Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2013, 5(7):267-271

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

New analytical methodology for sugar quality assessment

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ABSTRACT

During recent years the proper control of intermediate stages of plantation white sugar manufacture is drawing an increasing amount of attention. The accounting of chemical behavior of sugars in their complex technology, certain controlling parameters as routine analysis is imperative. In the ongoing process these parameters should have wider range for better control.Conventionally the Brix, Pol., Purity, pH, Temperature are the usual parameters, which are measured in a routine way. The oblique view of these parameters is having constraints for obvious hidden reasons. To explain point wise constraints, the parameter Brix can be taken as an error prone because of calibration based value in pure sucrose solution. It deviates in technical solution and does not maintain linear relationship on dilution. Regarding Pol, it is affected in the presence of other optically active substances in the sugarhouse products. Secondly the lead sub acetate is a great pollutant and should be avoided.In sulphitation process the clarification norms are based on parameters viz. purity rise and pH. From mixed juice to clear juice rise in the range of 0.2 to 0.8 unit only which is having a very narrow range of control. Besides these, the importance of representative sampling in terms of their corresponding data to audit the process behavior has to be ascertained. In fact this is not practicable for routine analysis hence defeats the basic purpose. Next come the ash determination for quality control is also having its own limitations. For ash determination, it demands a great expenditure of time, error prone for high tare mass, hardly suitable for routine analysis and due to its poor reproducibility the parameter can not be considered as a routine control.

Keywords: Sugar Conductivity, quality control, non sugar, cane juices.

INTRODUCTION

The sugar manufacture process basically is a conversion of cane juice into plantation white sugar, and can be divided into eight different stages of processing viz. extraction of the juice from cane and its clarification, concentration/evaporation, crystallization, crystal separation/centrifugation, drying and bagging of the end product. Out of these the nodal point of the present study is the clarification zone only. Furthermore, Honig **[**1**]**mentioned that most misleading of all the figures determined is purity.

To study the degree of clarification, a few points cast doubts on the validity of the measurement in terms of its accuracy as described above. The error is owing to the fact that the percentage of the dissolved impurities differs from the corresponding percentage of sucrose **[**2**]**.

In order to have the idea of reality prevailing in the system it is necessary to use a different dimension, which should be meaningful and magnified enough for better control of the process system. Similar to colour audit, the conductivity audit can also bring out as a very effective controlling system.

Vikesh **[**3**]** in way back 2011, has established the purity determination by conductivity measurements. The conductivity ashes, the degree of staleness in cane by means of conductivity data**[4]**have also been established for their reliability. Conductivity titration can be utilized for balanced reaction of phosphate addition **[**5**]** which is another beneficial aspect. The aqueous solution falls just about half way between the tow extremes in conductivity. This is a point of consideration in case of cane juice being 85% aqueous in nature. Besides this ICUMSA has also recommended in that specific conductivity of sugar solution have its own significance and so the conductivity ash percent. The extension of such logical approach has been utilization by way of measuring the conductivity[6] of sugarhouse products at different stages. This has opened a new horizon of estimation in the process control **[7]** in terms of 'Conductivity Audit'.

EXPERIMENTAL SECTION

This study has been taken up initially in all types of cane juices as obtained directly from sugar factories. In the present investigation, the conductance of Mixed Juice, Clear Juice, Sulphited Syrup, Unsulphited Syrup have been carried out. All the chemicals taken as AR grade obtained from BDH. The cane juices samples were collected from different sugar factories .The conductance measurement were carried out by using Thermo Orion model 555 – A, having auto temperature compensation system..

The conductances for above types of juices were measured at different temperature and for different sets of readings till reproducible values were obtained. Because of good linear dependency and unproblematic handling KCl solution is favored as standard for calibrating the instruments and measuring the cell constant.

All the observations were collected for three parallel set of readings and the average values were utilized for delineating the graphical presentation.

RESULTS AND DISCUSSION

Data observed

Five sugar factories of different zones of India were chosen for data collection. All data relates to white cane sugar manufacturing system with similar process control. Only clarification zone has been studied i.e. mixed juice to sul.syrup with clear juice and unsul. syrup as intermediate stages.

Cane juice clarification depends on the degree of primary flocculation/ precipitation which scavenges the turbidity particles to produce clear juice. The mixed juice which is subjected to clarification treatment leads to separation of insoluble ionic impurities by means of precipitation or flocculation. However, the soluble ionic impurities enter the clear juice and onward. And accordingly the account of these soluble ionic impurities can provide a control over ongoing process.

