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Agricultural Biomass Energy Equivalent Potential of Aksaray

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İlker SİVRİ[1], Bahadır DEMİREL[2] , Gürkan Alp Kağan GÜRDİL[3]

[1]*Erzincan Binali Yıldırım University, Ali Cavit Çelebioğlu Civil Aviation Vocational School, Plane Repair and Maintanence Department, Erzincan, Türkiye*

[2]*Erciyes University, Faculty of Agriculture, Biosystems Engineering, Kayseri, Türkiye*

[3]*Ondokuz Mayıs University, Faculty of Agriculture, Department of Agricultural Machines and Technologies Engineering, Samsun*

***sorumlu yazar**: bahdem@erciyes.edu.tr

İlker SİVRİ, ORCID No: 0000-0002-5906-3693, Bahadır DEMİREL, ORCID No: 0000-0002-2650-1167, Gürkan Alp Kağan GÜRDİL, ORCID No: 0000-0002-5906-3693

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Renewable energy, Agricultural wastes, Biomass, Aksaray

Abstract

Renewable energy sources are alternative fuel types that are environmentally friendly, healthy and can be used continuously as a solution to the harmful effects of fossil fuels on the environment and the problem of depletion of these fuels. Biomass, which is the residue of agricultural activity or a direct agricultural product, can be converted into a modern energy carrier by biochemical or thermochemical processes. Biomass energy of agricultural origin is an important renewable energy source such as wind, solar and geothermal energy types.

Within the scope of this study, the agricultural biomass energy equivalent potential for the province of Aksaray was determined for the years 2011-2020, and the data determined for the aforementioned province were compared with the values reached in the Central Anatolia region and Turkey. Agricultural Biomass resources were examined under five main headings: Fruits - beverage - spice plants, Vegetables, Cereals - other herbal products, Clover and Sugar Beet. The energy equivalent potentials of these sources were determined in MW. In the conclusion part of the study, the average agricultural biomass energy equivalent of Aksaray province was determined as 39,027 MW in total for the five main topics. Also, the energy equivalents of Aksaray province determined in the last ten years were evaluated among themselves under each heading. In addition to all these, the same agricultural biomass energy calculation processes in Aksaray province were applied to Central Anatolia and Turkey as well, and small, medium, and large-scale evaluations were made on the table. In light of the obtained values, it was concluded that Turkey's agricultural activities were not adversely affected by the negative effects of the pandemic process.

Aksaray İli Tarımsal Biyokütle Enerji Eşdeğer Potansiyeli

Anahtar Kelimeler

Yenilenebilir enerji, Tarımsal artık, Biyokütle, Aksaray

Özet

Yenilenebilir enerji kaynakları, fosil yakıtların çevreye zararlı etkilerine ve tükenme sorununa çözüm olarak çevreci, sağlıklı ve sürekli şekilde kullanılabilir özelliğe sahip alternatif yakıt türleridir. Tarımsal faaliyet artığı ya da doğrudan ürünü biyo-kütle, biyokimyasal veya termokimyasal işlemlerle modern enerji taşıyıcısına dönüştürülebilir. Rüzgar, güneş, jeotermal vb enerji türleri gibi tarımsal kökenli biyo kütle enerjisi de önemli bir yenilenebilir enerji kaynağıdır.

Bu çalışma kapsamında Aksaray iline dair 2011-2020 yılları arasında tarımsal biyokütle enerji eşdeğer potansiyeli belirlenmiş olup, bahsi geçen il için tespit edilen verilerin İç Anadolu Bölgesi ve Türkiye genelinde ulaşılan değerler ile mukayesesi yapılmıştır. Tarımsal biyokütle kaynakları meyveler - içecek - baharat bitkileri, sebzeler, tahıllar - diğer bitkisel ürünler, yonca ve şeker pancarı olmak üzere beş ana başlıkta incelenmiştir. