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Food Yeast from Cane Molasses

By

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Yeasts are unicellular fungi which thrive in a sugary medium and are responsible for various types of fermentation. They are widely employed in industrial concerns for the production of alcohol and alcoholic drinks. The yeasts themselves are rich in proteins and also vitamins of the B complex (especially thiamin, riboflavin and nicotinic acid). These are important accessory factors in human nutrition. Consequently the yeast sludge obtained from fermentation industries is dried and marketed.

But food yeast is another type, which is more palatable and grows readily on molasses. It does not produce much of alcohol. The use of yeast is highly desirable in a country where the people use as staple food starchy grains like polished rice, so that the deficiencies in protein and vitamins can be made up.

Cane molasses from one of the chief raw materials in yeast manufacture and this is available in plenty as a waste product of sugar industry. From the point of view of agricultural economy the utilisation of such waste products is of great importance. The following extract from the booklet published by the Colonial Food Yeast Ltd., is interesting. It says "Taking as a basis the acreage required for the production of necessary sugary material, the most bulky of the raw materials the yield of protein per acre in food yeast is several times that of the best protein producing plants directly available as human food, i. e. leguminous seeds, and many times that derived indirectly from plant material in the form of animal food products (meat, milk, eggs etc.). From this point of view the production of food yeast promises to be a most economic means, in terms of the use of agricultural resources, of improving the dietaries of people who have a low standard of living".

Much progress has been made in foreign countries in perfecting a process of manufacturing food yeast, by using a particular strain of the organism called *Torulopsis utilis* and large-scale developments are taking place in the establishment of food yeast industry. The Colonial Food Yeast Ltd., London, a Government undertaking sponsored by the British Colonial Office have started as early as in 1944 a project in Jamaica for the establishment of a huge food yeast factory at a cost of £.150,000/-; the funds being provided by an interest-free loan by the Government under the Colonial Development and Welfare Act. The Government of South

Africa have also recently sponsored the establishment of an experimental factory for the manufacture of food yeast with the idea of supplying the protein requirements of the native population.

Work at Coimbatore: In order to find out the commercial possibilities of food yeast production under South Indian conditions and to help private enterprise in a new venture calculated to contribute to the rectification of nutritional deficiencies in the dietary of our people, investigations were undertaken in the first instance in a small laboratory plant. This consisted of a cylindrical aluminium fermentation vessel of 50 gallons capacity provided with a lid. The lid had two openings, one in the centre to admit a $\frac{3}{4}$" air main of a star-shaped aerator resting on the bottom of the vessel and another provided with a hinged shutter to admit a large-size funnel for addition of periodical charges of concentrated wort (molasses solution). The vat was provided with a sampling tap on the side and an exhaust tap at the bottom for emptying the contents. The air main was connected to an air blower worked by a $\frac{1}{4}$ H. P. motor.

The Process: The following process was first adopted. Twenty five pounds of cane molasses of an average total sugar content of 50 per cent were diluted with an equal volume of tap water, 4 ounces of arsenic-free double superphosphate and 21 cc. of 1 : 1 sulphuric acid added to the solution and kept at boiling point for ten minutes. The mixture was left undisturbed for 3 to 4 hours and the precipitates allowed to settle. The supernatant clear liquid was then siphoned off. A solution of ammonium phosphate was prepared by mixing an aqueous solution of ammonium sulphate (280 grams of ammonium sulphate in two litres of water) with an aqueous extract of arsenic-free double superphosphate (500 grams in 3 litres of water) and siphoning off the clear liquid. With the above stock solutions 8 litres of the concentrated wort was diluted with 35 gallons of tap water to form the initial charge. The sugar level had to be maintained at 0.6 percent. Ammonium phosphate solution was added at the rate of 100 cc. for every pound of molasses used. Seed yeast originally multiplied from single cell cultures of *Torulopis utilis* var. *major* (A Teddington strain obtained through the courtesy of the Head of the Division of Mycology. Indian Agricultural Research Institute, New Delhi) and kept over from the previous day's production was added at the rate of 6 litres of cream (equivalent to about 12 oz. of dry yeast). Filtered air was blown through the medium at the rate of about 2 c.ft. per minute. Additional charges of concentrated wort were made at the following rates.

1. After 1½ hours — 8 litres of concentrated wort and 130 cc. phosphate solution.
2. " 3 " 8 litres do
3. " 5 " 6 litres do

The temperature of the wort at the start was round about 28°C. and the rise in temperature during the generating period of 8 hours was about 2 to 3°C. The initial pH of the medium was kept at 5 by addition of 1 : 1 sulphuric acid. With the progress of aeration and multiplication of yeast a rapid fall in the pH of the wort was noted. The pH was however, checked up at intervals of 30 minutes and maintained at about 4-8 by addition of a ten percent solution of commercial ammonium carbonate. At the end of 8 hours the aeration was stopped. The yeast settled to the bottom of the tank in about an hour. The spent wort was drained off through the side tap and the sludge was further washed by changes of fresh water and settling again. The cream yeast was then passed to a basket type centrifuge from which it was collected as a wet cake. This was drawn into strings and spread over a cloth tray and dried in the hot air oven at about 50°C. The dried vermicelli was ground into fine powder. In the initial stages wide variations were observed in the yield of yeast; on an average a net yield of 18 ounces of dry yeast was obtained for every 25 pounds of molasses used. It was necessary to exercise the utmost care in regard to the supply of nutriments and to the maintenance of purity of the culture, to ensure satisfactory returns.

In order to determine the optimum amount of sugar required to produce the maximum outturn of yeast within a period of 8 hours, variations were tried in the total quantity of molasses used. 18 lb., 25 lb. and 30 lb. of molasses were used and the other factors were kept constant. The total sugars in the wort were estimated at intervals and the periodical addition of concentrated wort was controlled so as to avoid excess of sugar at any stage. The results showed that with 25 lb. of molasses 11 percent by weight of dry yeast was obtained as against 10% and 8% with the use of 18 and 30 lb. of molasses respectively.

The optimum pH of the wort for satisfactory production was reported to be 4·8. With the progress of the growth period the pH showed a sharp fall within an hour from the start. Alkaline agents like liquor ammonia and caustic soda have been recommended to bring up the pH. Caustic soda was found to be unsatisfactory, apart from having an inhibitory effect on yeast growth it also affected adversely the settling quality of yeast. A ten-percent solution of ammonium carbonate was tried and found to be a very good substitute for liquor ammonia. Its availability as a commercial product of fairly high purity and the absence of any harmful effects on the yeast are favourable points for recommending it in the place of liquor ammonia.

A small pilot plant with a productive capacity of about seven pounds of food yeast per day was installed early in 1948 and has been working for about two years now. The important items of equipment fitted up are: (1) a clarification tank (400 gallons), (2) a clear wort tank (200 gallons), (3) two sterilization and storage tanks (200 gallons),

(4) two yeast generators (350 gallons) (5) a centrifuge for separating yeast, (6) a vermicelli press, (7) a drying oven and (8) a pulveriser. An air compressor and ceramic aerators were also fitted up for aeration of the medium. A separate set of seed multiplication equipment was also got up.

The method followed in the pilot plant was generally on the lines adopted in the laboratory plant with suitable modifications wherever necessary. Studies on some important aspects were taken up.

Clarification of molasses: This is an important operation which helps in removing substances that are harmful to yeast growth. There are several methods of clarification among which the lime process gave satisfactory results. 1,000 lb. of molasses were dissolved in about 120 gallons of water. Two litres of sulphuric acid were added bringing down the pH from 6 to 4·8. The solution was heated to about 70°C. by letting in live steam. Then 10 lb. of calcium superphosphate were added and the heating continued to bring the solution to boil for ten minutes. After an hour's time milk of lime prepared by slaking 5 lb. of quick lime was added and the solution was agitated. It was then allowed to stand overnight and the clear brown wort was decanted and pumped to the storage tank for sterilization. This method of clarification resulted in considerable improvement in the colour and flavour of yeast and a marked increase in yield was also noted.

Utilisation of sugar by the organism: During a fixed period of seven hours quantities of molasses solution containing 50 lb., 56 lb., 60 lb. and 64 lb. of total sugars were used, the quantity being distributed four charges. The sugar content of the wort was estimated and the addition of molasses solution was so regulated as to avoid accumulation of sugar. It was found that the maximum utilisation of sugar by the organism took place when 50 lb. of sugar were used and a yield amounting to 14% recovery of yeast was obtained. In other cases the sugar levels in the substrate became uneven and the yields were also low.

Optimum level of inoculum: An experiment was carried out in which the quantities of inoculum used were varied, keeping other factors constant. Quantities equivalent to ½%, 1% and 1½% of the weight of the medium (calculated on wet yeast basis) were used as seed. The average yield of yeast obtained worked out to 11, 12 and 14 percent on sugars, thus showing that the optimum quantity of inoculum to be used was 1% of the weight of the medium.

The use of roller drier: It was found that much time and labour could be saved if the roller drier was used for drying yeast instead of the vermicelli press, the drying oven and the pulverisor. Roller drying of yeast was a quick and simple process and the product obtained had also a better flavour compared to oven-dried yeast.

Economics of yeast production: By the experiments carried out in the pilot plant at Coimbatore, it has been possible to increase the recovery of yeast from 8% at the start to 14%. This is of course still considered as a low yield and much higher percentages of recovery have been claimed in other countries. Further work in the pilot plant is being pursued to improve production. The cost of production of yeast in the pilot plant has been high (about Rs. 3/- per pound) and two factors have contributed towards it, the high steam charges and the cost of purchasing and transporting molasses, the chief raw material. But this cost of production should not be taken as a standard. The experience so far gained has shown that yeast manufacture can be a profitable concern if it is started as an adjunct to a sugar factory where molasses form a waste product and there is no charge for transport. Further the overhead charges can also be considerably reduced as many of the facilities available in the sugar factory, can be easily utilised for yeast production.

Yeast industry is bound to be of national importance in a country of undernourished population like ours. The raw material is available in plenty as a waste product. It is hoped that the work carried on at Coimbatore will provide the necessary incentive and encouragement to private enterprise.

Cardamom — (Elettaria Cardamomum, Maton)

By

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Cardamom Specialist

Cardamom occurs wild in the evergreen jungles of the Western Ghats in Travancore, Madras, Coorg and Mysore. It is also cultivated in those areas between 2,500 to 4,500 ft. above sea level. It can be grown only under the shade of forest trees and it does well in areas where the annual rainfall is about 100 inches and well distributed. Cardamom is almost entirely a South Indian product though its cultivation extends to Ceylon, Eastern Archipelago and Java to a comparatively small extent.

Cardamoms are used in India for flavouring sweets and curry powders. They from part of some Indian medicines. They are used for flavouring cakes in Europe especially in Russia, Sweden, Norway and parts of Germany. In European medicine, they are chiefly used in tincture of cardamom, as a stomachic, and in combination with other