Data analysis

Initially the dilution effect on specific conductivity of mixed juice has been evaluated. Table 1 provides the data and same is delineated in Fig.1. The figure shows a linear relationship between dilution and specific conductivity. It clearly indicates that at any dilution the conductivity audit can be estimated but it depends on couple of points. Firstly more the diluted sample betters the homogeneity of ions and their mobility which ultimately is responsible for the conductivity measurement. Secondly it depends on the conductivity meter for its maximum range of readability. Taking both the points and in particular the conductivity meter, in the present case a pen type model is used and all the observations were taken at 5% v/v dilution. The dilution was done by demineralized water of zero iconicity. By carrying out 5% v/v dilution the consequent effect of temperature on conductivity is also nullified. This is due to making the making the sample at almost room temperature.

Table – 1

S. No.	% Dilution	Conductivity (µS/cm)
1.	2%	160
2.	5%	360
3.	7%	500
4.	10%	620
5.	20%	1130

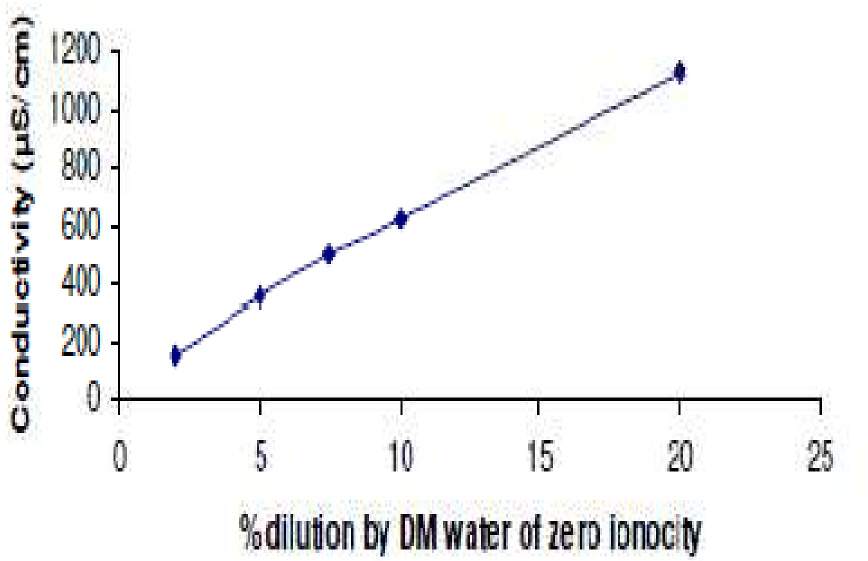
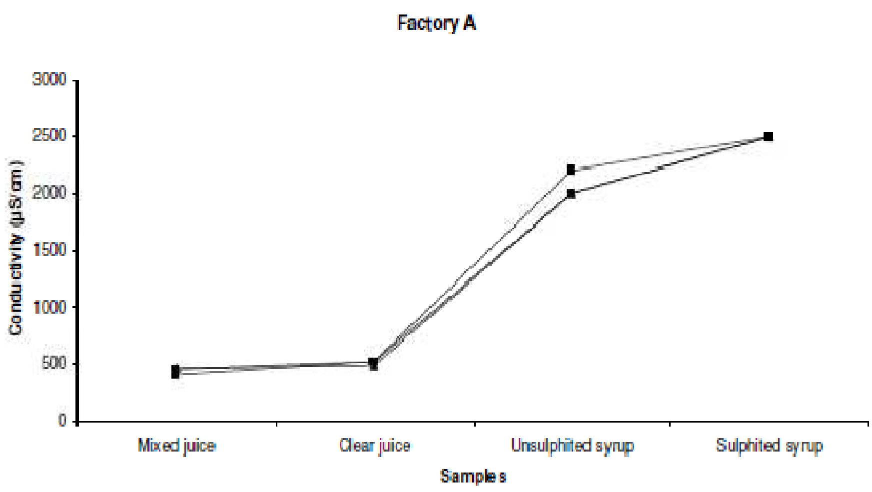


