for animal feed. It is even fit for human consumption and there is evidence to show that *Torulae* were used as human food during certain wars in France. The yeast can be consumed either in the wet condition or in the dry form. The drying is fairly easy and can be carried out either in the sun or in a current of hot air. The dried product which may be described as a form of concentrated food would contain nitrogen and the essential minerals in organic combination—a condition that is most desirable from the point of view of efficient assimilation—together with the related vitamins, and other valuable food accessories. The nutritive value of the final product would thus be very much greater than that of the original molasses, a fact which, if sufficiently known, would soon raise the yeast into a position of great favour with the farmers.

In recent years increasing evidence has also been obtained to show that yeasts and allied organisms contain certain ingredients which help to promote the growth of plants. More recently, it has also been observed that yeast extracts also help to increase the reproductive efficiency of plants (*Curr. Sci.*, 2, 161, 1933). These and related observations would suggest that use of the dry yeast may soon find an important place in regular field practice.

From the above it would be seen that the manufacture of dry yeast (or an allied organism) from cane molasses is a promising line of enquiry which requires careful investigation.

Direct utilisation of molasses as fuel has been tried in a few countries, but the result does not appear to have been satisfactory. The product has low fuel value and added to that there is trouble with clinkering in boilers which is highly undesirable.

Among the various methods so far known, alcoholic fermentation for the manufacture of spirituous liquors and for the production of industrial alcohol would appear to be the most satisfactory way of utilising molasses. For various reasons, the consumption of molasses, by distilleries, has, so far, been only a small fraction of the total output, but it may be reasonably expected that, with more favourable conditions and improved methods of distilling for absolute alcohol, the major part of the molasses produced in the country would soon be taken up by that industry. In addition to its uses as a solvent and as an essential basic material for the manufacture of a variety of fine chemicals and pharmaceuticals, the utilisation of absolute alcohol, either by itself or in association with petrol (upto 30 per cent.) for internal combustion engines, deserves careful consideration. The merits and demerits of alcohol as a fuel have been indicated elsewhere in this issue (*Curr. Sci.*, 2, 202, 1933). Suffice it, therefore, to point out that if the difficulties associated with the illicit consumption of alcohol can be avoided; if the mixture of absolute alcohol and petrol can be moderately stabilised so that even if some moisture is absorbed, the two liquids will not separate; if the defects associated with incomplete combustion of alcohol can be eliminated; and if the problems connected with the transport and distribution of alcoholic petrol can be satisfactorily solved without imposing additional burden on the consumer, then the process of fermentation to alcohol will be one of the most satisfactory methods of utilising cane molasses.

A number of investigations have been carried out to study the possibility of utilising molasses in a number of minor fermentation industries such as those of lactic or citric acid, acetone and butyl alcohol or glycerin. Some of these studies have led to encouraging results, but the related processes are more difficult to control than that of alcoholic fermentation. The conditions of fermentation will therefore have to be carefully standardised if satisfactory yields of the desired products are to be obtained. The cost of manufacturing the different products should be compared with those by other known methods and the production adjusted to the limited demands of the market. The cost of manufacturing glycerin from molasses is stated to be less than that of recovery during soap manufacture but the estimates would require verification under the tropical conditions. The above and related subjects require further investigation.

A few years ago there appeared an announcement regarding the successful polymerisation of sucrose to yield a number of valuable solid and plastic materials (sakaloids). It was claimed by Ford, the inventor, that depending on the nature of the treatment, he could convert refined sugar or molasses into the following:—(1) A hard glassy substance which could be used as a glass substitute. The glassy material was claimed to be shatter-proof and to possess the advantage of being cut into the desired shape with a sharp knife: it was also found suitable for the manufacture of lenses and other useful articles. (2) A transparent substance with elastic properties and suitable for use as a substitute for rubber and leather. (3) A celluloid-like solid that could replace the inflammable celluloid. (4) A moulding powder that could be pressed to any desired shape in a hot press. A number of uses were contemplated for the new plastic materials both by themselves and in association with cellulose esters—artificial leather, wall hangings, adhesives, textiles, lenses, photographic films, transparent wrapping sheets, roofing tiles, paints and varnishes. It was claimed by the enthusiasts of the new process that 'the woman of the immediate future might look forward to being clothed from head to foot in spun sugar polymerised by the Ford process, wearing shoes of sugar leather with heels of sugar plastic; write with a sugar pen from a sugar mounted bag, which contains an unbreakable sugar mirror, sit in a sugar plastic chair and watch a picture projected by a sugar lens through a sugar photographic film.' (Cited from *Int. Sug. Jour.*, **33**, 375, 1931.) Nothing has, however, since been heard of the process which started under such favourable auspices. It is not improbable that the cost of production which was reckoned to be 9½ cents. (5 As. at the present rate of exchange) per pound was found to be excessive as compared with casein and other plastic materials which could be obtained at cheaper rates. It would be of interest, however, to study the properties of sakaloid and such other sugar plastics with a view to determining whether they possess any rare properties which would entitle them to preferential use in some manufactures.

It has been stated that molasses can find application, in the foundry, as a substitute for core oils and core gums (*The Chem. Trade J.*, Nov. 9, 1928). A recent German patent (No. 537128) claims a method of manufacturing linoleum cement, a composition containing molasses, kaolin, copal and alcohol. These and similar uses deserve examination though it is hardly likely that any large quantities of molasses will thus be consumed.

