A STUDY IN THE DEXTRAN CONTENT IN SUGAR CANE AND ITS CONTROL IN SANGHAR SUGAR MILLS LTD., SANGHAR

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ABSTRACT

With the proper cane management, improved hygiene at the mills and process streams, etc., at the Sanghar Sugar Mills Ltd (SSML), the problem of very high content of dextran in sugar cane i.e. above 18,000 ppm was checked and brought down to a level of 3000. Due to reduction in the dextran content in cane, the cane juice pH increased by 0.3o, the final molasses purity decreased by 3o, steam consumption decreased by 12%, purity drop between crusher juice and mixed juice decreased by 21%, the process house including centrifugals were able to accommodate higher cane crushing, the boiling house and overall efficiencies increased by 10%, the sugar recovery% cane increased by 0.57o, the colour of sugar decreased by 50% and pol of white sugar increased by 0.2o.

INTRODUCTION

The SSML was confronted with the problem of high dextran content i.e. above 18,000 ppm in sugar cane. This was creating serious problems in processing of the cane, pan boiling, difficulty in purging of massecuites in sugar centrifugals, reduced crushing capacity, low sugar recovery % cane, higher consumption of steam, lower boiling house & overall efficiencies, higher purity of final molasses and high color of sugar. From crushing season 2007-08 onward a comprehensive plan was chalked out to control the dextran in sugar cane and avoid its harmful effects in milling, boiling house operation and the overall working.

REVIEW OF LITERATURE

Dextran, a gummy substance, is a polymer of glucose and is produced by micro-organisms as a result of post harvest deterioration of sugar cane. Sucrose (disaccharide) is biologically degraded into glucose and fructose (monosaccharides), particularly by leuconostoc mesenteroides, which produces dextran sucrose to cause polymerization of glucose into a polysaccharide called dextran. It is melassigenic and carries through the manufacturing process into sugar. Dextran becomes a problem when the dextran content of juice rises above 2000mg/kg. Due to increased dextran levels, the factory capacity is reduced with increased viscosities, increase evaporation and boiling time, decrease in crystallization rate. Besides processing problems, dextran causes great loss to sugar in cane. Dextran also increases the polarization reading and interferes in the sucrose analysis (Guglliemone *et al*, 2000 and Rein, 2007).

Formation of dextran starts in the cane after harvesting but its multiplication takes place much faster after 6 hours of harvesting. Dextran is a finished product of the microbial infection caused through bacteria. Dextran is commonly produced in sugar processing streams by bacteria of the Genera Lactobacillus, Leuconostoc and Streptococcus.

However, of these Leuconostoc Mesenteriod (LM) is most effective organism in sugar cane which degrades its sucrose contents and produces dextran. The LM duplicates its population every 10 minutes and almost 3 – 4 Kg of sucrose is lost for each Kg of dextran formation. LM grows at 60oc feely or below and at slightly acid to neutral pH, in cane tissues exposed to the environment, also in cane juice and low brix solutions. The bacteria mainly Leuconostoc species enter the cane at places of exposed tissues caused by machine harvesting, cutting, burning, freezing, disease and pests. Any delay in the cut to mill time allows the bacteria to proliferate and the dextran level soar, especially in the wet muddy cane. (Cuddinhy, 2001; Pulido and Raza, 1987).

Dextran in juice, syrup and sugar can cause false pol, because dextran polarizes about 3 times as much as sucrose and gives a high pol. Dextran in solutions increase viscosity, lowers evaporation rates and reduces heat transfer. It slows boiling time and purging in centrifugals. It is estimated that for every 300ppm dextran in syrup there is a 1% increase in the molasses purity (William, 2001). Level of dextran in cane is co-related with from cut to crush time. It is likely to build up in numbers on wet, muddy cane, on cane with lot of exposed tissue surface or injury from frost, disease or pests. Also dextran content of cane varieties with hard rind contained lower quality of dextran as compared to soft rind cane varieties (Imtiaz Ali, 1987, Hayat 2006).

