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Preparation of Ethanol From Vegetable Waste Materials

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Ethanol was prepared by adopting the method of fermentation from vegetable waste followed by the techniques of conventional and indigenous which is generally practised by tribal people of Tripura, India. Manufactured ethanol is not free from methanol, claims moderate method for more purified ethanol. Dried residues can be used as cattle feed and tested in laboratory animals, showed good acceptance and devoid of any untoward action. It is eco-friendly and economical approach.

Key Words: Vegetable waste, Fermentation, Ethanol.

INTRODUCTION

People seldom realize the importance of vegetable waste materials which are being generated in terms of thousands of tones both of urban and rural areas of India. The effort of this compilation has been given not only to prepare ethanol but also to decrease the level of environmental pollution created by indiscriminate disposal of these waste materials to our surrounding. India, a land of physical, climate, geographic, ecological, social, cultural and linguistic diversity. Municipal solid waste management continues to remain one of the most neglected areas of urban development in India[1]. The 23 cities in India generate about 30,000 tones of such wastes per day. Piles of garbage and wastes of all kinds littered everywhere have become a common sight in our urban life. Municipal agencies spend about 2-25 % of their budget on municipal solid waste management. The physical composition of the waste can be characterized as in Metro cities as paper, textile, leather, plastic, metal, glass, ash fine earth and others, compostable matter *etc.*[2]. The biodegradable fraction is quite high in India, essentially due to the habit of using fresh vegetables. As per survey conducted by Tripura State Pollution Control Board; Agartala, Tripura, India, done generates 200 tones of solid waste materials per day. Out of this 60 % is biodegradable part on weight basis.

Considering the potential of this compostable waste matter, there may be an introduction of segregation method specially to separate fermentable vegetable waste materials which contain adequate quantity of starch. Thus, it will give easy asses to

raw material for fermentation. Such practice will give tremendous benefits being a part of SWM programme and both urban and rural dwellers can take part actively without much effort. If this trend can be spread on mass basis it will help to improve public health up to some level and the environmental quality in general. Moreover people get beneficial fermentation product *i.e.* ethanol and fermentation residue which are having varied uses in many field *viz.* cattle feeds.

EXPERIMENTAL

The total process of manufacturing of ethanol can be divided in different segments such as collection of raw materials, preparation of inoculums, preparation of fermentation medium, fermentation, recovery and yield.

The produced ethanol was identified[3] by taking 5 mL of 0.5 % v/v solution followed by addition by 1 mL of 1 M NaOH and 2 mL of iodine solution, that the odour of iodoform developed and a yellow precipitate was produced. The ethanol content was also determined[3]. The ethanol content of a liquid was expressed as the number of volumes of ethanol contained in 100 volumes of the liquid, the volumes being measured at 24.9-25.1 ºC. This is known as the 'percentage of ethanol by volume'. The content may also be expressed in grams of ethanol per 100 g of the liquid. This is known as the percentage of ethanol by weight. 25 mL of the preparation being examined was taken and the relative density was determined at 24.9-25.1 ºC. Further a test for identification of methanol was also performed[3].

Discarded portion of vegetables, fruits and some seeds of fruits can be used as raw material for the fermentation process. A small amount of yeast, *Saccharomyces cervisiae*, was inoculated with 10 mL of sterile medium in a test tube. The pH was adjusted between 4.8 to 5 and the temperature between 28 to 30 ºC. The collected raw materials were cut into slices and crushed. Then 6 kg of crushed mass is taken and divided equally into two parts *i.e.* 3 kg in each part. Both parts of crushed mass were then boiled under pressure for *ca.* 15 min. In this way the cell walls containing starch particles are broken and starch brought into solution. The resulting solution is called MASH[4]. To one part of the MASH obtained, 10 % w/v HCl was added and boiled for 1 h to induce hydrolysis of starch. The hydrolysis of starch with hot dilute acid yields a mixture of glucose, maltose and high molecular weight saccharides. The mixture is called dextrin[5]. It was allowed to cool and diluted with water. The volume of MASH was mixed with two volumes of water. Finally pH was adjusted between 4.8 and 5. Acidic environment is favourable to the growth of yeast but unfavourable to most other bacteria. Another part of MASH was transferred into a tray and kept it acid untreated for 2 d. These fermentation medium were examined for the presence of fermentable sugar using Benedict's solution. Both the medium were confirmed for the presence of fermentable sugar.

