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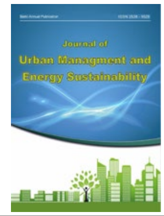

ORIGINAL RESEARCH PAPER

Potential measurement of bioenergy production from urban waste in Isfahan city

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ABSTRACT

The growing trend of urban waste production and the environmental pollution caused by it, are among the factors that have forced mankind to try to obtain renewable fuels. In the case of Isfahan city, an average of 1000 tons of urban waste is produced daily and 76% of it is organic matter. Therefore, in the direction of producing renewable fuels, there is a potential for biogas production. This research has a descriptive-analytical view, which is purposed at development and application. The method of collecting information is the library and survey, and in addition to that, direct surveys, and reliable sources have also been used. The municipal waste was analyzed according to the Hans method according to the VDI 46030 standard, and the biogas analysis was done using a gas chromatograph equipped with a TCD detector, and also to check the potential of biofuel production after digesting the dried waste, the amount of free sugar It was checked by DNS method, then after detoxification and fermentation, the amount of bioethanol in the obtained samples was measured by HPLC. The results show that for 6 kg of organic waste after 54 days of anaerobic digestion, an average of 490 ml/gr of biogas was obtained, 60% of which is methane, and 8 grams of ethanol were produced for 20 grams of dry waste. According to the studies, if 5% gasoline is used in Isfahan city, the carbon monoxide pollution index will decrease by 11% and the suspended particles index will decrease by 67%.

Running Title: Potential measurement of bioenergy production from urban waste

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1. Introduction

Waste is considered one of the important sources of pollutants in big cities. The lack of proper management can play a significant role in the occurrence of human and urban environmental crises. To solve this problem, you must think of a solution and use appropriate methods to reduce or return these materials to the production cycle. In this case, we will face environmental problems in the not-too-distant future., (Karmee, *et al.* 2016; Sohoo, *et al.* 2021) The high composition of food and plant waste, which includes carbohydrates, glucose, starch, fructose, cellulose, and lipids in urban waste, which are easily decomposed, is a good source for the production of biofuels such as hydrogen, methane, and bioethanol. If this amount of organic waste is properly managed, it can take a positive step in preserving the environment and reducing greenhouse gases. (Sohoo *et al.* 2021, Taherzadeh, et al. 2008, Hoover, et al. 2001.) On the other hand, energy is one of the most important axes of development of any society. Decision-making and policy-making in this field without considering the changes that will occur in the future and the needs that will arise in the future will result in nothing but failure.) (Escobar, *et al.*, 2009). Because the organic matter in urban waste is a suitable source for the production of renewable fuels, according to the studies carried out today, the production of methane gas and biofuel (bioethanol), and electricity from urban solid waste is a cost-effective solution. And environmentally friendly, it is used to reduce waste and dispose of it without environmental consequences. (Schirmer et al. 2014; Shomal *et al.* 2019) In developed countries, especially in European countries, many factories have been built to produce electricity and heat from methane obtained from waste (Chen, et al., 2016, Hoang, et al., 2022). Therefore, it is necessary to investigate the potential of producing renewable fuels from urban waste, and in another measure, to investigate their economic and environmental aspects, considering the information and data that exist from the past and present, with a vision for the future and opportunities. existing can be planned for it (Shumal. et al. 2020; Gonzalez, *et al.* 2017). It should be mentioned that the establishment of a management system requires the identification of various factors such as the economic status of the people, social conditions and customs, material components It has solid waste, the humidity of solid waste, percentage of organic matter, availability of required land, type of technology. Therefore, a management system can be unique management system for each city. (Norbakhsh *et al.* 2020).

2. Materials and Methods

2.1. Investigating the chemical characteristics of waste in Isfahan city

To analyze urban waste, a 200 kg sample of the screened material of line 3 (bag opener line) was removed. This sample was mixed enough. and turned into pulp. Then, organic carbon, phosphorus, pH, total soil nitrogen, and elemental analysis (CHNS) were measured. (Shomal, et al. 2019) To produce biogas, a method similar to Hans' method was used following the VDI 46030 standard. The analysis of the produced biogas and the determination of the percentage of methane and carbon dioxide was performed using a gas chromatograph equipped with a TCD detector. (Drosg, et al. 2012; Ritzkowski, et al. 2021) To measure the potential of biofuel (bioethanol) production, the amount of dried waste after digestion, and the amount of released sugar were determined by the DNS method. Then a step was detoxified with lime under standard conditions, then pre-processing was done using sodium carbonate and the amount of extractable material was determined. In the next step, the culture medium was prepared according to the standards and Mucoindicus mushroom was used for fermentation. The amount of ethanol in the samples. It was measured by HPLC, which was used for higher accuracy than standard samples with specific concentrations containing ethanol, glycerin, and glucose. (Verhe.R. et al. 2022; Miezah, et al. 2017 (