High level of dextran has been found to lead to higher final molasses purites. It is expected that levels of above 10,000 mg/kg dextran on solids, the target purity should increase by 0.2 units for each increase in dextran level of 1000 mg/kg dry solids (Rein, 2007).

WORKING DATA

The SSML commenced its operation during 1987-88 with a crushing capacity of 5000 tons cane per day (tcd) following defection remelt phosphotation process for production of white sugar of 99.8o pol and 60 (+ 20) ICUMSA color. The technical results obtained during the first 20 years of operation (1987-88 to 2006-07) of the SSML are **given** as under (Table-1).

Table-1 SSML technical results, 1987-88 to 2006-07

Description	Average of Five seasons (per season)			
	1987-88 to 1991-92	1992-93 to 1996-97	1997-98 to 2001-02	2002-03 to 2006-07
Cane Crushing/ day, tons	2591	2966	3360	3472
Sugar recovery % cane	8.99	9.17	8.92	9.00
Purity drop from crusher to mixed juice	1.58	1.52	1.46	1.52
Steam consumption % cane	n/a	72	70	66
Av. Purity drop from massecuite to molasses	14 – 16	14 - 16	14 - 16	14 - 16
Final molasses purity	36.35	36.14	36.61	36.16
Boiling house efficiency %	81.66	82.54	83.21	84.00
Overall efficiency %	74.50	76.78	77.31	79.27
Color of raw A-sugar, ICUMSA	850 – 1000	850 – 1000	850 – 1000	850 – 1000
ICUMSA Color of R1, R2 & R3 white sugars	50 – 120	50 - 120	50 – 120	50 – 120
Polo of white sugar	99.4 – 99.7	99.4 – 99.7	99.4 – 99.7	99.4 – 99.7

From the available date (table-1), it will be noted that: Cane crushing was low i.e. 70% of the capacity. Sugar recovery % was low i.e. about 9% on cane. Purity drop from crusher juice to mixed juice was high, i.e. + 1.5o. Steam consumption % cane was high i.e. 66%. Final molasses purity was very high i.e. +36o. The boiling house efficiency was low i.e. 84%, and overall efficiency was below 80%. The purity drop between all the A, B & C massecuites and relative molasses was low i.e. 14-16o. The ICUMSA color of raw A-sugar was high i.e. 850-1000, white sugar 50-120, and the pol of white sugar was low i.e. 99.4 o - 99.7o. Considering all the above points during 2006-07 season, the attention was focused towards improving the working efficiency of SSML with special reference to increasing the productivity, the sugar recovery and sugar quality, and minimizing the sugar losses, etc. With the physical observations and analysis of the sugar cane being crushed in the SSML, it was noted that: Old cut cane,

borer pest damaged, with lot of top, and trash was coming to the mills. There was a long queue of cane loaded vehicles (more than 400 at a time with + 15 tons cane weight each) were waiting for their turn at the mills. On survey of cane farmers fields, huge heaps of old harvested cane was observed. On analysis of cane juice, the pH was found to be between 4.9 – 5.2 i.e. a sign of old harvested and pest damaged cane. As there was no arrangement in the SSML for analysis of dextran in cane, it was got analysed from neighboring sugar mills, the Agricultural University and Agricultural Research Institute. The results obtained showed alarmingly high dextran content in cane juice ranging from 9259 to 23928ppm. The color of cane syrup was dark, and viscous dark colored massecuite was boiled in the vacuum pans. The viscous massecuite was creating difficulties in centrifugal purging with reduced capacity and extra washing.

WORK PLAN

With the available data, a work plan was prepared and followed from crushing season 2007-08 onward, main of them are:

a. Proper, computerized cane procurement program was chalked out and followed.
b. Regular visits to cane farmers and their cane fields by the SSML staff was organized to make them observe the cane supply program and manage harvesting accordingly.
c. Check the pests and diseases of sugar cane with the use of healthy seed, use of pesticides and biological control, etc.
d. The Cane Department was strengthened and re-organized with the establishment of a cane development cell.

A biological control laboratory was established at the SSML to produce Trichogramma Chilonis cards which were distributed to sugar cane farmers at 50% subsidised rates. Literature, wall posters, banners, etc on cultivation of sugar cane, plant protection, variety selection, seed treatment, pest management and other agronomic practices, etc were distributed freely to the sugar cane farmers of the area. Get- together meetings of the cane farmers were organized at the SSML and also at the farms of prominent cane farmers of the area to make them aware of latest agronomic practices and the SSML requirements. It was addressed by prominent agricultural scientists.

a. Arrangements for analysis of dextran in the SSML chemical laboratory was made, and dextran was analysed on regular basis, at least once in every shift.
b. Analysis of pH of crusher juice was made a routine every hour, and the purity

drop from crusher juice to mixed juice was also noted on hourly basis. Proper sanitation at the mills and process house was maintained with hot water washing, steaming, and use of bleaching powder and biocides. However, the use of enzyme dextranase to check dextran in process was not considered being an expensive treatment.

RESULTS AND DISCUSSION

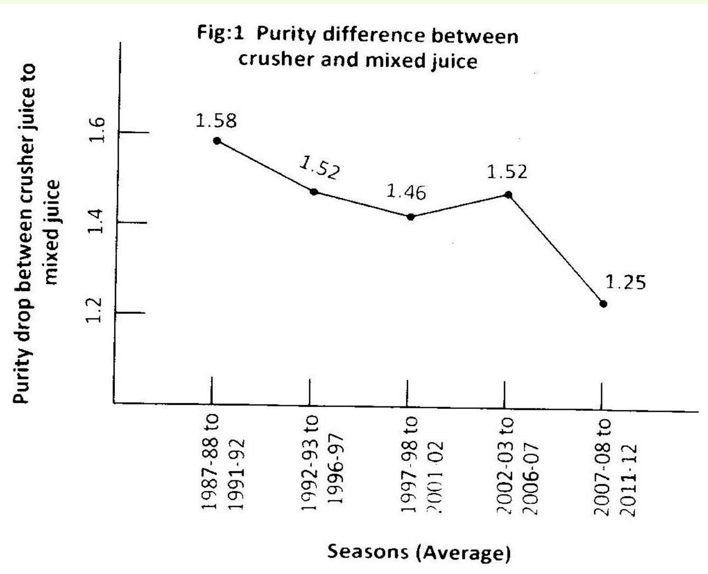
As a result of all the above mentioned measures taken from 2007 onwards, including the procurement of healthy, fresh & clean cane, improving the sanitation at the mills and the process streams, reduction in cut to crush time, etc., marked improvements were observed in the overall working of the SSML. The results obtained between seasons 2007-08 to 2011-12 and compared with previous 20 seasons 1987-88 to 2006-07 are discussed herewith:

Dextran: The dextran content in cane juice reduced to 3588ppm during 2008-12 as compared to +18965 previously. This resulted in the improvements of overall working and the production results. Given below are the analysis results of dextran in cane juice from 2006 to 2012. (Table-II)

Table- 2 Dextran content in SSML sugar cane 2006 to 2012

Description	Dextran in cane juice ppm / Brix	
	2006-07	2008-12
Sample No. 1	21093	4063
Sample No. 2	15563	3222
Sample No. 3	9259	2560
Sample No. 4	23928	4151
Sample No. 5	18030	3995
Sample No. 6	20711	3560
Sample No. 7	23478	3569
Average	18965	3588