Fermentation process was induced using two methods *viz.* (1) Conventional fermentation and (2) Indigenous method.

Conventional fermentation method: The previously prepared inoculum was transferred to the fermenting Vat (15 L) capacity bucket) which contain one part of the fermentation medium (*i.e.* acid treated). Fermentation starts with in few hours after the addition of yeast, *Saccharomyces cerevisiae*. Ethanol fermentation is an anaerobic process. The process becomes rapid after 24 h to complete the fermentation. Yeast furnishes the enzymes maltose and zymase. While the former converts maltose into glucose, the later converts glucose into ethanol.

Indigenous method[5]: In this method following materials were used *i.e.* (i) earthen pot (ii) *Chuwan* (iii) acid untreated MASH. *Chuwan* is the main fermenting agent. The bark of *chuwanthwy* (*Chuwanthwy* means bark of tree from which *Chuwan* is prepared) tree and the leaf of *Chuwanlay* (*Chuwanlay* means leaf of tree from which *Chuwan* is prepared) tree and sunned rice is required to prepare *Chuwan*. Besides this jack fruit leaf, sugar cane leaf *etc.* were also added for the taste of wine. The words *Chuwan, Chuwanthwy, Chuwanlay* are tribal dialect of Tripura, India. The plants *Chuwanlay* and *Chuwanthwy* were authenticated by local tribal expert, but they are not aware about their scientific name. Later prominent botanists of Agartala, Tripura are consulted, they could able to say the family of the plants as *Leguminoseae* and *Meliaceae* for *Chuwanlay* and *Chuwanthwy*, respectively, but the scientific names are still not explored, thus the photo of these two plants are Figs. 1 and 2, respectively.

Fig. 1. *Chuwanlay*

Fig. 2. *Chuwanthwy*

All these materials were just pounded into a powdery form and made into round tablets by mixing water. The tablets were dried in the sun. Another part of MASH *i.e.* acid untreated is mixed thoroughly with powdered *Chuwan*. Transferred into earthen pots and the mouth of pots were covered with paper and allowed to keep for 3 d to complete the fermentation process. After fermentation, two volumes of water were poured into one volume of fermented MASH to convert into slurry. This is the method actually adopted by the tribal people of Tripura, India.

The fermented liquids (wash)[6] obtained from conventional and indigenous method were stirred thoroughly and allowed to settle for few minutes. Then filtration was done separately for each fermented liquid and filtrates obtained were stored in

vessels separately. The residues obtained after filtration in both the cases of conventional and indigenous method were collected and sun dried for 1 week. Part of the dried residues were fed to laboratory animals (mice and rabbits) and they consumed it relishly and no behavioural alterations have been observed till up to the end of 4th week though laboratory test was not conducted on that purpose. Finally product was recovered by distillation of filtrates obtained. The purification was done at below 100 ºC as boiling point of ethanol is 78.3 ºC.

On an average 0.4 gallons (1.5 L) of ethanol is obtained from one gallon (3.8 L) of molasses. About 90 % of carbohydrate is converted into ethanol[6]. Yield of conventional method was obtained as the fermented filtrate was 1.5 L, which gave about 50 mL of ethanol and thus yield was about 3.3 % v/v. Yield of indigenous method was recorded as the fermented filtrate was 1.2 L, which gave about 36 mL of ethanol and thus yield was about 3 % v/v. Ethanol content obtained by conventional method was 12 % v/v (approx) and by indigenous method was 8 % v/v (approx.). In both the cases, samples obtained were tested and confirmed for ethanol; but they did not pass as per Indian Pharmacopoeia (IP), 1996 due to presence of methanol, which was confirmed also by chemical test. Therefore, further purification and separation of ethanol and methanolic content is essential.

Conclusion

It can be said that fresh vegetable waste materials may be disposed off, in better way, as animal food after production of ethyl alcohol. The presence of methanol and other alcohols, as impurities, may be avoided by further modification of the process and strict maintenance of the conditions for fermentation. Adoption of such practice on large scale basis, at the municipal level, will be eco-friendly and helpful to reduce the problem associated with huge garbage disposed and may also be profitable economical.

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