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Production of Ethanol from Fruits and Waste Food

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ABSTRACT

Ethanol was produced from different fruits using Baker's yeast. We had chosen fruits having sugars >10%. Some juices were used for ethanol production. Food materials after the expiry date are generally thrown. We have used some of these food materials for ethanol production. Ethanol is obtained depending on sugar present in the fruits. We achieved maximum 6.63%w/v ethanol using banana. Among juices we obtained maximum 6.38% ethanol using guava juice. Tamarind was subjected to extraction and fermentation simultaneously. We have obtained 8.99% w/v alcohol from tamarind. Pectin and tartaric acid were precipitated as calcium salts. After precipitation ethanol concentration was 7.68% w/v having 85.42% efficiency.

Keywords: Ethanol, Banana, Grape juice, Tamarind, Yeast, Fermentation, Calcium

INTRODUCTION

Ethanol is widely used. It is used in industries. It is used as beverage. Recently it was proposed that it can be blended in petrol up to 10% to reduce the price of petrol and import demand. Also recently it was reported that vehicles running on alcohol are under trial. Ethanol is prepared by chemical and biochemical routes. Beverages are prepared only by the biochemical route. Ethanol is mainly prepared by the biochemical route. There are references where it is found that ethanol was prepared from fruits before 1940 to meet the requirements. Some fruits deteriorate in few days, which cannot be consumed. Such fruits are thrown. Some fruits are produced in large quantities. Extra quantity goes in waste. Tamarind is a popular tree. It is very useful from ancient time. Many authors have studied fermentation of tamarind to ethanol. There are many references in the literature about downstream processing of tamarind by the chemical method where tartaric acid, pectin and sugars are separated. In this study we have combined extraction of tamarind product in water and fermentation. Ethanol can be prepared from such fruits. Juices and food materials sold in market have a definite expiry date. After the expiry date it can be used for ethanol production. Various researchers have studied the production of wine from fruits due its flavour and demand. Some have attempted the preparation of alcohol.

In this paper, we are proposing a simple process for production of ethanol from fruits, juices and food materials. The purpose of this study is to utilise waste material for energy production. The patent preparation on this work will be completed in future.

MATERIALS AND METHODS

Chemicals

Ethanol was purchased from Thomas Baker, Mumbai. Other chemicals were purchased from S.D. Fine Chemical, Mumbai. Fruits and juices were purchased from the local market.

Cultures

Bakers' yeast was purchased from the local market.

Analysis

Reducing sugars were analysed by the DNSA method

(Miller, 1959). Ethanol is analysed by the dichromate method (Fletcher and Staden, 2003).

Fermentation

Juices, fruits and food materials were used for the study. Juices after the expiry date were used: grape and guava juices. We have used cheap, easily available and deteriorated fruits: banana, guava, sapota, fig, pineapple and pomegranate. Sugar concentrations in fruits, reported in the literature, are given in Table 1. Food material jam (after the expiry date) was used for study. Studies were carried out at 25 ml and higher scale.

Table 1: Sugar concentration in different fruits

Fruits	Sugar reported in literature	
	Carbohydrate(%)	Sugar (%)
Banana	22.84	12.23
Guava	14.32	8.92
Pineapple	13.12	9.85
Pomegranate	18.7	13.67
Grape	18.1	15.8
Sapota	19.96	
Fig	16	

Juices and Waste Food

Juice and waste food were used for the study. Grape juice, guava juice and jam were used for the study. Baker's yeast (5%) was used. The reaction was carried out at 28°C and without shaking. In between it is mixed. The analysis was done after 24 h (Table 2).

Table 2: Fermentation of juices and food

Juices	Ethanolformed (% w/v)	Ethanol efficiency (%)
Guava	6.38	80.70
Grape	4.15	54.24
Jam	6.14	86.97

Fruits

Banana, guava, sapota, grape, pineapple, fig and pomegranate were used for the study. Fruits were cut into pieces and water was added. It is mixed well. Baker's yeast was added and again mixed well. It is kept at 28°C for 24 h. In between it is mixed. The analysis was done after 24 h (Table 3).

Table 3: Ethanol formation from deteriorated fruits

Fruits	Ethanol (% w/v)	Ethanol formation efficiency (%)
Banana	6.63	56.95
Guava	4.2	57.50
Sapota	3.98	48.95
Fig	3.56	54.56
Pineapple	3.18	47.61
Pomegranate	4.72	61.82
Grape	5.35	58.05

Tamarind was soaked in hot water and mixed well. The stirring speed was 100 rpm. It was allowed to come at 28°C. Then Baker's yeast was added to have 5% concentration. It was stirred for 24 h. Broth was centrifuged. Supernatant contained ethanol, tartaric acid and pectin. Calcium hydroxide was added till neutralisation. Tartaric acid and pectin were precipitated. Precipitate was separated by filtration. The analysis of ethanol before and after precipitation was done. Mixture of calcium tartarate and calcium pectate was not further processed as our main aim was to get ethanol from sugars of tamarind. Calcium tartarate and calcium pectate can be further separated by the chemical method because their solubilities in water are different

