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EXPERIMENTS IN SYRUP MAKING.

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EXPERIMENTS IN SYRUP MAKING.

Several years since a bulletin (No. 66) was issued by the Experiment Station, with reference to the making of syrup from sugar cane upon a small scale, and in this bulletin were embodied the results of experiments conducted by the chemist of the Station up to that time. Since that date numerous inquiries have been addressed to this department, asking for additional information on the subject, and it is deemed advisable to present at this time a report of the results of further experiments in the clarification and manufacture of syrup on a small scale.

This subject is one that should be of especial practical interest at this time on account of the very low price of our chief staple crop, and the consequent tendency of the farmers to diversify their crops to a greater extent than heretofore. As noted in a previous bulletin, the supply of home manufactured syrup only meets a portion of the demand for the article during a very small part of the year, and the remainder of the product is obtained from without the State.

While the purchaser of the home made article can rest assured that his goods are free from adulteration, the consumer of the imported syrup cannot be at all certain as to its quality and composition, owing to the extent to which the addition of adulterants is carried. A large proportion of the syrups obtained from outside markets contain considerable admixtures, of corn glucose, and some are obtained by the reboiling of syrups and molasses which have undergone partial fermentation, while still other syrups may have been produced from dark colored and low grade molasses which have been brightened by chemical treatment.

Some years since the writer ascertained by personal investigation that in some of the chief syrup markets of the

country, dark colored plantation molasses was being bleached by the dealers by means of chemical processes, bi-sulphite of soda and pulverized zinc being the chief chemical agents employed.

With the exercise of proper care in the clarification and preservation of the genuine cane syrup, the imported or, at least, the adulterated article, should soon be excluded from the market, and the consumer can then be assured of the purity and good quality of the goods which he purchases. As stated in the previous belletin, but little attention has been given, as a rule, to the clarification or defecation of syrups in this State, and in many cases a considerable proportion of the scums and suspended impurities are boiled down with the syrup, darkening its color, affecting its taste and making its preservation more difficult. A satisfactory clarification of the juice not only brightens the product very materially, but also effects the removal of a large proportion of the albuminous matters, whose presence favors the growth and action of ferments.

It is also of the greatest importance that more attention be given to the density to which the syrup has been cooked, since in most cases the syrup boiler determines by the eye and in a very crude way the point at which the syrup should be drawn off.

In many cases the syrup is cooked to too thick a consistency, and as a consequence, a crystallization and deposition of sugar takes place, while on the other hand, if the syrup is not boiled to the proper density, fermentation is likely to ensue and the preservation of the syrup becomes a more difficult problem.

When the ordinary form of evaporator is at hand, the actual process of evaporation can be conducted in the usual manner, but the crude preliminary system of clarification now in general use can be much improved by resorting to the sulphuring process outlined in Bulletin No. 66.

In this process, the juice fresh from the mill is allowed to run slowly through a sulphuring box containing a number

of inclined shelves, and, as the juice trickles slowly down from shelf to shelf, it meets with an ascending current of sulphur fumes which are produced by burning brimstone or roll sulphur in a roughly constructed brick furnace.

In this way the juice is at once rendered lighter in color, and when heated in the evaporator, the separation of albuminous matters and other impurities is effected much more readily and rapidly. After the heating of the juice is commenced, the addition of a small amount of milk of lime is frequently found to facilitate the clarification and renders the separation of scums more easy.

Where the above process of clarification is employed, the resulting syrup is much clearer and brighter, and at the same time, it can be preserved much more readily. If it is desired to preserve the syrup for a considerable period of time, the hot liquid, concentrated to the proper strength, is run into a bottle or a well glazed jug of from half gallon to one gallon capacity, which has been rinsed out with hot water. The vessel is filled almost up to the mouth with the hot syrup and is then securely sealed and stored away for future use.

By this process, syrup has been successfully preserved at the laboratory for from one to four years, and crystallization of sugar can also be prevented if care is taken to avoid cooking the syrup to too great a density.

