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ASSESSMENT OF ENERGY PRODUCTION POTENTIAL FROM AGRICULTURAL RESIDUES IN AZERBAIJAN

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Abstract: The geographical conditions of Azerbaijan have provided a favorable environment for planting all kinds of agricultural products. Therefore, in recent years, paying attention to the potential of biomass resources has been the subject of increasing research and discussions in this country. This study aimed to estimate the amount of biomass energy that can be acquired from agricultural residues in Azerbaijan. The energy potential of the residues was obtained by considering the calorific value and amount of available residues. For the year 2021, the total amount of available agricultural residues for the ten studied products was estimated at 1,099,346 tons. Cotton and barley had the highest amounts of waste with 47% and 14.47%, respectively. Also, the total heating value of residues was obtained 19610.4566 GJ. Therefore, according to the obtained results, part of the country's energy consumption can be supplied in this way.

Keywords: Biomass energy, Agricultural residue, Renewable energy, Azerbaijan

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1. Introduction

Azerbaijan is an oil-abundant country and depends greatly on its oil, natural gas, heavy industries, and agricultural sectors. According to the statistics of the Central Bank of Azerbaijan, oil and gas industries accounted for approximately 54% of GDP in 2010 and 90% of exports in 2019. On the other hand, this country has made significant investments for development in the renewable energy sector since the 2000s, using oil export revenues and the established legal infrastructure (Aydin, 2019). In 2004, the Republic of Azerbaijan approved "The State Program on the Utilization of Alternative and Renewable Energy Sources". As a result of the successful implementation of planned programs and orders, the IRNA's renewable energy statistics report in 2019 shows that the total amount of renewable energy in the country during 2009-2018 was accompanied by a steady increase from 989 (MW) to 1394 (MW) (IRENA, 2020). From different aspects, alternative and renewable energy sources are important for Azerbaijan. There are 12 large and seven small hydropower plants in this country, as well as 6 wind, 10 solar, and 6 biomass power plants (Mukhtarov et al., 2020). Considering the existing prospects for RES in Azerbaijan, the strategic goal of the country for the future is to increase the share of RES (Renewable energy source) in total energy production (especially in the field of biomass energy) and to diversify its energy portfolio (Aydin, 2019).

Considering that agricultural lands occupy 50% of the total area of Azerbaijan and the high variety of crops in this country, it is important to pay attention to energy production from biomass (Zh, 2018).

Investigating the energy potential of biomass from agricultural residues in different countries and comparing it with the results of this research can be effective. For this purpose, in a research conducted in the Black Sea region of Turkey, it was found that 33,594,583 GJ of thermal energy can be produced from 1,861,323 tons of plant residues. In this study, various plant residues were investigated, and it was found that the largest share of energy is provided by hazelnuts (42.33%) and maize (13.68%) residues (Karaca et al., 2017). In the country of Sudan, the total amount of agricultural residues and total heating value of 10 different types of plant residues were estimated as 11214310.64 tons and 154121769 GJ, respectively (Demirel et al., 2019). The results of a study show that sugarcane, soybean, corn, rice, sorghum and sunflower residues produce 3.8 million tons of dry biomass per year in Bolivia. The biomass energy potential from all residues is equivalent to 50% of the annual electricity production. Moreover, it could supply energy to 58% of the population (Morato et al., 2019). In relation to the research conducted in the field of energy evaluation

from biomass in the countries of Eritrea and Kenya, the total amount of plant residues were estimated 85265.28 and 13913223 tons per year, respectively, and the total heating value of these residues were 1332340 and 187341440 GJ, respectively (Kimutai et al., 2014; Gürdil et al., 2021). The results of this study will provide information on biomass potential from agricultural residues in Azerbaijan. Considering that RES is a relatively new and unconventional sector in this country, it has nevertheless made significant progress. It is estimated that the share of energy production from biomass will increase in the coming years in Azerbaijan.

2. Materials and Methods

The geographical conditions of Azerbaijan create a favorable environment for planting all kinds of agricultural products. In this research, plant residues of wheat, oat, maize, barley, rice, potato, melon, and cotton, onion and suger beet were used to investigate the energy potential of biomass. Also, the residual amounts of the specified products were calculated using the statistical data of The State Statistical Committee of The Republic of Azerbaijan for the seasonal year of 2021. The net potential of residues was calculated by using the availability of residues and the amount of agricultural product based on the Equation 1 (Karaca, 2015).

$$AAR = AAP \times RPR \times A \quad (1)$$

Where AAR is the available amount of agricultural residues of the crop in tons, AAP the amount of agricultural product in tons, RPR residue-to-product ratio, and (A) the availability of residues. The RPR and A values were obtained from different published research works (Table 1).