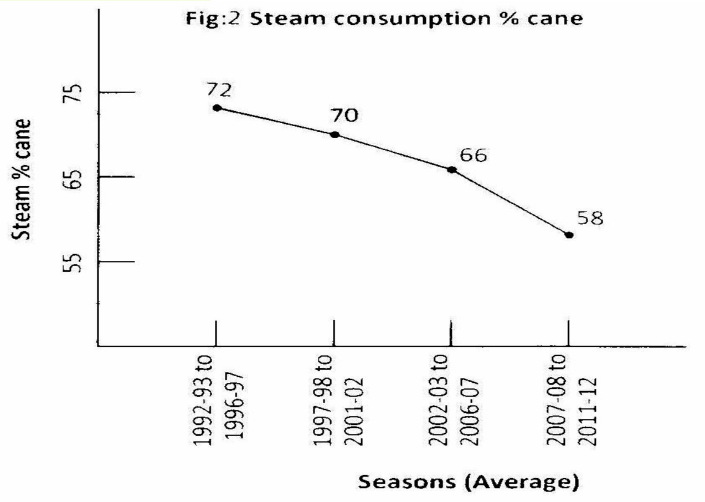
Juice purities: The purity difference from crusher juice to mixed juice dropped to 1.25 as compared to previous + 1.5o i.e. a decrease of 21% (Fig-01).



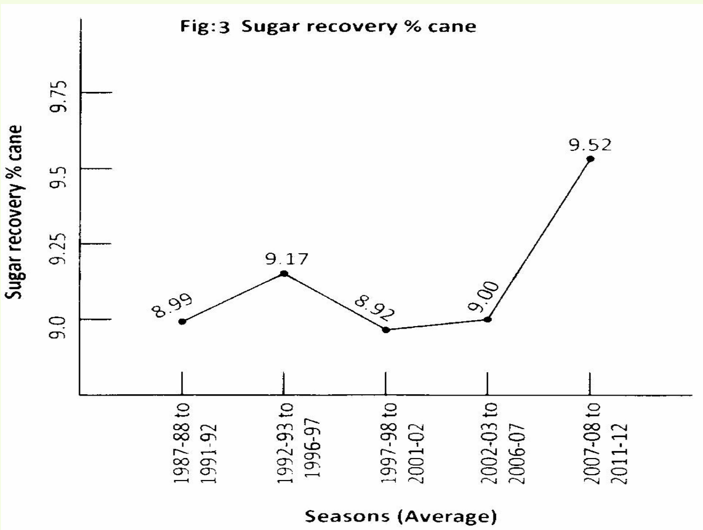
pH of cane juice: The pH of the cane juice improved to 5.4 and 5.5 i.e. near the natural pH of the juice during 2007-08 to 2011 as compared to 4.9 – 5.2 pH in 1987-2007 seasons i.e. an increase of 8%.

Cane crushing: During 2007-08 to 2011-12 the cane crushing rate of 4447 tcd was achieved which was an increase of 29% as compared to 2002-03 to 2006-07 seasons. One of the reasons being that the boiling house was able to accommodate higher crushing due to lower dextran in cane, easy pan boiling, good quality massecuite, easy purging at centrifugals, etc.

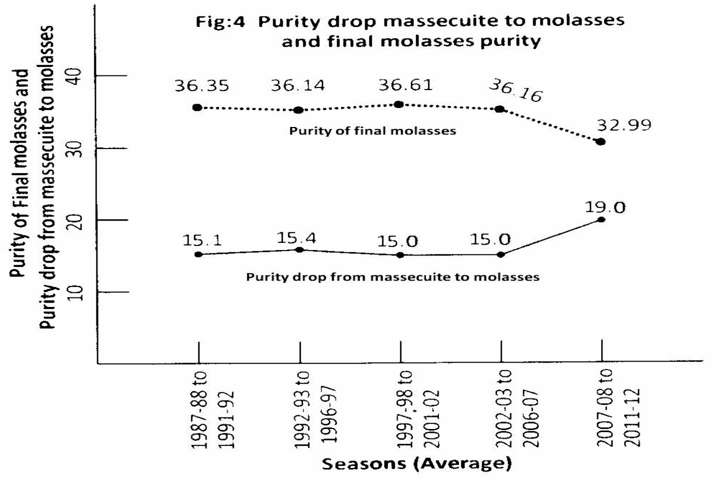
Steam consumption: with the decrease in the dextran content, there was improvement in evaporation, smooth pan boiling and ease at the purging of massecuites in centrifugals, etc. Therefore, there was a decrease of 12% in the steam consumption during 2007-08 to 2011-12 as compared to 2002-03 to 2006-07 seasons (Fig-02).