RESULTS AND DISCUSSION

Surplus fruits, fruits having less demand and fruits that deteriorate in less time can be diverted to the alcohol production. Wine is prepared from the fruit pulp (Pawar *et al*., 2011; Zhang, 2014; Wang *et al*., 2013; Zuo *et al*., 2013; Liu, 2014; Younis *et al*., 2014). Preparation of wine requires more days. Quantity of fruits required for wine production is less as compared to its production in nature. Sugar reported in fruits in the literature is given in Table 1. Fermentation of juices and food product was carried out. Results are presented in Table 2. Kumar *et al*. (2004) studied ethanol production from guava juice. Tiwari *et al*. (2014) have obtained 5.36% ethanol in 3 days from grape juice. Sugar in fruits was fermented and resulting data is presented in Table 3. Comparison

of our data with other researcher's work is shown in Table 4. Other researchers have used more steps, which add cost factor to the production of ethanol. In our case no autoclaving, no enzyme pretreatment, etc., were done. Just make slurry, add baker's yeast and mix it thoroughly. Intermittant stirring was done when it was necessary. In the case of banana we have lower results than reported in the literature. Anuradha *et al*. (2013) have reported ethanol fermentation from starchy substrates. We have lower results with pineapple and pomegranate. We got 4.72% ethanol from pomegranate. Ordoudi *et al*. (2014) prepared ethanol from pomegranate juice. Alvarenga *et al*. (2014) have studied fermentation of pineapple pulp. Tanaka *et al*. (1999) have produced ethanol from juice of rotten pineapple. We have got lower results with guava, sapota and fig. Before 1940, alcohol production from fig and banana is reported. Balasubramanian *et al*. (2011) have studied ethanol production from banana and pineapple. Patil *et al*. (2000) have studied the effect of fruit supplement on ethanol fermentation. Bhatt *et al*. (1987) have studied ethanol production from banana and guava juices. Thomas (2002) has produced wine from juices.

Tamarind contains tartaric acid (12%), pectin (3%) and sugars (30%). We have subjected tamarind to fermentation. We obtained 8.99% ethanol in 24 h. Other products, i.e., tartaric acid and pectin, were precipitated as calcium salts. Ethanol concentration was 7.68% w/v. Overall ethanol efficiency is 85.42%. Ethanol is distilled. Preparation of tamarind beverage is reported by Lingappa *et al*. (1993), Singh *et al*. (2004), etc. Patil *et al*. (1998) have studied the effect of tamarind on ethanol fermentation of molasses. Batham and Nigam (1924), Almeida and Valsecchi (1951), Lewis *et al*. (1954) have prepared alcohol from tamarind. Marsdun (1923) has prepared alcohol, distilled and further precipitation was tried. We have precipitated tartaric acid and pectin before distillation. Generally extraction is carried out first and then further processing is done. In our case initial extraction and fermentation are done simultaneously. Product concentration vary batch to batch as the tamarind composition is dependent on biosynthesis. Key results are compared in Figure 1.

Table 4: Literature survey of ethanol production from fruits

Fruits	Alcohol % (w/v)	References
Banana	7.7	Saha and Banerjee (2013)
	7.84	Alvarenga *et al*. (2011)
	8.6	Patel (2009)
	6.63	This paper
Guava	5.8	Srivastava *et al*. (1997)
	4.2	This paper
Sapota	6.68 on 3rd day	Tiwari *et al*. (2014)
	3.98	This paper
Pineapple	5.9	Tanaka *et al*. (1999)
	Ethanol	Alvarenga *et al*. (2014)
	3.18	This paper
Fig	Ethanol, vinegar	Zhang *et al*. (2003)
	Ethanol	Gois (1938)
	Ethanol	Benavet (1922)
	Ethanol	Vasseux (1920)
	3.56	This paper

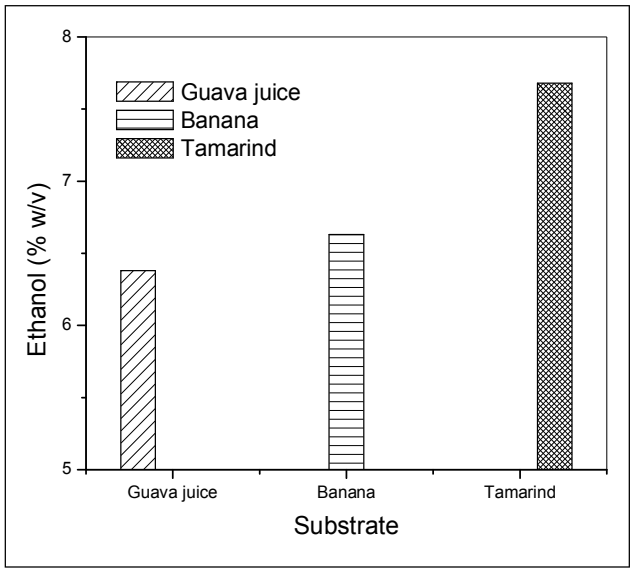

Figure 1: Comparison of ethanol production

Here we have used fruits as such for alcohol production to avoid wastage of fruits. Fruits produced vary in sugar content batch to batch; therefore alcohol will also vary batch to batch. Before starting deterioration fruits can be taken for production of alcohol. The literature search on alcohol production from fruits, juices and waste foods was done thoroughly. Whatever references we got were added in this paper. There may be some references that might have remained unknown.

CONCLUSION

Fruits, juices and food were used for production of ethanol. We had considerable ethanol production using banana (6.63%). Guava juice has also been useful for production of ethanol (6.38%). We have achieved 8.99% ethanol from tamarind in 24 h. Other products are separated as calcium salts. Final ethanol concentration after precipitation was 7.68%, having 85.42% efficiency. Large-scale trials are under consideration and will lead to a feasible process where patent can be attempted.

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