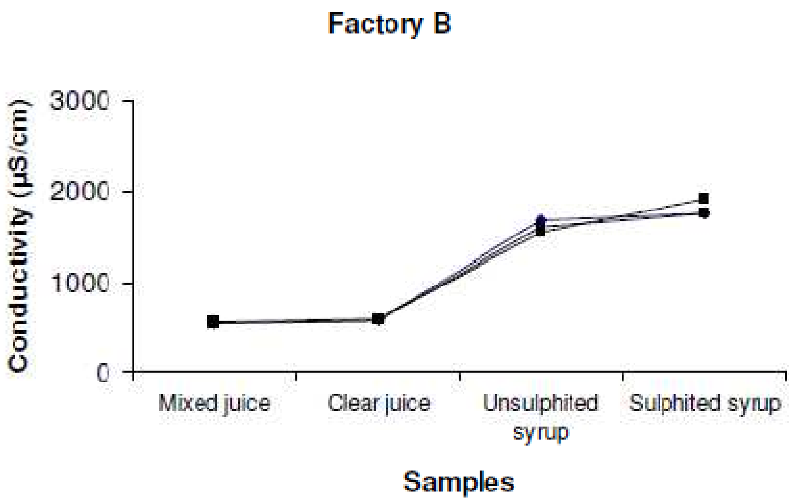
Figure 1 Dilution effect on conductivity of mixed juice

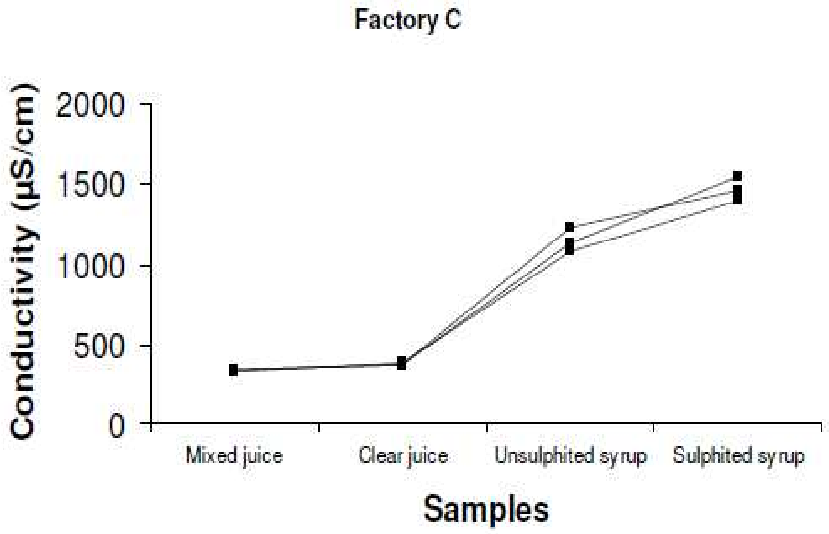
As described under data observed, five sugar factories of different zones were chosen and their conductivity audits were drawn as given in Table II. Graphs are delineated from the given table and shown as factory A, B, C, D, & E.

