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An overview of bioethanol production from local fruit waste and its optimization

[1]Rohit Satao [2]Akshay Shirbhate, , [3]Nishant Rathod, [4]Akash Shewale, [5]Shyam Mirge, [6]Pankaj Wankhade

[1,2,3,4,5] B.Tech Final year student, Shri. Shivaji College of Agril. Biotechnology, Amravati .

[6] Assistant professor, Dept. of Post-harvest & food biotechnology, Shri. Shivaji college of Agril. Biotechnology, Amravati.

Abstract :-

Renewable energy is now capturing a headlines because of concerns about supplies of fossil fuels, escalating population and industrialization triggering ever-increasing demand of fuels. All over the world, governments have encouraged the use of alternative sources of energy for overcome energy crisis. The high price of crude oil (Fuel) has attracted the greater attention to biofuels, especially bioethanol. In this research we see an overview of bioethanol production from local fruit waste and its optimization of fermentation processes. The waste of seasonal fruit, i.e. apple, grape, orange, banana, pineapple etc; was used in the study. Saccharomyces cerevisiae (baker's yeast) was used for the fermentation process.

Keywords: fossil fuels, biofuels, bioethanol, fermentation, yeast.

Introduction:

A large amount of fruit waste and residues are generated after industrial processing of various fruits. In Such waste includes apple, oranges, sapota, banana, pineapple, watermelon etc. This fruit wastes have high levels of fermentable sugars (such as sucrose and fructose) that can be converted into bioethanol after fermentation with the help of yeast. Because they are a renewable resource, fruit wastes have proven to be a useful source of waste for ethanol production. Yeasts is used for bioethanol production scientifically known by Saccharomyces cerevisiae. This fungus ferment the sugars which comes from fruit wastes to produce ethanol. In the alcoholic fermentation process 1 mol of glucose converts into 2 mol of ethanol and 2

mol of carbon dioxide, ($C_6H_{12}O_6$ $2C_2H_5OH$ $+2CO_2$) (Baskar et al. 2012). Ethanol (CH_3CH_2OH), also known as ethyl alcohol or bioethanol.

Literature review and related work

Abambagade Abera Mitiku& Tanje Mada Hatsa 2020. [1] In this research work, commonly available huge volume-fruit peels (Banana, Mango and Papaya) were investigated for bio-ethanol production via fermentation by yeast, Saccharomyces cerevisiae. This work also proved that the waste product of fermentation may be used as animal feedstock or used as a fertilizer to enrich the soil for plant growth.

Rishabh Chitranshi and Raj Kapoor 2021 [2] carried out the research to produce bioethanol via cost-effective and eco-friendly techniques. The waste of seasonal fruit, i.e., apple, grape and Indian blueberry, was studied. Saccharomyces cerevisiae (baker's yeast) was used with $KMnO_4$ (5.0%), sucrose (47 g) and urea (1.5 g) for the fermentation process.

J.L. Rasoanaivo, I Aziz , L. Lehimena, A.O. Ravoninjatovo, L. Andrianaivo, 2020 [3] reported fruit waste has a huge potential in (fructose, sucrose) sugars. To manage this waste, the solution is the application of fermentation technology followed by distillation transform it into bioethanol.

Kamlesh R. Shah, Rani Vyas and Gayatriben Patel 2019 [4] suggested one such technique is production of biofuel, an alternative to the present petrol and diesel, from fruit wastes by using well known yeast Saccharomyces cerevisiae RK1.

Pooja Dular, Chirag Shah, Bhupesh Yagnik and Dipika Singampalli 2019[5] reported different fruit wastes were used as a raw material for the production of bioethanol by using Saccharomyces cerevisiae. The results of this work show that the rate of bioethanol production through fermentation of grape fruit waste by Saccharomyces cerevisiae (baker's 5.82% than other fruit waste. Fruits wastes that contain fermentable sugar should not be discarded into our environment, but should be converted to useful products like bioethanol that can serve as an alternative energy source and save the envirment.

Muhamad Ariff Amir Hamzah, Azil Bahari Alias, and Nor Elina Ahmad 2019 [6] reported production of bio-ethanol via hydrolysis and fermentation process. Banana peels, a lignocellulosic biomass, possesses compositions which favor these processes, where the banana peels are rich in cellulose content and less in lignin content. Mechanical pre-treatment of the banana peels was conducted to further ease the hydrolysis process by decresing the particle size of the biomass.

Mohammad Moneruzzaman Khandaker, KhadijahBinti Qiamuddin and Ali Majrashi 2018[7] suggested Bioethanol can be produced by the fermentation of fruits and vegetables waste, which carried out in bottle using Saccharomyces cerevisiae. This experiment was to determine the ethanol percentage from fruit and

vegetable wastes produce through a fermentation process using the yeast, Saccharomyces cerevisiae and to analyze the chemical amount and glucose content in manufacturing of bioethanol. At the end of this experiment, the best wastes that highest production of bioethanol were recoded.