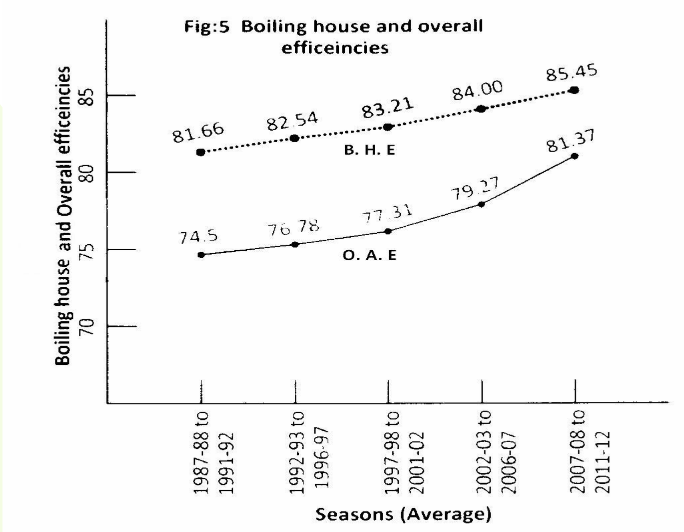
Sugar recovery % cane: The sugar recovery % cane during 2007-08 to 2011-12 increased by 0.57o i.e. an increase of 6% as compared to 2002-03 to 2006-07 seasons (Fig-03). This was due to fresh, clean and healthy cane with low dextran content and improvements in the boiling house and overall efficiencies, etc.



Massecuite and molasses purities: The purity drop from massecuites to molasses during 2007-08 to 2011-12 remained between 18-20o. This was an increase of 12% as compared with 2002-03 to 2006-07. Similarly the final molasses purity also decreased by 10%. (Fig-04)



Boiling house and overall efficiencies (BHE & OAE): During 2007-08 to 2011-12, the B.H.E. and O.A.E. increased to 85.45 and 81.37 respectively (Fig-05). This was an increase of 10% over the 2002-03 to 2006-07 seasons.



Sugar quality: During 2007-08 to 2011-12, the ICUMSA color of white sugar improved to 30-60 and the polarization to 99.8 as compared to 50-120 color and 99.4 – 99.7 pol sugar during 2002-03 to 2006-07 seasons.

SUMMARY AND CONCLUSION

Various measures were taken to reduce the high content of dextran in sugar cane coming to the SSML e.g. to procure healthy, clean and fresh cane, reduce the time between harvesting of sugar cane and milling of the same, and improve the hygiene at the mills and process streams. This resulted in decrease in dextran content in cane by +500% and improvements in the overall working results of the SSML, i.e.

Increase in sugar recovery % cane by 0.57o.
Increase in boiling house and overall efficiencies by 10%.
Increase in the cane juice pH by 0.3o.
Decrease in purity drop from crusher juice to mixed juice by 0.27o.
Decrease in steam consumption % cane by 12%.
Decrease in color of sugar by 50%.
Increase in the pol of white sugar by 0.2o.
Decrease in final molasses purity by 3.01o.
Increase in purity drop from massecuite to molasses by 12%.
Improvements in the color of cane syrup and massecuites, easy vacuum pan boiling and purging at centrifugals due to low viscosity, etc.

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