International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 12, Issue 8, 2020, pp.-9778-9780.
Available online at https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

# SUGAR BEET-THE POTENTIAL FEEDSTOCKS FOR ALCOHOL PRODUCTION

**PAROHA S.*, SINGH S. AND GUPTA A.**
National Sugar Institute, Kanpur, 208017, Uttar Pradesh, India
*Corresponding Author: Email - seemaparoha@rediffmail.com

Received: April 12, 2020; Revised: April 26, 2020; Accepted: April 28, 2020; Published: April 30, 2020

**Abstract:** Sugar beet is one of the most efficient converters of solar energy into stored energy. It is an important sugar crop which has great potentiality of augmenting sugar production at lower cost. Tropical sugarbeet is yet to be produced on commercial scale in India and it is still considered to be toddling baby in the ethanol industry. Although, few industries are claiming to be using sugarbeet as feed stock for ethanol production, its growth has not reached the level expected. With this aim the experiment was carried out with 3 Sugarbeet varieties *viz*; LS-6 (subtropical zone), PAC-60008, SZ-35 (temperate zone) the same were planted for production of alcohol. After six months the sugar beets were harvested and sucrose was extracted from the beet roots. LS-6 performed best as in term of biochemical traits followed by PAC-60008 and SZ-35. Ethanol yield was observed 101.6 (l/ton) in LS-6 variety, 80.16 (l/ton) in PAC-60008 and 74.24(l/ton) in SZ-35 variety.

**Keywords:** *Sugar Beet, Ethanol, Energy, Biofuel, Total Reducing Sugar*

**Citation:** Paroha S., *et al*., (2020) Sugar Beet-The Potential Feedstocks for Alcohol Production. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 12, Issue 8, pp.- 9778-9780.



**Academic Editor / Reviewer:** Dr Vinod Tiwari, Dr Jai P. Rai, Ajit Kumar Singh

## Introduction

At present world is passing through an energy crisis due to fast depleting fossil fuels. These fuels may not last beyond six or seven decades, if their use continues at current pace. India is a fast-growing economy and is facing the challenge of increasing energy demand which is usually met by fossil fuels. The energy demand of the country for the automotive sector is also increasing continuously and is mainly met by crude oil, majority of which is imported at the cost of drainage of huge amount of foreign exchange. To meet increasing demand of energy, bio-fuels *i.e*., fuels derived from renewable substrates (agricultural products) represent the alternative option. Ethanol is a biofuel which can partially replace fossil fuels and reduce the dependence the latter to a certain extent. With the energy demand only growing higher, it is imperative to develop clean, renewable sources of energy. Many studies have been done that focus on production improvement and decreasing its costs [1-5].

The production of molasses in India, under normal circumstances is about 11 to 12 million tonnes/ year which can produce alcohol to an extent of around 2500-2800 million litres, out of which it is also utilized by potable and industrial sector leaving around 1000-1300 million litres for ethanol blending. It is thus seen that molasses from conventional route alone (C- molasses) cannot fulfil the need even for 5-6% Ethanol Blending and it is far from being adequate for the proposed 10% EBP [6]. Thus, there is a need to look in for alternate feed-stocks for fermentative production of alcohol. In this context, the viability and economics of using Sugar beet can be a cheap feed stock to meet the requirement of alcohol for fuel sector.

Sugarbeet (*Beta vulgaris* L.) belongs to the family Chenopodiaceae, is considered as the second important sugar crop all over the world after sugar cane (*Sacchurum officinarum* L.). It is grown in 57 countries. Top fifteen sugarbeet producing countries are Russian Federation, Ukraine, United States of America, Germany, France, Turkey, China, Poland, Egypt, United Kingdom, Iran, Belarus, Netherlands, Italy and Belgium. Sugarbeet is mainly produced in Europe and, to a lesser extent, in Asia and North America [7]. The storage organ of this plant is usually called the root, of which 90% is actually root derived and the remaining 10% (the crown) is derived from the hypocotyls [8,9].

Composition wise, a freshly harvested sugarbeet root contains 75-76% water, 15-20 % sugars, 2.6% non-sugars and 4-6 % the pulp. Processing one ton of fresh sugarbeet roots yields 121 kg sugar, 38 kg molasses (containing 18.2 kg sugar, 12.1 kg impurities and 7.8 kg water) and 50 kg of pulp.

The great importance of sugar beet crop is not only from its ability to grow in the newly reclaimed areas as economic crop, but also for producing higher yield of sugar under these conditions as compared with sugar cane. Moreover, sugar beet is specialized as a short duration crop, where its growth period is about half that of sugar cane. Furthermore, sugar beet requires less water, which a kilogram of sugar requires about 1.4 $m^3$ and 4.0 $m^3$ water to be produced by sugar beet and sugar cane, respectively [10].

## Sugarbeet as potential alternatives

In India, sugarcane is main crop grown for processing of sugar. However, as an alternative crop sugarbeet has an important role in decreasing the production cost, reducing crop period and arresting decline in factor productivity as well as sustaining crop productivity at higher level under abiotic stresses *viz*., water and salt stresses. This is mainly because of its short-duration (6-7 months as compared to 10-12 months of sugarcane), high sugar content (15-17%), high sugar recovery (12-14%), high purity (85- 90%), and ability to withstand drought and tolerant to salinity. There are differences in sugar and sugar-products derived from sugarbeet and sugarcane.

## Material and Methods

The quality and quantity of the ethanol produced from sugar beet is strongly dependent on variety. In order to evaluate some characteristics of sugarbeet varieties that depended on bioethanol production, this experiment was carried out with 3 beet varieties *viz*; LS-6 (subtropical zone), PAC-60008, SZ-35 (temperate zone) for production of alcohol in present study. The study was carried out at Biochemistry Division of National Sugar Institute, Kanpur. Field experiment was conducted at agriculture farm, National Sugar Institute, Kanpur.

Table-1 *Chemical composition of juice*

| SN | Particulars | Sugar beet LS-6 | Sugar beet PAC-60008 | Sugar beet SZ-35 |
|---|---|---|---|---|
| 1 | Brix (Total Dissolved Solids) | 19.8 | 11.8248 | 10.1686 |
| 2 | Pol (Apparent Sucrose) (%) | 16.5 | 9.8 | 7.9 |
| 3 | Purity | 83 | 83 | 78 |
| 4 | Reducing Sugars (%) | 2.2 | 2.5 | 2.0 |
| 5 | Total Reducing Sugars (%) | 19 | 11.4 | 9.9 |
| 6 | pH | 5.6 | 5.4 | 5.4 |

Table-2 *Table of fermentative production of ethanol from selected varieties of sugar beet*

| SN | Particulars | LS-6 | PAC-60008 | SZ-35 |
|---|---|---|---|---|
| 1 | Quantity of Sugar beet | 3 Kg | 3 Kg | 3 Kg |
| 2 | Final Volume of Juice | 5 litres | 5 litres | 5 litres |
| 3 | Total Reducing Sugar Content of juice (g/100 ml) | 11.4% | 9.14 % | 8.25% |
| 4 | Residual Sugars after fermentation (g/100 ml) | 0.4% | ND | ND |
| 5 | Fermentable sugars in wort (g/100 ml) | 11.00% | 9.10% | 8.38% |
| 6 | Theoretical Ethanol percent (v/v) | 7.08% | 5.8% | 5.40% |
| 7 | Actual Ethanol percent (v/v) | 6.1% | 5.01% | 4.64% |
| 8 | Fermentation efficiency | 86.16% | 86.11% | 85.90% |
| 9 | Ethanol yield in AL (l/ton) | 101.6 | 80.16 | 74.24 |
| 10 | Ethanol yield in BL (l/ton) | 107.5 | 84.4 | 78.1 |

The studied parameters include biochemical traits such as Reducing Sugar, Total Reducing Sugar, Alcohol%, Total dissolved solid and Fermentable sugar. Fresh sugar beet root was used for producing ethanol in laboratory. Determination of total soluble solids in beet juice was carried using brix spindle method, Determination of pol % in beet juice was carried out through Polari meter and estimation of total reducing sugars in beet juice was done by lane & eynon method

**Extraction of juice from Beets**

For the purpose, 3 kg of beet was grated and hot water extraction of juice was carried out. The pulp was washed a few times with hot water and all the washings were mixed and filtered with muslin cloth. The final volume of juice was made up to 5 litres. All the analysis was carried out in extracted Juice

The juice was expressed from the beets in the following manner:

Beet Harvested
|
Washed Thoroughly
|
Weighed and Grated
|
Subjected to hot water treatment (30 min)
|
Pulp is pressed in order to extract the Juice is filtered and volume made up to a known quantity with distilled water

**Ethanol Production**

The juice was fortified with nutrients like potassium hydrogen phosphate and ammonium sulphate, the pH was adjusted to 4.5 and sterilized at 15 p.s.i.g for 15 minutes. It was now inoculated with yeast strain (*Saccharomyces cerevisie*) already attenuated for a few transfers on to sugar beet juice and fermentation was carried out for 48 hrs., and fermented wash was analyzed for residual sugars and alcohol % in wash based on which fermentation efficiency and ethanol yields were calculated.

**Results and Discussion**

The sugar beet juice of all the three varieties (LS-6 (subtropical zone), PAC-60008, SZ-35 (temperate zone) was analyzed for various chemical constituents and the results are given in [Table-1]. It is seen from the table that that juice had a brix of 19, sucrose content of 16.5%, purity of around 80, reducing sugars 2.2% and Total Reducing Sugar content of around 19% with a pH value of 5.6 for LS-6 variety. Off the three varieties PAC-60008 & SZ-35 showed less sucrose content and total reducing sugar, as compared to LS-6.Total solids content was also found to be less in both the varieties *i.e.*, PAC-60008 & SZ-35 may be since these varieties are of temperate zone and require some special agronomical practice.

The results obtained are presented in [Table-2]. It is seen from the table that alcohol percent in wash was 6.1% (from initial TRS value of 11.4%) and a fermentation efficiency value of around 86% was obtained corresponding to an ethanol yield of around 101 AL/ton corresponding to an ethanol yield of around 107 BL in LS-6 Variety. Similarly, the other two Varieties PAC-60008 & SZ-35 gave 5.01% and 4.64% alcohol percent in wash from initial TRS value of 9.14 % and 8.25% respectively. Ethanol yield of PAC-60008 & SZ-35 varieties was recorded to be 80.16 AL (l/ton) and 74.24 AL (l/ton) corresponding to an ethanol yield of around 84.4 BL (l/ton) and 78.1 BL (l/ton) respectively.

**Conclusion**

Sugarbeet (*Beta vulgaris* L.) having growth period of about half of sugarcane but productivity per unit time is higher and requires less water than sugarcane. Many environmental and agronomic factors influence sugarbeet yield and quality. Thus, to harness maximum benefits from sugar beet, there is need to select the most appropriate varieties, planting time, planting methods, planting density, sowing depth, providing adequate crop nutrition and irrigation schedule. For successful production of sugarbeet under subtropical environmental conditions there is needed to evaluate the performance of different varieties under subtropical Indian conditions [11,12].

**Application of research:** Proper combinations of farm yard manure and inorganic fertilizers should be worked out to derive the best possible advantage of inputs.

**Research Category:** Alcohol Production

**Acknowledgement / Funding:** Authors are thankful to Biochemistry Division, National Sugar Institute, Kanpur, 208017, Uttar Pradesh, India

****Principal Investigator or Chairperson of research: Dr Seema Paroha**
Institute: National Sugar Institute, Kanpur, 208017, Uttar Pradesh, India
Research project name or number: Research station study

**Author Contributions:** All authors equally contributed

**Author statement:** All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

**Study area / Sample Collection:** Biochemistry Division, National Sugar Institute, Kanpur, 208017, Uttar Pradesh, India

**Cultivar / Variety / Breed name:** Sugarbeet (*Beta vulgaris* L.)

**Conflict of Interest:** None declared

**Ethical approval:** This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

**References**


[1] Sreenath H.K., Jeffries T.W. (2000) *Biores. Technol*., 72, 253-260.
[2] Davis L., Jeon Y., Svenson C., Rogers P., Pearce J., Peiris P. (2005) *Biomass Bioenerg*, 29, 49-59.
[3] Ruanglek V., Maneewatthana D., Tripetchkul S. (2006) *Process Biochem*., 41, 1432-1437.
[4] Mohagheghi A., Ruth M., Schell D.J., (2006) *Process Biochem*., 41, 1806-1811.
[5] Cristopher B. (2008) *International Journal of Sugar and Sweeters*
[6] Mohan N., Swain D. and Paroha S. (2019) *Proceedings of the International Society of Sugar Cane Technologists XXX ISSCT Congress was held in Tucumán, Argentina from 2 to 5 September* 2019.
[7] Kumar R. and Pathak A.D. (2013) *Souvenir- IISR-Industry Interface on Research and Development Initiatives for Sugarbeet in India, 28-29 May, Sugarbeet Breeding Outpost of IISR IVRI Campus, Mukteswar-263138, Nainital. Organised by Indian Institute of Sugarcane Research (ICAR) and Association of Sugarcane Technologists of India*. pp 46-47.
[8] Anonymous (2013) *Hand Book of Agriculture (Published by Indian Council of Agricultural Research, New Delhi*, 110 012.
[9] Shrivastava A. K., Shukla S. P. and Sawnani A. (2013) *Souvenir- IISR-Industry Interface on Research and Development Initiatives for Sugarbeet in India, 28-29 May, Sugarbeet Breeding Outpost of IISR IVRI Campus, Mukteswar-263138, Nainital. Organised by Indian Institute of Sugarcane Research (ICAR) and Association of Sugarcane Technologists of India*, 43-45
[10] Sohier M.M. Ouda (2001) *Zagazig J. Agric. Res*., 28(2), 275-297.
[11] Singh B.N., Singh D.B., Saini K.S. and Sharma P.K. (2015) *Agricultural Reviews*, 6 (3), 184-197.
[12] Shrivastava A.K., Sawnani A., Shukla S.P. and Solomon S. (2013) *Souvenir- IISR-Industry Interface on Research and Development Initiatives for Sugarbeet in India, 28-29 May, Sugarbeet Breeding Outpost of IISR IVRI Campus, Mukteswar-263138, Nainital. Organised by Indian Institute of Sugarcane Research (ICAR) and Association of Sugarcane Technologists of India*, 36-39.