The energy potential of the residues was obtained by calculating the total heating value of agricultural residues according to Equation 2 (Jorjani et al., 2021).

$$THV = AAR \times LHV \quad (2)$$

Where THV is the total heating value of agricultural residues of the crop in GJ, AAR is the available amount of agricultural residues of the crop in tons, and LHV lower heating value of air dry residues of the crop in $MJ.kg^{-1}$.

Table 1. The ratio of product to residue, Availability and heating values of a selection of agricultural residues

Field Crops	RPR	A (%)	LHV ($MJ.kg^{-1}$)	References
Wheat	0.45	15	17.90	Karaca et al., 2017
Oat	0.94	15	17.40	Karaca et al., 2017
Maize	0.55	60	15.50	Karaca et al., 2017
Barley	0.95	15	17.50	Karaca et al., 2017
Rice	0.10	100	16.00	Karaca et al., 2017
Potato	0.10	50	15.34	Soucek and Jasinskas, 2020
Melon	0.15	50	20.50	Nyakuma, 2017
Cotton	3.00	60	18.61	Demirel et al., 2019
Onion	0.10	100	16.51	Malatak and Dlabaja, 2016
Suger beet	1.00	50	17.21	Brachi et al., 2017

3. Results and Discussion

The total amount of agricultural residues for 10 crops of wheat, oat, sugar beet, rice, barley, maize, potato, melon, cotton and onion were calculated to be about 1100000 tons in Azerbaijan (Table 2). As shown in Figure 1, cotton and barley had the most residues with 47% and 14.47%, respectively. The usage of cotton waste as an energy source has become a subject of many studies in recent years. In many cases, the plant residue of the cotton stalk that remains in the field after harvesting is buried or burned, and in rare cases, it is used in the composting industry (Al Afif et al., 2019). Several studies on the subject of cotton waste pyrolysis show that pyrolysis of cotton stalks has potential as one of the technological solutions for its management (Al Afif et al., 2019). In many studies, barley straw has been used to produce different energies such as bioethanol (Raud et al., 2021) and biogas (Morales-Polo et al., 2021). It seems that the production of biomass energy from plant wastes investigated in this research has not been expanded in Azerbaijan. Nevertheless, the country has made significant investments in the development of the renewable energy sector since the 2000s (Aydin, 2019).

The total heating value of agricultural residues of 10 products investigated in this research was calculated to be about 19611 GJ (Table 3). According to the results of this study, it can be said that the production of heat and electricity from alternative and renewable energy sources means the protection of conventional energy sources in the country. According to the report of the Energy Information Administration in 2019, the amount of electrical energy consumption in Iran was 254,724 GW.h/yr, and according to the data of this research, part of this energy can be provided through the biomass of agricultural residues. According to the CEICDATA website, Azerbaijan's electricity production in 2020 was 25,839 GW.h/yr, which can be concluded that part of this energy can be supplied through biomass energy in this country.

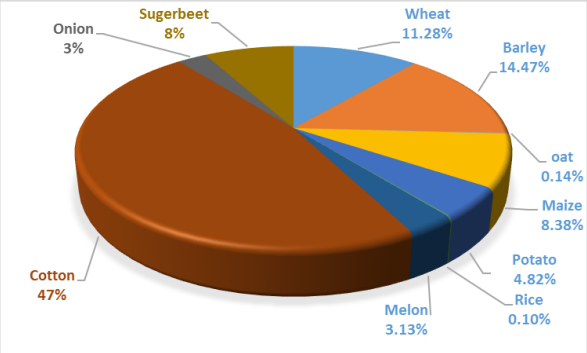

Figure 1. The amount of agricultural product and available residues of Iran.

Table 2. The amount of agricultural product and available residues of Iran

Field Crops	AAP (Tons)	AAR (Tons)
Wheat	1837188	124010
Oat	11663	1644.48
Maize	279248	92151.8
Barley	1116729	159134
Rice	10062	1006.2
Potato	1061958	53097.9
Melon	459872	34490.4
Cotton	287041	516674
Onion	286375	28637.5
Suger beet	177000	88500
Total	5527136	1099346

Table 3. Total heating values of agricultural residues in Iran

Field Crops	LHV ($MJ.kg^{-1}$)	THV (GJ)
Wheat	17.90	2219.7824
Oat	17.40	28.6140
Maize	15.50	1428.3535
Barley	17.50	2784.8429
Rice	16.00	16.0992
Potato	15.34	814.5217
Melon	20.50	707.0532
Cotton	18.61	9615.2994
Onion	16.51	472.8051
Suger beet	17.21	1523.0850
Total		19610.4566

