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Potentials of *Prosopis pallida* and *Prosopis juliflora* for bioethanol production

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Abstract

Pods of *Prosopis pallida* and Prosopis juliflora were collected from different parts of Rajasthan. Mesocarp of Prosopis pods was fermented. Initial sugar concentration 13% and 40% was reduced resulting into 6.14% and 18.89% of alcohol production in P. juliflora and P. pallida respectively. Therefore this plant has high potential for making the biothanol in arid and semiarid reigons of India. Biofuels are being increasingly seen as potential alternatives to the liquid fossil

Keywords: *Prosopis pallida, Prosopis juliflora,* bioethanol.

INTRODUCTION

India is one of the fastest growing economies of the world, with its gross domestic product growing at an average annual rate of over seven percent since 2004 (http://www.icrier.org/ pdf/Policy _Series _No_9.pdf). Energy inputs are a critical component of national economic activity. However, since it is believed that the conventional source of energy will be exhausted in few decades. Keeping this in view of the past efforts have made and work on alternate source of energy viz. wind, solar and biofuels etc. Among them biofuels are being increasingly seen as potential alternatives to the liquid fossil fuels. In this context, ethanols is being seen as promising renewable fuel for transportation purpose for the near future. Biofuel are of two types: alcohols (ethanol and butanol) and diesel substitutes, (such as biodiesel and hydrotreated vegetable oil). Ethanol is produced from starch contained in crops such as corn and sorghum (U.S.A.) or through fermentation of sugarcane, molassess(India) , and sugar-beet (Brazil).Presently in India it is primarily made from sugarcane molasses and not from grain as in many other countries. Ethanol in India is used to produce potable liquor (45%) , about 40% is used in the alcohol based chemical industry and the rest is use for blending with petrol and other purpose (Fig.1). The Government of India policy mandating 5% ethanol blending in petrol is currently being implemented in the country and by 2020 it would be 15%. Bio-ethanol is a high octane fuel and has replaced lead as an octane enhancer in petrol with an octane rating of 129, compared to about 91 for fossil-petrol; engines fired on ethanol can run at a much higher compression ratio without the octane-boosting additives.. (www.icrier.org/pdf/policy_series_no_9.pdf). Bioethanol blended fuel burns more completely because the ethanol molecule contains oxygen, the result, CO_2 and CO emission can be reduced by nearly 90% as compared to engines run exclusively on fossil fuels. Therefore potential benefits of biofuels are reduction of greenhouse gases, recuperation of soil productivity and degraded land, economic benefits from adding value to agricultural activities and improving access to and quality of energy services(http://www.bioenergyindia.org/Overview.aspdf).

The demand for ethanol has been continually increasing on account of the growth of user industries and use of ethanols as a fuel in the country. However, the production and availability of ethanol has largely lagged behind because presently ethanol requirement is 3723 million litre according ISMA estimates and making assumption about industry growth rates, a grand total of approximately 545 million tonnes sugarcane is estimated to be required for consumption in India by 2011-12 (with the mandated 5% blending for transport). India is the fourth largest producer of ethanol in the world after Brazil, USA and China producing approximately 2000 million litres of ethanol, mainly by fermentation of sugarcane molasses. (http://www.scribd.com/doc/96139083/sugarreport-120422085346-phpapp01)

In India sugarcane production has increased nearly 2.5 times since 1950-51 (Pohit et al. 2009) (reaching about 5.04 million hectares in 2007-8), it has tended to stagnate in the recent part (Table 1). There has also been considerable variation in the area under sugarcane production over time. Cultivation of this crop tends to follow a cyclical pattern of output (with three-four years of bumper harvests followed by relatively poor crops over a similar period subsequently).

The production trend data of molasses in India published by the ISMA (Indian Sugar Mills Association), the sugarcane production in 2008-09 was 271.2 million tonnes. In India's case industry sources reveal that ethanol production in India has been taking place almost entirely through the final 'C' grade molasses (oness litre ethanol can be extracted from .004 tonnes of molasses). As reported by ISMA the ethanol production was 1,560 million tonnes in 2008-09. Deriving ethanol from sugarcane consume very high amount of water which ultimately leads to (lowering) depletion of water level.

Government support of biofuels with taxbreaks,mandated use and subsidies so diversion of food crops to biofuel' which could result in escalating food prices (Food and Agricultural Policy Research Institute 2005, Rajagopal and Ziberman 2007.) and the potential destruction of natural habitats.Large increases in biofuel production

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in the United state and Europe are the main reason behind the steep rise in global food prices (approximately 20%) (http://en.wikipedia.org/wiki/Food_vs._fuel) Keeping in view of some adverse affect by using sugarcane crop now a day research on non food crops and cellulosic materials getting great attention worldwide, because they are cheap, easily available and profitable as compared to food crops. Recently some efforts have been made to utilize *P.juliflora and P. pallida* pods for ethanol which grow widely and huge amount of sweet pods available it will not compete with the food production as well as not required high water use, as in case of sugarcane and sugarbeet.

P.juliflora is a tree species native to Northern Mexio and the Southern U.S.

Prosopis palliada is native to southern Colombia to Peru, Hawain Islands, that survives in drought and thrive in sunny arid region plant fix own nitrogen, requires no seedling, fertilization or irrigation and grows on dry nutrient-poor soil.The pods of *P.pallida|P.juliflora* are very sweets(Table 2) and can be used for production of ethanol.