In recent years a large amount of interest has centred round the utilisation of molasses as fertiliser. In some of the sugar-producing areas it was found difficult to dispose of all the molasses produced in the course of a season and since discharging the product into rivers tended to pollute the water and kill the fish, some experiments were carried out applying the molasses to land at the rate of 8—10 tons per acre. The result was unexpectedly favourable. Although the immediate effect of the application was to kill out the existing vegetation, the subsequent crops came out exceedingly well. In Queensland, the effect was most marked on soils which are naturally deficient in potash (*Int. Sug. Jour.*, **35**, 422, 1933). In Java, investigations have been in progress since 1911 mainly with a view to standardising the conditions for the application of molasses to land. As the result of these researches it may now be stated that application at the rate of about 1,600 gallons per acre, together with the irrigation water, is perhaps the cheapest method of application. The rice crop which follows benefits as the result of the treatment and increased yields averaging about 43 per cent. have been reported. The molasses can be applied either before or after trenching provided at least three weeks are allowed for the initial reaction to subside prior to transplanting. The application may also be made, after planting, either of diluted or undiluted molasses, on the ridges or in the trenches, in very diluted form (approx. 0·1 per cent.) with irrigation water, and of these, the first is preferable. Application of undiluted or slightly diluted molasses has nothing to recommend it. In general, the effect of application of molasses is marked in the case of the succeeding rice crop than in that of cane. In the latter case the fertilising value of the molasses would appear to be largely influenced by soil conditions and water supply (*Int. Sug. Jour.*, **34**, 416, 1932). In Hawaii, on the other hand, molasses would appear to have proved quite useful as a fertiliser for sugarcane. Marked increases both in the yield of cane and percentage of sugar have been reported. The molasses would also appear to have some useful residual effect rendering phosphoric acid and potash more available for subsequent crops. In addition to direct application to land, experiments would also appear to be in progress in Hawaii investigating the possibilities of preparing a solid, easily granulated and portable material by submitting molasses to a charring treatment with concentrated sulphuric acid followed by additions of raw rock phosphate, ammonium phosphate and other nutrients, which should produce a mixture having many advantages as compared with the original molasses. It is expected that treatment with sulphuric acid would not only render molasses easy to handle but that it would also increase the availability of added phosphates and potassic salts (*Int. Sug. Jour.*, **34**, 108, 1932). Another method that has been proposed by the Hawaii workers is to mix the molasses with begasse, filter press cake, furnace ash and other factory wastes and then apply the mixture to land. These proposals deserve careful consideration in connection with the disposal of surplus molasses.

The use of molasses as a fertiliser raises a fundamental question as to what it is that is mainly responsible for the fertilising action; how it is that the earlier vegetation are adversely affected while the subsequent crops benefit; why some time should lapse between the application of the molasses and the transplantation of the rice seedlings;

and how it exerts a residual action by increasing the availability of minerals though none of the molasses is left behind? After about twenty years of research, the Java workers have come to the conclusion that the fertilising action is mainly due to the sugars, the effect produced by equivalent amounts of minerals and nitrogen being very small as compared with that of the molasses as a whole. Study of the associated microflora has shown that fungi are prominent when molasses is applied in high concentration while yeasts and bacteria are in considerable evidence when the product is applied in a diluted form. The mechanism of the action of the different organisms has not yet been thoroughly understood, but judging from previous evidence relating to the decomposition of carbohydrates under similar conditions, it would appear that various organic acids are the initial products of the fermentation of molasses in the soil (*J. Agric. Sci.*, **19**, 627, 1929). The sugar as well as the free acids are, as such, toxic to the living plant, but, after a time, the sugar disappears and the acids react with the soil minerals rendering them more soluble. The buffer action of the soil helps to adjust the reaction. As the result of a succession of such changes the land becomes suitable for transplantation of crop after about three or four weeks. More mineral food being thus available, the plants make better growth and increased yields are obtained. Although the above would help to explain some of the hitherto obscure aspects of the problem, further research directed towards the elucidation of the biochemical mechanism of the decomposition of molasses during 'wet' and 'dry' cultivation is greatly needed. If the biological transformations can be properly controlled so as to avoid undue loss of carbon in the gaseous form or profuse leaching out of soluble minerals; if the field practice can be so standardised that the application of molasses can be carried out without any special equipment or technical advice; if increased yields corresponding to those reported from Java can be consistently obtained under Indian conditions, then the utilisation of molasses as a fertiliser would deserve extended adoption, even in preference to use in fermentation and other industries.

It would be hardly possible to do justice to all the aspects of the problem in the course of a brief review as the present one is intended to be. It is hoped, however, that the discussion would create some interest in the subject as a whole and that the promoters of the industry and scientific workers in the country will actively co-operate in organising and carrying out an intensive programme of research which would soon help to throw light on different hitherto obscure aspects of the problem. It may further be hoped that, as the result of such efforts, the conditions for the most profitable method of utilising molasses will be standardised and that the troublesome by-product of the present moment will soon become an important source of revenue to the sugar industry.

Asiatic Society of Bengal.

ON the 15th of January 1934, the Asiatic Society of Bengal, which was founded under the name of the *Asiatick Society*, on the 15th January 1784, by Sir William Jones, will reach the age of 150 years since its foundation The Society was founded to inquire into the history, civil and natural, the antiquities, laws, arts, sciences and literature of Asia, and during its long existence its usefulness has spread far and wide and it has to its credit a wonderful record of achievements.

The President and Council of the Society have decided to celebrate, on the 15th of January 1934, the 150th Anniversary of this foundation. The Anniversary programme will consist of a Conversazione in the Indian Museum, and a Banquet in the hall of the Society, followed by a special Anniversary Meeting to receive addresses from learned societies and to elect a number of Honorary Anniversary Members of the Society.

In connection with the centenary celebration in 1884 a volume depicting the progress of Letters and Science during the preceding 100 years was published, and it has been decided to undertake the preparation of a special volume on similar lines covering the period of the last 50 years.