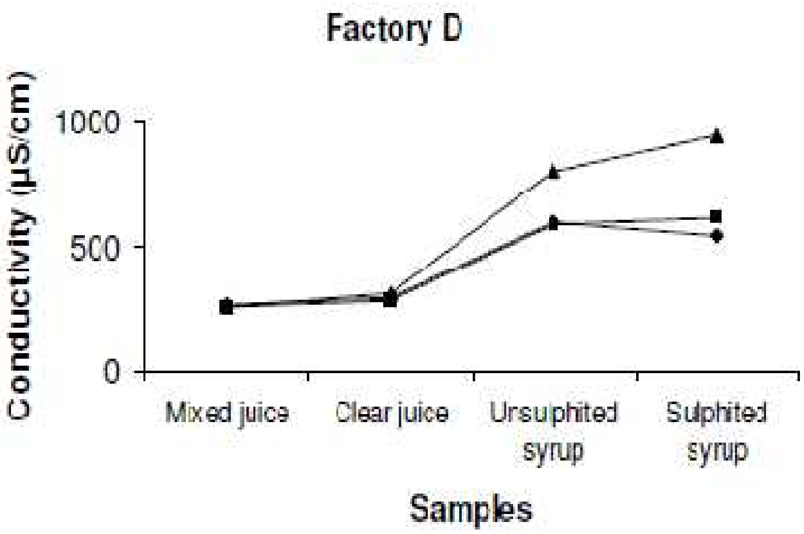
Table – 2

Factory Set No.	Particular	Mixed Juice	Clear Juice	Un.S. Syrup	S. Syrup	%Rise from M. J to Cl.J	% Rise from M. J.to S.Sy
A-1	Conductivity(µS/cm)	400	520	2200	2500	23.077	84.00
A-2	Conductivity(µS/cm)	450	520	2000	2500	13.462	82.00
A-3	Conductivity(µS/cm)	460	520	2000	2500	11.538	81.60
B-1	Conductivity(µS/cm)	530	580	1670	1750	8.621	69.71
B-2	Conductivity(µS/cm)	560	590	1530	1910	5.085	70.68
B-3	Conductivity(µS/cm)	530	580	1600	1750	8.621	69.71
C-1	Conductivity(µS/cm)	340	370	1130	1540	8.108	77.92
C-2	Conductivity(µS/cm)	340	370	1230	1460	8.108	76.71
C-3	Conductivity(µS/cm)	330	380	1080	1400	13.158	76.43
D-1	Conductivity(µS/cm)	264	292	596	541	9.589	51.20
D-2	Conductivity(µS/cm)	260	290	590	620	10.345	58.60
D-3	Conductivity(µS/cm)	260	310	800	950	16.129	72.63
E-1	Conductivity(µS/cm)	440	510	1720	1980	13.7	78.0
E-2	Conductivity(µS/cm)	450	580	1780	1870	22.4	75.9
E-3	Conductivity(µS/cm)	410	490	1700	1850	16.0	77.9




Factory B
Conductivity (µS/cm)
3000
2000
1000
0
Mixed juice
Clear juice
Unsulphited syrup
Sulphited syrup
Samples


Factory C
Conductivity (µS/cm)
2000
1500
1000
500
0
Mixed juice
Clear juice
Unsulphited syrup
Sulphited syrup
Samples


Factory D
Conductivity (µS/cm)
1000
500
0
Mixed juice
Clear juice
Unsulphited syrup
Sulphited syrup
Samples

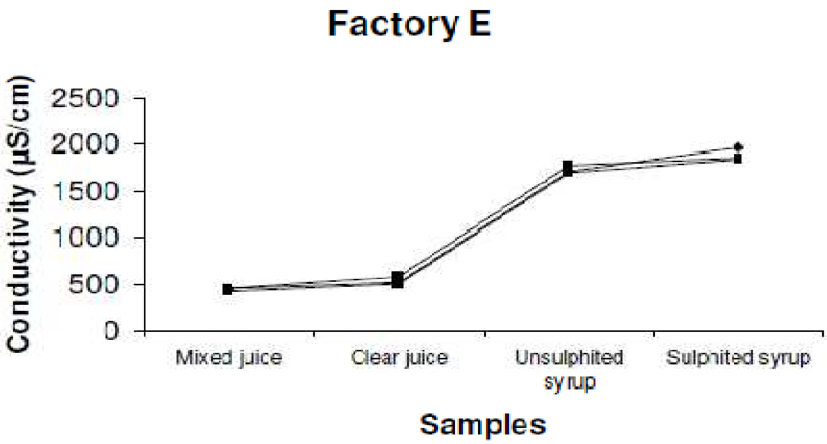


Figure 2 A-E -Conductivity analyses of different mill juices of different mills

It is evident in conductometric titration[6] that at neutralization point there is a dip in the curve followed by a rise. In the present system the rise in clear juice clearly indicates the percent rise in CaO content after precipitable calcium ions are consumed. Each factory shows an overall rise in a consistent trend. This clearly indicated that, lesser the impurity i.e. soluble ions cause higher conductivity and consequently upon the decrease in viscosity gives a rise in conductivity.

Furthermore the close observation of factory D shows a significant rise in the last column i.e. from fifties to 72.6. This rise was brought upon by changing the milk of lime dose and other adjustment in the clarification system in the factory. This change clearly indicates that conductivity audit is a true reflection of any change in the clarification system and hence can cause a better control on the process by way of its routine analysis. More work and data collection is in progress and shall be communicated in much detail form covering the complete process stage by stage.

Inference

As observed over the years of experience the control of process is imperative in sugar industry, conventionally the parameter being used can be of meaning for complete auditing of the sugar processing from start to end stage. However this study and observations concludes a new step for the control of the process. This proposed method is quick and accurate with a wide range of control in comparison of present system. The proposed method is non-dependent of chemical used and provides high degree of reproducibility with wider range of control. In the present study only clarification zone has been evaluated and further work is in progress for its interpretation in the mills as well as pan boiling also.

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