Mohammad Jahid, Akanksha Gupta and Durlubh Kumar Sharma 2018[8] informed, Fruit wastes are available in plenty as wastes world over. In fact, there is a need to recover value added products from these Fruit wastes. This wastes are rich in sugars and carbohydrates which can be recovered and utilized for the production of bioethanol.

Ashna Trivedi 2018[9] reported Biomass used to bring out the process of converting non-food-based materials into cellulosic ethanol and also minimises the amount of fossil fuel energy used in production. Production of ethanol as an alternative fuel from food and agricultural waste was done by fermentation.

R. Sathish Kumar & K. Sureshkumar 2017[10] suggested in this research work, it was attempted to give value addition to the waste decayed Manilkara Zapota fruit by producing bioethanol from it. Manilkara Zapota fruit wastes were taken as a substrate for the microorganism (Saccharomyces cerevisiae) to grow under a controlled environment condition in order to facilitate the fermentation process. The temperature of fermentation process was maintained at 37°C with the help of biological oxygen demand (BOD) incubator for 72 hrs. Once the fermentation process was completed the bio-ethanol was extracted by distillation process at the temperature of 72°C. The purity of the ethanol was identified using infrared spectroscopy and gas chromatography mass spectrometry.

Suryaprabha, Akalya. V, Ramya. V, Manivasagan 2017[11] informed, biologically produced alcohol, most commonly bioethanol is produced by the action of microorganisms and enzymes through the fermentation of sugars. Bioethanol is another biofuel capable of providing enough energy when burnt to be used as a biofuel for transport. The production of bioethanol must be increased using cheaper and environment friendly raw materials. Based on these characteristics, fruit wastes can be considered as cheaper and environment friendly. different fruit wastes used as a raw material for the production of ethanol by using Saccharomyces cerevisiae and the result were compared.

Ashish G. Waghmare, Shalini S. Arya 2016[12] reported, banana is second largest produced fruit of total world's fruits. Cooking banana or plantains processing industry is generating enormous amount of waste in the form of unripe banana peel at one place, thus important to study waste management and its utilization. Therefore, unripe banana peel was investigated for ebiothanol production. In this study involved chemical characterization, optimization of acid hydrolysis, selection of yeast strain and optimization of fermentative production of bioethanol from dried unripe banana peel powder (DUBPP)

Snehal Ingale, Sanket J. Joshi, and Akshaya Gupte 2014 [13] studied focuses on exploitation of banana pseudo stem as a source for bioethanol production from the sugars released due to different chemical and

biological pretreatments. Two fungal strains Aspergillus elliptic us and Aspergillus fumigatus used for producing cellulolytic enzymes on sugarcane bagasse were used under co-culture fermentation on banana pseudo stem to degrade holocellulose and increse release of reducing sugars.

Sandesh Babu, K.M.Harinikumar and Ravi Kant Singh 2014[14] reported bioethanol production from fruit juices of four different fruits such as grapes, Sugarcane, Mosambi and Watermelon using yeast (Saccharomyces cerevisiae) for fermentation and optimizing several factors of bioreactor that influence the process for bioethanol production such as temperature, pH and sugar concentration.

R. Arumugam & Manikandan 2011[15] revealed that the fermentation of hydrolysates obtained from the dilute acid pretreatment followed by enzymatic saccharification of mixed fruit pulps (banana and mango) and the banana fruit peels were found to be best for higher bioethanol production at optimized conditions.

Table No. 1 An overview of bioethanol production from local fruit waste and its otimization of fermentation processes

Sr. No	Title of research paper and year of publication	Name of Author	Remarks
1	Bioethanol Production from Decaying Fruits Peel Using Saccharomyces cerevisiae (2020)	Abambagade Abera Mitiku & Tanje Mada Hatsa	In this research work, commonly available large volume-fruit peels (Banana, Mango and Papaya) were investigated for bio-ethanol production via fermentation by yeast, Saccharomyces cerevisiae. • Optimum temp. of fermentation-30^{0}C. • Hydrolysis temp.-98^{0}C for 24 hours. • Optimum pH of fermentation-(5.0-5.5).
2	Utilization of over-ripened fruit (waste fruit) for the eco-friendly production of ethanol. (2020)	Rishabh Chitranshi Raj Kapoor	The use of mixture of three fruits namely Banana, Grapes and Mango was used as a possible substrate for production of cellulosic ethanol by modifying parameters. • Temperature of fermentation-28^0 C • Incubation days-8 days • Optimum pH-6.
3	Production of Ethanol From Tropical Fruit Juice	J. L. RASOANAIVO & Others	The present research work focused on lychee and pineapple waste. Its purpose is: first, the production of bioethanol through the energy

	Pasteurization Waste. Case of The Company Madagascar Premium Exotica (MPE). (2020)		recovery of the waste from pasteurization of these fruits; second, the contribution to the solution of the BEP waste rational management problem. Bioethanol is a renewable, ecological and alternative energy source to wood energy. • Temp. of distillation – 78^0C • Optimum days of fermentation -5days
4	Bioethanol production from pulp of fruits (2019)	Kamlesh R. Shah & others	The use of mixture of three fruits namely Banana, Grapes and Mango was used as a possible substrate for production of cellulosic ethanol by modifying parameters Methods used in bioethanol production • Optimum pH – 6 • Optimum Temp. – 28^0C • Incubation Days – 8 days
5	Bioethanol Production from Rotten Fruit (2019)	Pooja Dular & others	Production of Ethanol from fermented renewable sources for fuel or fuel additives are known as bioethanol. pH 5.6, temperature 30°C, • specific gravity 0.876, • concentration of about 5.82%
6	Production of Biofuel (Bio-Ethanol) From Fruit waste: Banana Peels (2019)	Muhamad Ariff Amir Hamzah & Azil Bahari Alias	Optimum pH value in the production of ethanol by using banana peels is highly dependent on the type of yeaste that has been used for fermentation process. Optimum temp.30^0C Optimum pH- 5 to 6.
7	Bio-Ethanol Production from Fruit and Vegetable Waste by Using Saccharomyces cerevisiae (2018)	Mohammad Moneruzzaman Khandaker, Umar Aliyu Abdullahi & others	Vegetables and fruits biomass is a resource of renewable energy with significant fuel source potential for the production of electricity and steam, fuel for consumption and laboratory solvents. • Temp. of fermentation – 20 To 50 • Optimum days of fermentation 7Days • Optimum PH of fermentation 5.5

8	Production of Bioethanol from Fruit Wastes (Banana, Papaya, Pineapple and Mango Peels) Under Milder Conditions (2018)	Mohammad Jahid & others	• pH- 4-8 • Incubate Time- 48 to72 hr • Centrifuged at 1000rpm for 5 minutes
9	Bioethanol production from fruit and vegetable waste using yeast (2018)	Ashna Trivedi	Production of biofuel from various waste such as agricultural waste, municipal waste, etc., has been carried out with the objective of converting the waste to useful material. • Temp. of autoclave at – 121 • Optimum days of fermentation - 10days • Optimum PH of - 5.5
10	Value Added Bioethanol Fuel from Waste Decayed Manilkara Zapota Fruit (2017)	R. Sathish Kumar & K. Sureshkumar	Decayed Manilkara zapota fruit can be one of the best substrates for ethanol production. The yield of bioethanol from Zapota fruits was found to be 10.45%(w/v). • Purity of ethanol 99.09% by volume. • Optimum temp. of fermentation-37^{0}C. • Temperature of distillation-72^{0}C. • pH-5.5
11	Comparative Studies of Bioethanol Production From Different Fruit Wastes Using Saccharomyces cerevisiae (2017)	Suryaprabha. & Others	Bioethanol is produced by the action of microorganisms and enzymes through the fermentation of sugars. The production of bioethanol must be increased using cheaper and eco-friendly raw materials. Based on these characteristics, fruit wastes can be considered as cheaper and eco-friendly. • Optimum temperature for incubation: - 35^0 to 40^0 C • Optimum day for incubation: - 7 days • Extracted ethanol percentage: - 6.3%2

12	Utilization of unripe banana peel waste as feedstock for ethanol production (2016)	Ashish G. Waghmare & Shalini S. Arya	The optimum conditions for fermentative production of ethanol from acid hydrolysate of DOBPD were seed age (12hr). • Fermentation time-36hr. • Optimum temp.-30^{0}C.
13	Production of bioethanol using agricultural waste: Banana pseudo stem (2014)	Snehal Ingale , Sanket J. Joshi and others	The hydrolysate obtained after alkali and microbial treatments was fermented by Saccharomyces cerevisiae NCIM 3570 to produce ethanol. Fermentation time - 7 days Optimum temperatures – 30^{0}C.
14	Optimization of Bioethanol Production from Fruit Wastes using Isolated Microbial Strains (2014)	Sandesh Babu & others	The present research work focused on lychee and pineapple waste. Its purpose is: first, the production of bioethanol through the energy recovery of the waste from pasteurization of these fruits; second, the contribution to the solution of the BEP waste rational management problem. Bioethanol is a renewable, ecological and alternative energy source to wood energy. • Temp. of distillation -78 c • Optimum days of fermentation -5days
15	Fermentation of Pre-treated Hydrolysates of Banana and Mango Fruit Wastes for Ethanol Production (2011)	R. Arumugam & M.Manikandan	Various methods are use like microbial enzyme production and extraction, liquid hot water treatment, dilute acid pre-treatment enzymatic saccharification and fermentation and ethanol production. • Optimum temp.-30^{0}C for 3 days • Ethanol extracted from • Mango-36% Banana-14%

Conclusion

In this study we observed the fruit wastes coming from fruits like Oranges, pineapple, grapes, apple, banana and all other seasonal fruits mainly available in India have fermentable sugar and it could be fermented using baker's yeast at different temperature, pH and specific gravity. Table no 1 showed that the maximum yield of ethanol was obtained overall at temperature 30°C; pH 5.5 and specific gravity 0.865. Since the fermentation

conditions are optimized, this optimum condition may be used for large scale production of bioethanol from fruit wastes.

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