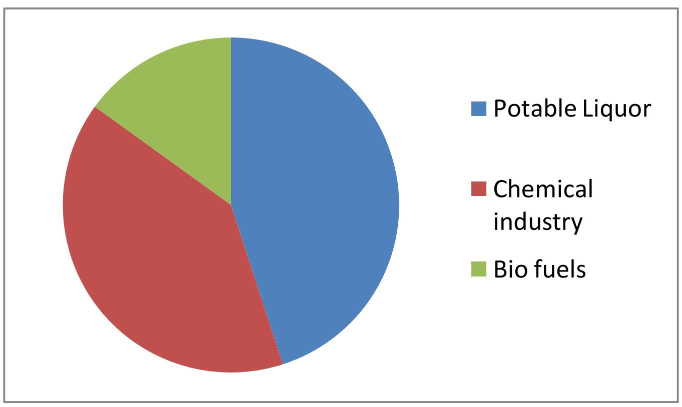

Fig. 1: Uses of ethanol in India

Table 1: Area under production, production and yield of sugarcane in India

Year	Area (million ectares)	Production (million tonnes)	Yield (tonnes/hectare)
1985-86	2.85	170.65	59.9
1995-96	4.14	282.94	68.4
2000-01	4.32	296.00	68.6
2001-02	4.41	297.21	67.4
2002-03	4.52	287.38	63.6
2003-04	3.94	233.90	59.4
2004-05	3.66	237.09	64.8
2005-06	4.20	281.17	65.6
2006-07	5.15	355.52	69.0
2007-08	5.04	340.56	67.5
2008-09 (P)	4.40	271.20	61.7

Source: Indian Sugar Millis Association, Indian Sugar Year Book 2008-09 Vol.1, pp.18; Handbook of Sugar Statistics October 2009, pp. 1. Note: (P):- Provisional estimates

TABLE 2: Chemical composition of *P. pallida fruit pulp*

Components	g/100g of Dry matter	Vitamins	Mg/kg original matter
Sucrose	46.35	A	Not detected
Total dietary fiber	32.22	E	5.00
Insoluble	30.60	B1	1.90
Soluble	1.62	B2	0.60
Protein	8.11	B6	2.35
Reducing Sugars	2.14	Nicotinic acid	31.00
Pectin	0.80	C	60.00
Fat	0.77	Folic Acid	0.18
Total soluble polyphenols	0.82	Calcium pantothenate	10.50
Minerals	Mg/100g of Dry Matter		
Potassium	2650		
Sodium	113		
Calcium	75.9		
Magnesium	90.4		
Iron	33.0		

MATERIALS AND METHODS

Pods of *P. juliflora* and *P. pallida* were collected.The *Prosopis* pods were sun dried, and broken down to fine powder using a hammer mill process. Grinding increased surface area of the pod's and enhance the contact between starch and water. The mesocarp of the pod was used for this experiment.

The *Prosopis* pod powder (100 g.) was hydrolyzed with 250 ml of distilled water in 500 ml. Erlenmeyer flask and separately heated at 90^{0}C for 15min. After hydrolysis the liquid fraction was cooled, filtered and determined for glucose cconcentration. The hydrolysates were adjusted to pH 5-6, and the solution were filtered and prepared for fermentation (Dawson and Boopaty, 2008).

Saccharomyces cerevisiae used for fermentation. Bach fermentation of hydrolysates were carried out in 500 ml Erlenmeyer flask incubated with 5g/l. *S. cerevisiae* at 30^{0}C, as described in the literature (Thuesombat et al., 2007).

The concentration of glucose was determined using polarimetry by taking D-glucose anhydrous as standard solution.

The concentration of ethanol was determined after 0, 18, 24, 42 hour's and determines the time for maximum production. For each experiment, 5 ml of the sample was run using NMR that involves running proton NMR spectrum for each sample by adding the known amount of reference compound (butanol) and determining the level of ethanol by peak area determining the level of ethanol y peak area comparison until it arrives maximal level (peak) (Patel 2009).

CALCULATION

First the ethanol yield was calculated based on the available glucose. It was expressed on either molar or weight basis. The relative ethanol yield (efficiency) was then calculated as a ratio of the ethanol yield and the theoretical maximal yield (.51g/g) (Hettenhaus, 1998)

$$\text{Yield} = \frac{\text{gram ethanol produced}}{\text{gram glucose}} \times 100$$

$$\text{Efficiency} = \frac{\text{gram ethanol produced}}{\text{Gram glucose} \times .51} \times 100$$

RESULTS

Mesocarp of *Prosopis* pods was fermented. Initial sugar concentration 13% and 40% was reduced resulting into 6.14% and 18.89% of alcohol production in *P. juliflora and P. pallida* respectively.

DISCUSSION

Prosopis is only the tree species utilized for its each and every part in various ways on a commercial basis (Pasiecznik et al., 2001). Due to its multiple uses, it has gained public acceptance as a plant of recognized economic value.

The pods of *P.pallida* contain 40% sugar and high amount of protein which is easy to digest and therefore rich food source for sheep, goats and cattle.The pods of *P.pallida* contain 40% sugar which can be converted into 18.89% ethanol, if one plant after a 10 years produce 20kg pods and if in one hectare area 100 trees maintained or planted on the farm boundaries then 2000 kilo pods can be harvested which can yield 190 litre bioethanol per hectare without sacrificeing crop yield as well as water. Therefore this plant has high potential for making the biothanol in arid and semiarid reigons of India.

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