2.2. Composition of the percentage of components in municipal solid waste

According to the information obtained from the amount of waste produced and its analysis, some of the characteristics and composition of the percentage of materials in the organic component of Isfahan urban solid waste are shown in Table 1-3. In the year 1400, an average of 31 thousand tons of all kinds of waste (except for construction refuse) were collected in Isfahan city. The physical analysis of the collected wastes shows that more than 76% are organic materials (food wastes), wastes. Green and branched (9%), other plastic waste (5.2%), diapers (4%), paper and cardboard (3%) accounted for the highest percentage of urban waste analysis, respectively, and 2.3% of other waste It includes recycled waste and special treatment of normal waste. Table 2-3 shows the amount of moisture, organic matter carbon, volatile and non-volatile solids, nitrogen, ash, phosphate, total fat, and pH. The pH of the sample is in the range of 5.1-6.5, so it should be checked regularly during the operation because, in anaerobic digestion, the pH depends on the alkalinity of the liquid in the digester and also the amount of carbon dioxide in the gas phase. In an anaerobic digestion process, by measuring the concentration of organic acids, it is possible to ensure the balance between the collections of microorganisms. If inhibitory compounds enter the system or the system is overloaded, the concentration of organic acids increases. If the buffering capacity of the system is lost, bicarbonate should be added to the system because the decrease in pH kills methanogens (Rittmann, et al, 2001; Teng, et al, 2014). According to the obtained numbers, urban waste has a high percentage of moisture, which causes negative economic effects in the fermentation sector and low combustion efficiency and energy production. The analysis

Table 1. Checking the percentage of waste components in the city of Isfahan in 1400

Amount in percent	Municipal waste components
76	Amount of organic matter
9	Green waste and branches
5.2	Plastic
4	diaper
3	Paper and cardboard
0.5	A special component of normal waste
2.3	Other waste (textiles and other recyclable materials)

Table 2. Examination of the chemical properties of urban solid waste

test method	amount	unit	Parameter of the organic part of the waste
	3.5-4.8	ds/m	EC (1:10)
	77-81	%	Organic Materials
	39-46	%	Organic Carbon
	5.1-6.5	-	pH (1:10)
	1700-3500	mg/Kg (wet)	PO_4^{2-}
ISIRI 13320	15.2	(weighted-weighted)%	Protein
ISIRI 1677	70.4	(weighted-weighted)%	moisture
ISIRI 13320	19.8	(weighted-weighted)%	ash
Soxhelet Method	2	(weighted-weighted)%	total fat
ISIRI 13320	2.5	(weighted-weighted)%	Nitrogen
drying oven method	95.4	(weighted-weighted)%	Total solids
Ash method	68.8	(weighted-weighted)%	volatile solids

of urban waste in Isfahan shows that due to the high amount of organic carbon, protein, and fat, it has a high potential for producing biogas and biofuels. (Noorbakhsh, et al. 2019/ Hoang, A, et al. 2022/ Schirmer, et al. 2014/ Sosnowski, et al. 2008) Anaerobic treatment microorganisms, like all microorganisms, need a series of nutrients. (Gerardi et al., 2003)

2.3. Measuring the amount of methane produced

The amount of biogas and then the amount of produced methane and carbon dioxide from the samples were checked in 54 days. The amount of methane produced from the samples and the cellulose sample has been increasing over time, and this increase was less in the first days, but with the increase of time, the amount of methane production increased more, and the methane production of the three samples was almost close to each other. From the witness sludge sample, it has been almost constant since the 12th day. The anaerobic digestion process on the organic materials in the control sludge started 5 days before the start of the experiment, and during this time, many polymeric materials and late digestion agents started their hydrolysis process. Therefore, the materials in the witness sludge are faster-digestible materials than other samples and require less time for anaerobic digestion. which is shown in Figure (1-3.) The amount of carbon dioxide gas production from the samples has increased over time with an almost constant slope, proportional to the increase in biogas production. Methane potential after 54 days of anaerobic digestion was obtained on average equal to 490 ml/g of volatile solid. These numbers were after correcting the amount of methane produced according to the gas law (temperature of 20 degrees Celsius and pressure of 1 atmosphere). The higher the percentage of

Table 3. The total amount of biogas and the percentage of methane after 54 days of the experiment (the numbers are related to the temperature of 37 degrees Celsius)

	Total Biogas (mL/g-VS)	Methane (Vol %)
Sample 1	939	60.4
Sample 2	1025	65.9
Sample 3	914	62.5
Cellulose	851	61.1
Sludge	204	50.6