In Bulletin 66 reference was made to the composition of syrup put up in sealed vessels in the fall of 1894, as compared with the composition of the same syrup in the fall of 1895. The syrup in question was put up in bottles of three quarts capacity each, and one of these bottles was kept in a sealed condition until quite recently. After a lapse of more than four years no perceptible fermentation had taken place, nor had there been any crystallization of sugar. The syrup possessed a fresh and quite natural taste and the subjoined analysis will show, had undergone very little change in composition as compared with the previous analysis. This bottle was opened accidentally several weeks in ad-

vance of the analysis and the increase in glucose and decrease in sucrose is no doubt largely due to this fact.

ORIGINAL SAMPLE.	PRESERVED SAMPLE.
Total solids....71.2 per cent.	71.2 per cent.
Cane Sugar....46.7	43.6
Glucose.....22.4	26.8

Well glazed jugs of from one half to one gallon capacity can be employed instead of bottles, and tin cans, with small screw top, can also be used advantageously.

When it is once known that syrup of good quality and high purity and possessing the fresh taste of the original article can be obtained any month in the year, it will be quite easy to build up a market for such goods and the demand will necessitate an increase in the supply of the article.

The Baume hydrometer or saccharometer, described in Bulletin No. 66, can be employed to good advantage in determining the point at which the syrup becomes sufficiently dense to be drawn off, and when the spindle immersed in the hot liquid, reads 34 to 35 degrees, the liquid can then be run out of the evaporator. Farmers who have used the Baume spindle report good results from its employment and state that by means of its use no difficulty is experienced in boiling the syrup to a uniform density.

In the employment of the common evaporators, heated by direct contact of flame, over an ordinary furnace, great trouble is generally experienced in the proper regulation of the temperature and of the rate of evaporation, and on this account, scums and suspended impurities are frequently boiled down with the syrup. If the temperature of the furnace becomes too high, the evaporation becomes too rapid for the satisfactory clarification of the juice and the syrup is scorched or darkened in color by reason of the high heat to which the thin layers of liquid are subjected.

In order to secure the best results in clarification and evaporation, the heat should be easily and quickly con-

trolled so that evaporation can be accelerated or retarded at will, or, if necessary, suspended instantaneously.

The employment of steam for heating purposes is the only sure means of attaining these ends, and during the past two or three seasons steam clarifiers and evaporators have been employed in the experiments conducted at the Station. Since the evaporation of juices and syrups is carried out in the sugar factories and refineries upon such a large scale, it was impossible to secure upon the market evaporation apparatus adapted to syrup making upon a small scale, and hence two small evaporators were especially constructed for experimental purposes, the smaller of the two being improvised from an ordinary open-fire evaporator already on hand.

This evaporator was about 4½ feet long, three feet wide and about six inches deep, while the large evaporator had a length of about five feet, a width of about three feet and a depth of ten inches.

The sides of the evaporators were of wood as usual, and the bottoms were constructed of sheet copper, but no partitions were employed as in the ordinary evaporators.

A series of pipes, connected at the ends by return bends, were placed in the bottom of each evaporator, almost the whole surface of the bottom being thus covered, with the exception of a space about four or five inches in width which was reserved for the collection of the scums from the boiling juice. This unoccupied space should be on the side of the evaporator opposite to the point at which the steam is admitted, and this side should also be slightly lower than the other in order to facilitate the removal of the scums. The piping employed was galvanized iron, three-fourths inch inside diameter, and valves were provided for the proper regulation of the steam used in the evaporation, while another set of valves enabled the operator to prevent the too rapid escape of waste steam from the coil.

The juice, after sulphuring, is first run into the small evaporator or clarifier, steam is turned on, and the contents of the clarifier brought gradually to a boil.

The scums and impurities come to the surface quite rapidly, the greater portion of them collecting over the space not occupied by the pipes, where they can be easily removed.

The clarifier is somewhat more elevated than evaporator, and when the juice has been well skimmed, it is at once run into the larger evaporator and the steam is immediately turned on.

Fresh quantities of juice are now run into the clarifier, boiled, skimmed and then run into the evaporator, the evaporation of the juice being conducted all the while.

Any scums which form in the evaporator can be removed in the usual way, and when the syrup has reached the proper density, the steam is shut off and the evaporator is emptied through the usual outlet.

By the employment of the steam heat, the temperature and the rate of evaporation can be regulated with great exactness, and a much more thorough clarification and satisfactory evaporation is secured than by the employment of the ordinary evaporators, where a large proportion of the scums are frequently boiled down with the syrup, darkening its color and rendering its preservation difficult.

The best results in clarification were found to be secured by boiling the juice in the clarifier at a very gentle heat, especial care being taken to prevent excessive foaming and frothing in the early stages of the operation, while a brisker rate of evaporation can be employed in the larger evaporator.

An important fact to be noted in this connection also is that steam gins and mills are frequently found located closely adjacent to lands well adapted to cane culture, and any surplus steam at their disposal could be easily utilized in the operation of evaporators of moderate size, and if desired, the cane mill could also be operated by steam power. By the cultivation of a good variety of sorghum as well as of sugar cane, the syrup making period could be lengthened somewhat, and the product could be correspondingly increased without any additional cost for evaporating apparatus.

Any one who has already at hand a steam boiler of proper capacity will find the employment of small steam evaporators very satisfactory, and a much brighter and clearer syrup can be obtained with little trouble and small cost.

Clarifying Agents.

The process for clarifying with sulphur fumes, as before stated, was described in detail in Bulletin 66, and essentially the same process and apparatus have been employed during the past two or three seasons with excellent results. As a rule, the juice after passing through the sulphuring box has been mixed with an equal bulk of fresh juice, thus securing the clarification of the additional juice without any increased consumption of sulphur, and an excessive absorption of sulphur dioxide gas is thus avoided.

Sulphur has been used as a clarifier, both with and without the use of lime, care being taken in the former case to add the lime in the form of a thin milk, in small quantities, to the slightly heated juice, and then bringing the liquid to a brisk boil. In the manufacture of syrup, the best results with lime have been secured where that substance is added just in sufficient proportions to leave the juice faintly acid, as indicated by a piece of blue litmus paper immersed in the liquid.

During the preceding season, the Provident Chemical Works, of St. Louis, kindly placed at the disposal of the laboratory about a gallon of the liquid clarifying agent manufactured and sold by them under the name of "Clariphos." This preparation is a strong solution of acid phosphate of lime and has very active clarifying and defecating properties. Some small lots of juice, treated with this agent, brightened very perceptibly in color, and on standing, quite a considerable amount of precipitated impurities settled. This suspended matter was separated by filtering through a coarse cloth, and the clear liquid was evaporated down to a bright syrup. "Clariphos" has been employed very successfully in the sugar houses in Louisiana and is undoubtedly a valuable

clarifying agent, but the increased amount of manipulation required in the way of settling, filtering, etc., interferes materially with its adaptability to syrup making upon a small scale.

In the present season, a small quantity of bi-sulphite of lime solution was purchased for use as a substitute for sulphurous acid, gas in clarifying juices. A severe freeze damaged the cane selected for experimental purposes and before the experiments in syrup making could be carried out, fermentation had set in, causing still further injury to the cane, as was indicated by the low sucrose and the high glucose content. A sample of the juice of the cane taken when the experiments were in progress showed 16.1 per cent. Total Solids, 8.8 per cent. Sucrose, and 5.0 per cent. Glucose.

A small lot of fresh cane gave quite a satisfactory syrup by the use of bi-sulphite of lime, but some of the products of fermentation of the larger lot of cane made the process of clarification much more difficult than in the case of the fresh cane. The bi-sulphite was employed on a neighboring plantation with fairly good results, and it is believed that under normal conditions it can be used to advantage as a substitute for the sulphurous acid gas. About one quart of the bi-sulphite was added to fifty gallons of juice, the clarification and removal of scums being conducted as before described. If settling vessels of sufficient capacity are at hand, it is best to allow the juice to stand for some time after the addition of the bi-sulphite of lime in order to secure the full clarifying effect of the latter.

The syrup produced in the experiments with the damaged cane was found on analysis to exhibit the following composition: Total solids, 71.9 per cent., Sucrose, 44.7 per cent., Glucose, 26.4 per cent. These figures show practically no loss from inversion on evaporation and with a good quality of fresh cane, a much better grade of syrup would have been produced.

Further experiments with clarifying agents and with steam evaporators will be conducted during the next season and it is hoped that additional information of value on this subject will be secured.