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PRODUCTION AND OPTIMIZATION OF BIOETHANOL FROM SOLID VEGETABLE WASTE

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***Abstract*— Bioethanol, a form of renewable energy has become the most valuable biofuel now a days. It can replace gasoline, petrol etc. to diminish the scarcity of fuel for vehicles. Besides, the problem of controlling the quantity of biowaste and recycling the waste materials demands for better solution. Research is developing day by day to find an appropriate and cost controllable solution for this process of recycling waste. Meanwhile, it has been proven that fruit waste can be used for the production of bioethanol. Fruit waste contain a huge amount of carbohydrates including other nutrient particles. In this review, production of bioethanol from different fruit waste is discussed. It has been mentioned that fuel like gasoline can be replaced with bioethanol. Different fermentable procedure of fruit waste and various enzymes used to speed up the reaction is described in this review.**

Keywords*—Bioethanol, renewable energy, Fruit waste, fermentation etc.

I. INTRODUCTION

Biowastes are the contaminated waste products produced from biohazardous agents which include materials like blood vials, surgical wraps, Petri dishes, pipette tips, syringes, needles, culture tubes, absorbent material, and personal protective equipment [1]. These wastes are also known as biodegradable waste that possesses organic material such as food waste, green waste, biodegradable plastics, and paper waste [2]. Moreover, potentially infectious wastes are mostly found in medical teaching facilities, medical research, health care, funeral establishments, laboratories, etc. These wastes are hazardous to the environment and human health [3]. Biomedical waste materials are usually burned and destroyed for taking precautions against infectious diseases [4]. One of the best biomedical waste management techniques is to avoid generating waste materials or initiating a waste recovery process instead of discarding the waste[5]. The best-known methods of biomedical waste disposal based upon the needs and requirements are to reduce the quantity of waste material by reusing the waste or recycling the unwanted non-biodegradable waste product, waste product recovery process by the treatment of waste and then disposing of the unrecyclable hazardous biomedical waste products. Production of bioethanol is mainly held by using a fermentation procedure with an optimum condition [6]. Generation of bioethanol is also possible by decomposing vegetable waste materials that generate bioethanol and high humus content with the help of microbes. Moreover, vegetable waste can be reused in different food preparation as it is a potent substrate that is rich in carbohydrates. They also act as natural fertilizers that provide a nutritional supplement to the plant. Ethanol production procedure from biomolecules includes liquefaction or saccharification techniques that enhance the productivity rate [7]. Ethanol is mainly produced from agricultural waste such as maize and sugarcane trees [8]. *Saccharum officinarum*, cornhusk, corncob, sugarcane bagasse, sugarcane bark, and corn husk are pre-treated with the help of acid hydrolysis that eliminates lignocellulose. Besides, Agri-waste products bioethanol can also be fermented using microbes from glucose to ethanol [9]. Sugar beets, sugar cane, and cereal grains are used as feedstock in this fermentation method. This biofuel is also fermented from corn wheat, barley, rye, potatoes, etc. and is rich in octane number [19]. To enhance the productivity and economic condition of the bioethanol production industry also produces salt and distilled water as an accessory product by utilizing marine water as it eliminates the cost of additional minerals which has to be added in the media

[12].

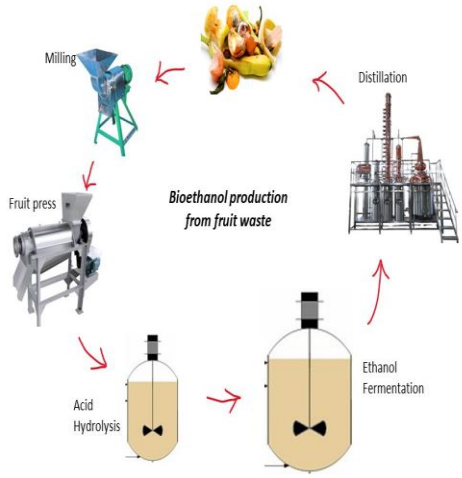

Fig: bioethanol production from fruit waste

II. RECENT RESEARCH ON BIOETHANOL PRODUCTION AND OPTIMIZATION:

Fermentation of kitchen waste (mainly vegetables and meat) can lead to the production of bioethanol very inexpensively [10]. The isolation of yeast from vegetables that contain cellulose brings out the production of ethanol. Bacillus subtilis were used in this research which gives an efficient conversion from lignocellulose to ethanol. The author found that 14.17% of the ethanol from the pretreated substrate and 6.21% ethanol from the untreated waste can be obtained. The study mentioned that *Saccharomyces* species is highly capable of fermenting ethanol whereas Bacillus subtilis enhance the rate of production. The use of Pontederia crassipes in the production of bioethanol was discovered in the year 2016 [11]. The author elevated the ethanol production rate with high cellulosic content with the use of yeast in the fermentation process. In this research, sugar was pretreated with an enzyme to get the optimal condition. It was said that the addition of 6.11ml yeast at 38.87°C per 81.87 hours can produce 1.291 grams per liter of bioethanol.