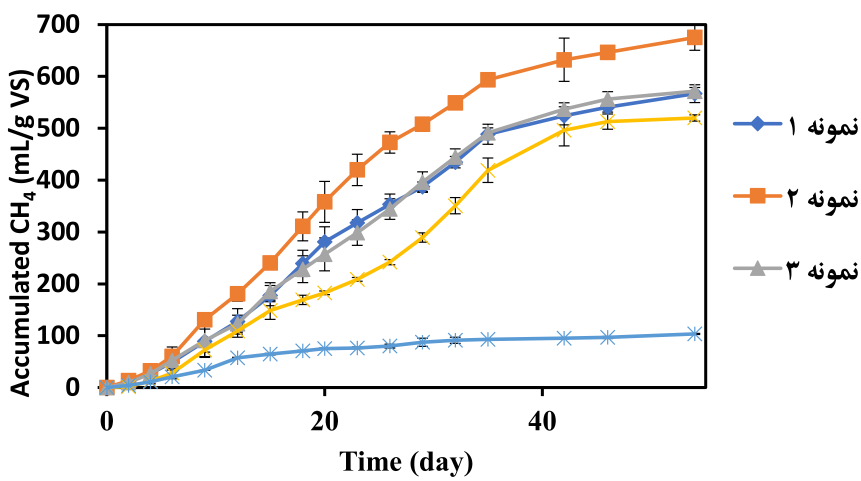

Figure 1. Cumulatively produced methane from the samples

methane, the higher the quality of the produced biogas. The results show that energy recovery from urban waste is one of the most widely used methods for managing urban solid waste through an anaerobic digestion system. This technology can be considered in energy recycling not only in developed countries (with high resource segregation) but also in developing countries (with poor resource segregation). According to the studies conducted in Isfahan city, due to the dry climate, it is more appropriate to use anaerobic digestion technology, which has been reported to have the potential for urban waste methane production, and it should be noted that the average amount of methane production can be achieved with different steps. Refinement and preparation of its raw materials increased (Noorbakhsh, S. et al. 2019/ Hoang, A, et al. 2022)

Considering that biogas is mainly composed of methane and carbon dioxide, in addition to the volume of methane produced, the volume of carbon dioxide produced is also important.

2.4. Investigating the potential of biofuel production (bioethanol)

According to the relevant analysis, it showed that more than 76% of urban waste is made up of organic materials, and on average, the organic part of the waste contains 58.6% starch, 11.8% glucan, 3.6% xylan, and 0.3% galactan. 8.8% acid-soluble lignin, 9.8% acid-insoluble lignin, 0.3% ash, and 0.4% other sugar polymers (weight percent) were analyzed based on the method by NREL (2008) (Sluiter, et al. The high

Table 4. Data related to the amount of methane production in terms of mL/g-VS units

Day	0	2	4	6	9	12	15	18	20	23	26	29	32	35	42	46	54
Sample 1	0	11	27	49	89	128	177	239	281	317	353	387	435	489	524	541	567
Sample 2	0	13	32	60	131	181	240	311	358	420	473	508	549	594	632	646	675
Sample 3	0	9	27	52	91	123	185	228	257	299	344	396	445	491	537	556	572
Cellulose	0	2	12	28	72	109	149	169	183	209	242	289	351	419	496	513	520
Sludge	0	4	11	21	34	58	64	71	75	76	80	87	91	93	95	97	103

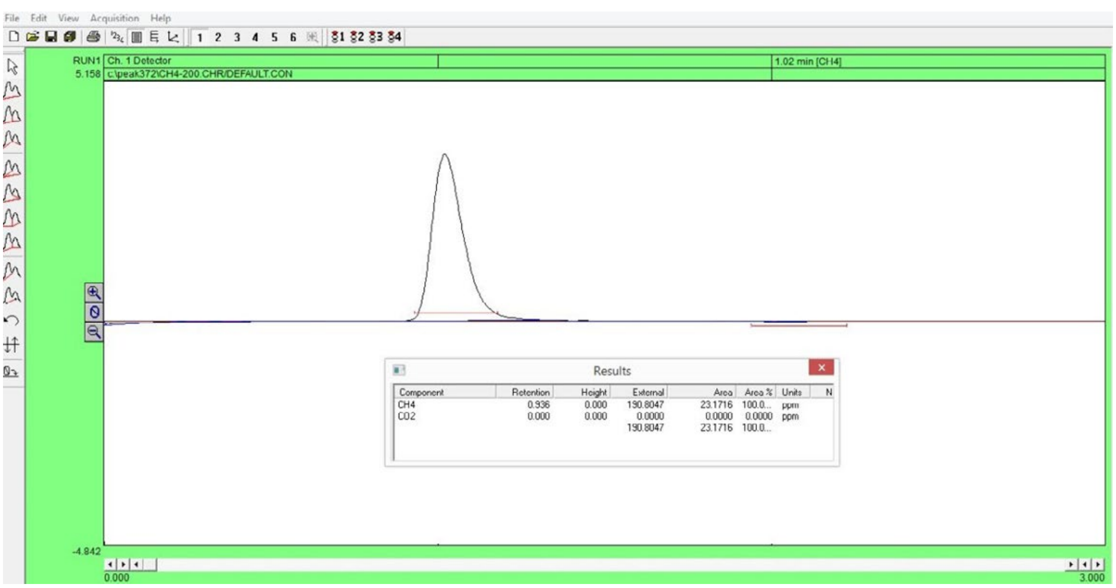

Figure 2. Peak curves related to pure methane with volumes of 50, 75, 100, 125, and 200 microliters.

composition of food (protein, lipid, carbohydrate, glucose, starch, fructose, and cellulose) and vegetable waste in urban waste, which is easily decomposed, is a good source for the production of biofuels in Isfahan city. If this amount of organic waste is managed properly, it can take a positive step in preserving the environment and reducing greenhouse gases (. (*Taherzadeh,etal 2008/ Hoover,etal 2001*)

The results of ethanol fermentation after fermentation and analysis of the samples taken, the theoretical yield of ethanol production was obtained from equation (1-3).

$$Theoretical\ efficiency\ of\ ethanol = \frac{Ethanol\ production}{1/1111*/051*\ An\ existing\ example\ of\ glucan} \times 100$$

In other words, the theoretical amount of ethanol is 0.51 grams of ethanol per gram of glucose. The amount of produced ethanol was 8 grams per liter or 43.07% by weight of dry waste by measuring by the FID_GC device. For 20 grams of primary dry waste, it is 8 grams per liter. Studies show that this result is consistent with the results of other studies (Miezah, et al., 2017).

. The urban waste of Isfahan is because more than 76% of it is organic matter, which includes bioactive compounds such as lignocellulosic materials and substrate starches, including protein, fat, and carbohydrates. All carbohydrates, fats, and proteins have a high potential to produce biogas and biofuels. According to the studies, the current potential of bioethanol production in Isfahan is 76230.0 liters per year (*Miezah et al 2016* (Taherzadeh, et al*.2008/* Kim, et al.2014)

2.5. Economic and environmental study of biofuel production from waste

2.5.1 Thermal and electrical energy and bioethanol that can be extracted from Isfahan's wastewater

According to the studies conducted and the review of the technologies presented for the production of biogas from solid waste and its efficiency. BTA in different countries (Germany), Valorga (France), and DRANCO (Belgium) waste production efficiency of biogas from waste is between 80 and 200 cubic meters per ton of waste. On average, this efficiency is considered to be 140 cubic meters per ton of waste(

By taking into account the efficiency of biogas production from more waste, the amount of biogas obtained from more waste can be estimated:

Daily capacity of biogas produced from urban waste in Isfahan:

$$883.122 \frac{ton}{day} * \frac{140\,m^3}{ton} = 123637 \frac{m^3\ biogas}{day}$$

The calorific value of biogas (combined with 35% carbon dioxide and 65% methane) is equal to 22 MJ/m3 (Sabziparvar, 2008). As a result, the amount of energy obtained from it is:

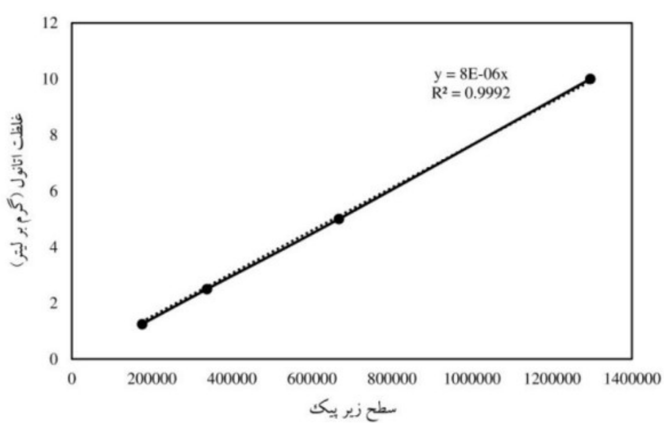

Figure 3. Calibration plot obtained for ethanol

$$123637\frac{m^3\ \text{biogas}}{\text{day}}\times\frac{22\ \text{MJ}}{1\,m^3}=2720014\frac{\text{MJ}}{\text{day}}$$

The typical electrical efficiency of biogas engine generators is about 40%; Therefore, if the produced biogas is used in the engine generator to produce electric power, there is the ability to produce 2.4 kWh of electricity per cubic meter of produced biogas (Davodinejad, 2015). As a result, the amount of electricity that can be produced daily from the produced biogas is equal to:

$$123637\frac{m^3\ \text{biogas}}{\text{day}}\times\frac{2.4\ \text{kWh}}{1\,m^3}=296729\frac{\text{kWh}}{\text{day}}=12.4\ \text{MW}$$

To calculate the trend of electricity production from biogas extracted from more waste, it was assumed that the per capita production of waste in the coming years is the same as in 1400. The amount of electricity obtained from it is calculated in the table below. This table shows that until 1404, the capacity of electricity produced from more waste can increase to about 14 megawatts. The investment cost for building a unit or units to produce electricity from biogas with a capacity of 14 megawatts is about 1120 billion tomans. Due to the non-separation of waste in Isfahan, due to the lack of high profit and sufficient attractiveness in investing in biogas, the private sector is unlikely to achieve this goal. Unless the relevant institutions increase the profitability of such units with their participation. For example (by providing special facilities or participation in investment, etc.)

Considering that bioethanol is the most

Table 5. The amount of air pollution reduction in the case of using bioethanol as a substitute for gasoline

The amount of pollution reduction in Isfahan city (percentage)	Pollution reduction rate (percentage)	Share of gasoline engines in pollution caused by traffic (percentage)	Share of traffic in Isfahan air pollution (percentage)	pollutant
-11	-15	99	76	Carbon monoxide
-67	-90	99	76	Particles
+13	+18	99	76	Nitrogen oxides

Table 6. Percentage reduction of carbon dioxide emission in the case of using ethanol in the current conditions of Isfahan city

CO2 reduction percentage	The total amount of CO2 produced (tons per day)	Amount of CO2 produced (kg/liter)	Alternative fuel	The total amount of CO2 produced (tons per day)	The amount of CO2 produced (kg/liter per day)	Daily consumption (million liters)	fuel
2.5	4617.6	2..116*	E5	4501.5	2..347	1.918	Petrol

The prediction of gasoline consumption in Isfahan city was made based on the population growth trend. Currently, the car per capita in Isfahan city is equal to the:

$$\text{Vehicles per capita}=\frac{1168000\ \text{vehicles}}{2168172}=\frac{538\ \text{vehicles}}{1000\ \text{person}}$$