4. Conclusion

Today, excessive consumption of non-renewable energies such as coal, gas and oil causes serious environmental threats. For this reason, the need to approach new energy sources compatible with the environment becomes clear. Using biomass as an energy source is important for the economic development of any country in addition to environmental reasons. Therefore, this study was conducted with the aim of estimating the residual amount and the total heating value of some agricultural products in order to produce energy in Azerbaijan. The total amount of agricultural residues (wheat, oat, maize, barley, rice, potato, melon, cotton, onion and suger beet) was obtained 1,099,346 tons. The total heating value of agricultural residues was about 19610.4566 GJ for the mentioned crops in all regions of Azerbaijan. Therefore, the agricultural residues of this country have the potential to generate a sustainable source of biomass.

Author Contributions

The percentage of the author(s) contributions is present below. All authors reviewed and approved final version of the manuscript.

	E.F.N.	G.A.K.G.	B.D.
C	50	50	
D		100	
S		100	
DCP	50		50
DAI	50	50	
L	50		50
W	50	50	
CR		50	50
SR		100	
PM		100	
FA		100	

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The author declared that there is no conflict of interest.

Ethical Consideration

Ethics committee approval was not required for this study because of there was no study on animals or humans.

References

Al Afif R, Pfeifer C, Pröll T. 2019. Bioenergy recovery from cotton stalk. In: Mahmood-ur-Rahman Ansari, editor. Advances in cotton research. IntechOpen, Faisalabad, Pakistan, pp: 84.

Aydin U. 2019. Energy insecurity and renewable energy sources: Prospects and challenges for Azerbaijan. Asian Development Bank Institute, Tokyo, Japan, pp: 22.

Brachi P, Riianova E, Miccio M, Miccio F, Ruoppolo G, Chirone R. 2017. Valorization of sugar beet pulp via torrefaction with a focus on the effect of the preliminary extraction of pectins. Energy Fuels, 31: 9595-9604.

Demirel B, Gürdil GAK, Gadalla O. 2019. Biomass energy potential from agricultural production in Sudan. ETHABD, 2(2): 35-38.

Gürdil G, Mengstu M, Medhn T. 2021. Biomass energy potential from agricultural residues in Eritrea. BSJ Agri, 4(3): 103-106.

IRENA. 2020. The post-COVID recovery: An agenda for resilience, development and equality. IRENA, Abu Dhabi, United Arab Emirates, ISBN 9789292602451.

Jorjani S, Yildirim HT, Rezaeinia S. 2021. Comparison of Iran and Turkey in terms of biomass energy use. Kent Akad, 14: 1235-1250.

Karaca C. 2015. Mapping of energy potential through annual crop residues in Turkey. Int J Agri Biol Eng, 8(2): 104-109.

Karaca C, Gürdil GAK, Öztürk HH. 2017. Determining and

mapping agricultural biomass energy potential in Samsun Province of Turkey. ICOEST 3rd International Conference on Environmental Science and Technology, October 19-23, 2017, Budapest, Hungary, pp: 190-194.

Kimutai SK, Muumbo AM, Iagi ZO, Kiprop AK. 2014. A study on agricultural residues as a substitute to fire wood in Kenya: a Review on Major Crops. J Energy Tech Pol, 4(9): 45-52.

Malatak J, Dlabaja T. 2016. Hydrothermal carbonization of kitchen waste. Res Agri Eng, 62(2): 64-72.

Morales-Polo C, Cledera-Castro MDM, Revuelta-Aramburu M, Hueso-Kortekaas K, 2021. Bioconversion process of barley crop residues into biogas-Energetic-environmental potential in Spain. Agronomy, 11(4): 640.

Morato T, Vaezi M, Kumar A. 2019. Assessment of energy production potential from agricultural residues in Bolivia. Renew Sust Energy Rev, 102: 14-23.

Mukhtarov S, Humbatova S, Hajiyev NGO, Aliyev S. 2020. The financial development-renewable energy consumption nexus in the case of Azerbaijan. Energies, 13(23): 6265.

Nyakuma BB. 2017. Bioenergy potential of melon seed husks. Lignocellulose, 6(1): 15-22.

Raud M, Rocha-Meneses L, Lane DJ, Sippula O, Shurpali NJ, Kikas T. 2021. Utilization of barley straw as feedstock for the production of different energy vectors. Processes, 9(4): 726.

Soucek J, Jasinskas A. 2020. Assessment of the use of potatoes as a binder in flax heating pellets. Sustainability, 12(24): 10481.

Zh RA. 2018. Agriculture in Azerbaijan and its development prospects. Int J Environ Sci Nat Resour, 13(4): 87-97.