The easily available seawater for ethanol production is in high demand in the marine industry by using marine yeast that can tolerate osmotic stress [12]. This high productivity in multistage fermentation can be gained by the use of sugarcane molasses with the addition of seawater. The author has tested *S. cerevisiae* to tolerate the presence of salt in seawater. It was proven that the yeast *S. cerevisiae* can tolerate 10.5% (w/v) of salt. In the presence of two seawater-based media ethanol was produced with a production rate of 4.15 grams per Liter per hour.

The second most used food waste for ethanol and methane production is the bread which is produced using *Saccharomyces cerevisiae*[13]. The author found that enzymatic and acidic saccharification of bread waste leads to 345 to 379 grams per kilogram of bioethanol including 75 to 98 grams per litre of glucose. Sweet potato and wheat were used in this study for the production of ethanol which was found to be more effective when compared to the production of ethanol using sugar cane and maize grain.

Food waste has become hazardous material after landfilling and incineration. To avoid that starch from human food waste can be used as a substrate to manufacture bioethanol. Food waste contains lipids, proteins, cellulose, and vitamin other than starch. The author has hydrolyzed the starch-based polysaccharide wastes into glucose which can be further utilized to manufacture ethanol [14].

Anyways, qualitative improvement in homogeneity and consistency of food waste for bioethanol formation is advised by HamedKazemiShariat Panahi and his colleagues [15]. Food leftovers are rich in carbohydrates and if converted into bioethanol can prevent the effect of greenhouse gas in the environment.

Fruit wastes are another source of food compounds that can be used to make bioethanol as a potential bioproduct along with other valuable substances [16]. The author mentioned that gasoline is replaceable by bioethanol production with the help of fruit waste as it contains a massive amount of carbohydrates and other nutrients. The researcher used sugar from fruit waste without using any acidic or even enzyme catalyst for faster production. Peels of pineapple, banana, orange etc. were used to check the rate of production of bioethanol including pentose sugar and reducing sugar. Cellulase and xylanase enzymes can be hydrolyzed (heating after soaking in water) to manufacture an increased amount of reducing sugar and pentose sugar. The author found that the pH should be 5.5 and the temperature has to be 32°C with a specific gravity of 0.865 for the production of bioethanol in optimum conditions. This optimization can help in reducing production costs.

The fermentation of bioethanol can be upgraded by optimizing different conditions of the process. A high amount of ethanol production requires 72.1 hours of incubation time, 4.07pH, and 32.2°Ctemperature [17]. In this condition, the final output of ethanol shows constant parameters such as 5.1pH, 1.005 mm^2 per viscosity, 0.9specific gravity, and 0.9987 g/ml density, with a boiling point of 79°C. The author used potatoes for the production of bioethanol which contains the composition of 9.46%protein, 39.7% starch,7.33% fat, 5.82%ash, and34.7%moisture. FTIR was used for confirming the important functional groups.

Eventually, in the year 2022, Amândio and his colleagues proves that bioproducts like polyhydroxyalkanoates, biogas and bioethanol can be manufactured from pulp and paper waste [18]. These waste products need to be deconstructed or valorized to process bioethanol kind of bioproducts. Therefore, instead of burning this waste material, it can be used to generate regenerative biofuels.

III. CONCLUSION:

Bioethanol is a renewable energy that can be manufactured from fruit waste products such as fruit peels, seeds etc. Waste like kitchen waste, fruit peels, waste generated from the food industry (for example bread), paper waste, etc. can be utilized to make bioethanol. This review mentions the different types of biowaste products that can be reused to prepare biofuel like bioethanol. Different techniques are discussed which confirms

the use of appropriate enzyme and microbial organisms. The ultimate goal of this idea is to reduce the cost of ethanol production with a biowaste material and to fulfil the demand for biofuel by replacing inorganic chemicals.

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