Per capita, gasoline consumption in 1400 is equal to:

$$\text{petrol consumption per capita}=\frac{987000000}{1168000\ \text{vehicles}}=\frac{845\ \text{liter}}{\text{vehicle}}$$

Table 7. Prediction of the amount of gasoline and bioethanol required until 1404 in Isfahan

Required ethanol (million liters per year)	Gasoline consumption (million liters per year)	The population of Isfahan (million people)	Car per capita (cars per 1000 people)	year
52.90	1058.19	2.32	538	1400
53.66	1073.32	2.36	538	1401
54.43	1088.67	2.39	538	1402
55.21	1104.24	2.42	538	1403
56	1120.03	2.46	538	1404

Table 8. Checking the amount of wastewater and electricity produced from it until 1404 in Isfahan

Produced electricity (megawatt)	Total production waste per year (tons per year)	More waste per capita per day (kg per person per day)	population (million people)	year
13.04	931.1	0.4	2.32	1400
13.22	944.4	0.4	2.36	1401
13.41	957.9	0.4	2.39	1402
13.60	971.7	0.4	2.42	1403
13.80	985.5	0.4	2.46	1404

important liquid biofuel known in the world, it is the most valuable and environmentally friendly urban waste recycling product. The biological raw materials used in the production of bioethanol are mainly organic. (Demirba, et al. 2003/, Bajpa, et al. 2013) On the other hand, currently, the main way of using fuel ethanol in the world is to add it to gasoline consumed by cars, instead of a harmful additive. Ethanol biofuel can be used alone as a fuel or as an oxygen carrier in fuel and increase its oxygen content and cause better oxidation of hydrocarbons and as a result reduce the output of carbon monoxide, sulfur dioxide, and volatile organic compounds. and hydrocarbon particles from the exhaust of cars (Brandberg et al. 2007), so in this regard, according to the investigations, 76% of the pollutants are from transportation traffic, of which 99% are related to gasoline engines. Mixture 5 The percentage of bioethanol in gasoline is called five percent gasoline. The use of five percent gasoline does not need to change the structure of the existing gasoline engines. Table 5-3 shows the amount of reduction in air pollution if ethanol is added to gasoline. (Vanetal. etal 2003, Demirba,etal.2005/)

(, (Agarwal, et al. 2007) The data in this table shows that the quality of the fuel used in gasoline engines has a great effect on reducing air pollution. By replacing ethanol, suspended particles can be reduced by about 70%. On most of the polluted days in the city of Isfahan, the air is suspended particles have exceeded the permissible limit (Purwadi, et al. 2004)

The use of bioethanol is not only effective in reducing pollutants, but also in reducing the emission of CO2 as a greenhouse gas. In this article, by examining the statistics of daily gasoline and diesel consumption in Isfahan and knowing the number of CO2 emissions from each liter of gasoline and diesel, the total amount of carbon dioxide emissions can be calculated (Arbor et al. 2014).

If it is assumed that the consumption of gasoline per capita and also the consumption of cars per capita in the city of Isfahan will remain constant in the next ten years, then according to table 6-5, it is possible to calculate the amount of gasoline consumption in Isfahan in the horizon of 1404 and predict its trend. In the production of ethanol, it is equal to 7.6 million liters per year, which is about 7 to 8 times this amount per year, to replace 5% gasoline with regular gasoline. It should be noted that considering the price of gasoline and receiving its subsidy, it is necessary to pay the difference between regular gasoline and 5% gasoline for the production of ethanol required for 5% gasoline by the relevant institutions, in this case, the use of fuel with less pollution will certainly be a priority for the people. Had

3. Results and Conclusions

The world's increasing need for new energy sources, especially in the transportation sector, is one of the basic problems of developed and even developing countries today. Pollution caused by fossil fuels is one of the other factors that have made mankind try to obtain renewable fuels. Also, the crisis caused by global warming and environmental pollution, about the production of greenhouse gases due to excessive consumption of fossil fuels, has increased the demand for alternative fuels. In line with this, a new economy has emerged in the 21st century, which is known as bio-economy, and emphasizes the use of clean and new technologies. Renewable energies are a suitable solution to solve these problems. In the first stage, the amount of waste production, especially physical and chemical, was investigated by library studies and the cooperation of the Urban Services Department and the Waste Management Organization. On average, 31,000 tons of all types of waste (except construction refuse) are collected in Isfahan city every month. The physical analysis of the collected wastes shows that more than 76% are organic materials, green and branched wastes (9%), Other plastic wastes (2.5%), diapers (4%), paper and cardboard (3%) respectively accounted for the highest percentage of urban waste analysis. According to the analyzes performed, the cumulative methane production rate was 493 ml per gram of volatile solids per 6 kg of waste, and 8 grams of ethanol were produced per 20 grams of primary dry waste. Because compounds such as food waste are rich in organic components, the presence of a high percentage of organic components in urban solid waste is obvious and creates a high potential for turning waste into energy. Because the yield and characteristics of the products produced in this process depend on the operating conditions and compounds in the feed such as carbohydrates (cellulose, hemicellulose, lignin and starch, proteins, fat, and ash). According to the library studies and matching them with the total urban waste, the calorific value of biogas (with a combination of 35% carbon dioxide and 65% methane) is equal to 2720014 mj/day in one day. Electricity production from biogas can produced as much as 14 megawatts of electricity in 1404. Generating electricity from waste creates both employment and protection of the environment, because generally now, waste is buried in the ground, which has a lot of environmental harm. Generating electricity from biogas requires the separation of waste, which is currently not fully implemented in Isfahan city, and as a result, this task has faced technical and operational problems. Generating electricity from biogas requires a very high investment (1120 billion Tomans), which certainly requires the participation of the private sector. Apart from the operational problems of implementing such units, due to the unattractiveness of investing in this sector (due to the low purchase price of the electricity guarantee), investors do not show much interest and currently, the laws of the country are not such that it can be seen as attractive. The use of biodiesel does not have much effect on the air pollution of Isfahan city because the number of diesel cars that travel in the city is much less compared to gasoline engines. According to the investigations, the current potential of bioethanol production in Isfahan is 7,623,000 liters per year. It is predicted that the consumption of gasoline in Isfahan in 1404 will be equal to 1120 million liters per year, and as a result, the need for bioethanol is 56 million liters. Expanding the use of bioethanol requires paying the difference between biofuel and regular gasoline. This number is about 157 billion Tomans annually on the horizon of 1404. which should be paid by the relevant institutions, otherwise the consumer will not have any incentive to use it. The current potential of bioethanol production in Isfahan is 7,623,000 liters. According to the studies, if 5% gasoline is used in Isfahan, the carbon monoxide pollution index will decrease by 11% and the suspended particles index will decrease by 67%. It is suggested that considering that the city of Isfahan has a specific organization for processing and separation from the source, planning and necessary arrangements for proper waste management and educating the citizens, with a more detailed examination of the amount of waste in the city of Isfahan, its potential for other biofuels can be investigated to be able to Pay attention to the economic, social and environmental conditions, the technology should be selected according to the existing conditions, on the other hand, the country should prepare the appropriate laws and platforms so that energy production is both economically efficient and can be done easily and quickly from a technical point of view.

References

Amin, S. (2009). Review on biofuel oil and gas production processes from microalgae. Energy Conversion and Management, 50,.1834-1840. https://doi.org/10.1016/j.enconman.2009.03.001

Agarwal, A. K. (2007). Biofuels (alcohols and biodiesel) applications as fuels for internal combustion engines. Progress in energy and combustion science, 33, 233-271. https://doi.org/10.1016/j.pecs.2006.08.003

Alamdari, P.; Nematollahi, O.; Mirhosseini, M. (2012). Assessment of wind energy in Iran: A review. Renewable and sustainable energy reviews, 16(1), 836-860. https://doi.org/10.1016/j.rser.2011.09.007

Andrade, I.; Vargas, S.; Fajardo, G. (2013). Biodiesel Production from Waste Cooking Oil by Enzymatic Catalysis Process. Journal of Chemistry and Chemical Engineering, 7(10), 993.

Brandberg, T.; Karimi, K. (2007). Continuous Fermentation of Wheat-Supplemented Lignocellulose Hydrolysate with Different Types of Cell Retention, Biotechnology and Bioengineering, 98:80-90. https://doi.org/10.1002/bit.21410

Chen. HC. (1990). Non-aseptic, multi-stage, multi-feeding, continuous fermentation of cane molasses to ethanol. Process biochemistry international. 23(12):254-260. https://doi.org/10.1007/BF01024433

Chen, P.; Xie, Q.; Addy, M.; Zhou, W.; Liu, Y.; Wang, Y.; et al. (2016). Utilization of municipal solid and liquid wastes for bioenergy and bioproducts production, Bioresource Technology. 215. 163-172. https://doi.org/10.1016/j.biortech.2016.02.094

Cheng, J.; Ding, L.; Lin, R.; Liu, M.; Zhou, J.; Cen, K. (2016). Physicochemical characterization of typical municipal solid wastes for fermentative hydrogen and methane co-production, Energy Conversion and Management. 117.297-3044. https://doi.org/10.1016/j.enconman.2016.03.016

Demirbas, A., (2008). Biofuel sources, biofuel policy, biofuel economy, and global biofuel projections. Energy Conversion and Management, 49(8):2106-2116. https://doi.org/10.1016/j.enconman.2008.02.020

Demirba, A. (2005). Bioethanol from Cellulosic Materials: A Renewable Motor Fuel from Biomass, Energy Sources, 21, 327-337. https://doi.org/10.1080/00908310390266643

Derbal, K.; Bencheikh-lehocine, M.; Cecchi, F.; Meniai, A.H.; Pavan, P. (2009). Application of the IWA ADM1 model to simulate anaerobic co-digestion of organic waste with waste-activated sludge in mesophilic condition, Bioresour Technol, 4, 1539. https://doi.org/10.1016/j.biortech.2008.07.064

Demirbas, A.H.; Demirbas, I. (2007). Importance of rural bioenergy for developing countries. https://doi.org/10.1016/j.enconman.2007.03.005

Drosg, B.; Braun, R.; Bochmann, G.; Al Saedi, T. (2012). Analysis and Characterisation of Biogas Feedstocks. In: The biogas handbook: Science, production and applications, Woodhead Publishing. https://doi.org/10.1533/9780857097415.1.52

Escobar, J.C.; Lora, E. S Energy Conversion and Management, 48(8):2386-2398.

Ghorbani F, Younesi H., (2011) Cane molasses fermentation for continuous ethanol production in an immobilized cells reactor by Saccharomyces cerevisiae. Renewable Energy, 36(2):503-509. https://doi.org/10.1016/j.renene.2010.07.016

Gonzáleza P.; Serrano. G. (2017). Economic and environmental review of Waste-to-Energy systems for municipal solid waste management in medium and small municipalities. Waste Management, 67.,360-374. https://doi.org/10.1016/j.wasman.2017.05.003

Han,W.; Hu,Y.; Li, S. (2017). Simultaneous dark fermentative hydrogen and ethanol production from waste bread in a mixed packed tank reactor, Journal of Cleaner Production,.141,608-611. https://doi.org/10.1016/j.jclepro.2016.09.143

Hwan, J. Shah, N.; Ul-Islam, M.; Park, J.K. (2011). Potential of the waste from beer fermentation broth for bio-ethanol production without any additional enzyme, microbial cells and carbohydrates, Enzyme and Microbial Technology, 49:298- 304. https://doi.org/10.1016/j.enzmictec.2011.04.016

Hoover, R., (2001) Composition, Molecular Structure, and Physicochemical Properties of Tuber and Root Starches: a Review, Carbohydrate Polymers, 45, 253-267, 2001. https://doi.org/10.1016/S0144-8617(00)00260-5

Hoang, A. (2022). Perspective review on Municipal Solid Waste-to-energy route: Characteristics, management strategy, and role in circular economy, Journal of Cleaner Production, 359, 131897. https://doi.org/10.1016/j.jclepro.2022.131897

Koh, L. P.; Ghazoul, J. (2008). Biofuels, biodiversity, and people: Understanding the conflicts and finding opportunities. Biological Conservation, 141(10), 2450-2460. https://doi.org/10.1016/j.biocon.2008.08.005

Kiran. E.; Liu, Y. (2015). Bioethanol production from mixed food waste by an effective enzymatic pretreatment,jornal Fuel,. 159, 463-469. https://doi.org/10.1016/j.fuel.2015.06.101

Karmee, S. (2016). Liquid biofuels from food waste: Current trends, prospect and limitation, renewable and Sustainable Energy Reviews,. 945-953. https://doi.

org/10.1016/j.rser.2015.09.041

Karimi, K. (2015). Lignocellulose-Based Bioproducts, Springer, sn.pub/extras. https://doi.org/10.1007/978-3-319-14033-9

Kim, I., Rehman, M. (2014). Glucose Yield and Structural Characterization of Corn Stover by Sodium Carbonate Pretreatment, Bioresource technology, 152:316-320. https://doi.org/10.1016/j.biortech.2013.10.069

McGraw-Hill. Horváth. S. (2016). Recent updates on biogas production - a review. Biofuel Research Journal, 10, 394-402. https://doi.org/10.18331/BRJ2016.3.2.4

Miezah, K., Obiri-Danso, K.; Kádár, Z.; Heiske, S.; Fei-Baffoe, B.; Mensah M. et al. (2017), Municipal Solid Waste Management in a Low Income Economy Through Biogas and Bioethanol Production ,Waste and Biomass Valorization,. 8:115-127. https://doi.org/10.1007/s12649-016-9566-5

Nair, R. Lennartsson, M.J. Taherzadeh (2017). Bioethanol Production From Agricultural and Municipal Wastes, Current Developments in Biotechnology and Bioengineering, 157-190. https://doi.org/10.1016/B978-0-444-63664-5.00008-3

Ngumah, C., Ogbulie, J.,etal.. (2013). Potential of organic waste for biogas and biofertilizer production in Nigeria. Environmental research, engineering and management, 63(1), 60-66 https://doi.org/10.5755/j01.erem.63.1.2912

Noorbakhsh Dehkordi, S.M. Taghipour Jahromi, AR.; Ferdowsi, A. Shumal, M.; Dehnavi, A. (2019). Investigation of biogas production potential from mechanical separated municipal solid waste as an approach for developing countries (case study: Isfahan-Iran).jornal Renewable and Sustainable Energy Reviews 119:109586. https://doi.org/10.1016/j.rser.2019.109586

Paul, C.; Xie, Q.; Addy, M. (2016). Utilization of municipal solid and liquid wastesfor bioenergy and bioproducts production,JoranlBioresource Technology, 163-172. https://doi.org/10.1016/j.biortech.2016.02.094

Peng, F.; Peng, P.; Xu, Fetal. C., (2012). Fractional purification and bioconversion of hemicelluloses, Biotechnol. Adv., 30, 879-903. https://doi.org/10.1016/j.biotechadv.2012.01.018

Purwadi, R.; Niklasson, C. (2004). Study of Detoxification of Diluteacid Hydrolyzates by Ca (OH) 2, Journal of Biotechnology, 114: 187-198. https://doi.org/10.1016/j.jbiotec.2004.07.006

Tsafara, P.; Passadis, K.; Christianides, D.; Chatziangelakis, E.; Bousoulas, I.; Malamis, D.; et al. (2022). Advanced Bioethanol Production from Source-Separated Bio-waste in Pilot Scale,jornal sustainability, 14(19), 12127. https://doi.org/10.3390/su141912127

Schmitt, E.; Bura, R.; Gustafson R.; Cooper J.; Vajzovic, A. (2012). Converting lignocellulosic solid waste into ethanol for the State of Washington: An investigation of treatment technologies and environmental Bioresource Technology, 104: 400-409. https://doi.org/10.1016/j.biortech.2011.10.094

Shafiei, M. (2014). Pretreatment of Lignocellulosic Materials for Enhancement of Ethanol and Biogas Production and Techno-Economic Analysis, PhD Thesis, Isfahan University of Technology. https://doi.org/10.1155/2014/320254

Sluiter, A., Hames, B., Ruiz, R., (2008). Determination of Structural Carbohydrates and Lignin in Biomass, Laboratory Analytical Procedure, National Renewable Energy Laboratory, U.S. Department of Energy -510-42618.

Sun, N., Xu, F., Sathitsuksanoh, N. (2015). Blending municipal solid waste with corn stover for sugar production using ionic liquid process, Bioresour. Technol., 186. 200-206. https://doi.org/10.1016/j.biortech.2015.02.087

Shumal, M.; Taghipour Jahromi, AR.; Ferdowsi, A.; Noorbakhsh Dehkordi, SMM.; Moloudian, A. (2020). Comprehensive analysis of municipal solid waste rejected fractions as a source of Refused Derived Fuel in developing countries (case study of Isfahan- Iran): Environmental Impact and sustainable development. J Renewable Energy. 146:404-413. https://doi.org/10.1016/j.renene.2019.06.173

Schirmer,etal(.2014).Methane production in anaerobic digestion of organic waste from recife waste from ((BRAZIL)land fill,evaluation in refuse of different ages Journal of Chemical Engineering, 02, 373-384. https://doi.org/10.1590/0104-6632.20140312s00002468

Sosnowski, P.; Klepacz-Smolka, A.; Kaczorek, K.; Ledakowicz, S. (2008). Kinetic investigations of methane co-fermentation of sewage sludge and organic fraction of municipal solid wastes, Jornal Bioresource Technology., 9:5731-5737. https://doi.org/10.1016/j.biortech.2007.10.019

Sohoo,I, Ahmed .S. (.2017).Institute of Environmental Technology and Energy Economics, Hamburg University of Technology, Blohmstr. 15

Rajeshwari, K. V., Balakrishnan, M., (2000). State-of-the-art of anaerobic digestion technology for industrial wastewater treatment, Renewable and Sustainable Energy Reviews, 4, 135-156. https://doi.org/10.1016/S1364-0321(99)00014-3

Rasetti, M. (2014). A comparison between ethanol and biodiesel production: The Brazilian and European experiences Liquid Biofuels: Emergence, Development and Prospects. 25-53. https://doi.org/10.1007/978-1-4471-6482-1_2

Roland ,V. (2022)Production of Bio-Ethanol from the Organic Fraction of Municipal Solid Waste and Refuse-Derived Fuel Biomass, 2(4), 224-236. https://doi.org/10.3390/biomass2040015

Ritzkowski,M. Ahmed ,S,etal.(2021) Estimation of Methane Production and Electrical Energy Generation from Municipal Solid Waste Disposal Sites in Pakistan,energies, 14(9), 2444. https://doi.org/10.3390/en14092444

Taherzadeh, M. J.; Karimi, K. (2008). Pretreatment of lignocellulosic wastes to improve ethanol and biogas production: a review. International journal of molecular sciences, 9, 1621-1651. https://doi.org/10.3390/ijms9091621

Taherzadeh, M. and Karimi, K. (2007). Enzyme-based hydrolysis processes for ethanol from lignocellulosic materials: a review. Bioresources, 2, 707-738.

Teng, Z., Hua, J., Wang, C., (2014). Design and optimization principles of biogas reactors in large scale applications. In: Reactor and Process Design in Sustainable Energy Technology, F. Shi, Editor., Elsevier: Amsterdam. 99-134. https://doi.org/10.1016/B978-0-444-59566-9.00004-1

Taherzadeh, M.J.; Karimi, K., (2008). Pretreatment of lignocellulosic wastes to improve ethanol and biogas production: a review, Int. J. Mol. Sci., 9.1621-1651, 2008. https://doi.org/10.3390/ijms9091621

Thygesen, A., Oddershede, J. (2005). On the Determination of Crystallinity and Cellulose Content in Plant Fibres, Cellulose, 12, 563. https://doi.org/10.1007/s10570-005-9001-8

Thomsen, A.B., Medina, C. (2003). Biotechnology on ethanol production, In Riso Energy Report 2, ISBN 87-550-3262-1. 40-44.

Verhe. R.; Varghese. S. (2022). Production of Bio-Ethanol from the Organic Fraction of Municipal Solid Waste and Refuse-Derived Fuel Biomass, 2(4), 224-236. https://doi.org/10.3390/biomass2040015

Van Thuijl,E, Roos.C. (2003). An Overview of Biofuel Technologies, Markets and policies in Europe,

Venturini, O. J.; Yáñez, E. (2009). Biofuels: environment, technology and food security. Renewable and sustainable energy reviews,13(6), 1275-1287. https://doi.org/10.1016/j.rser.2008.08.014

Wang, L.H., Wang, Q., Cai W., Sun, X. (2012). Influence of mixing proportion on the solid-state anaerobic co-digestion of distiller's grains and food waste. Biosystems Engineering, 112, 130-137. https://doi.org/10.1016/j.biosystemseng.2012.03.006

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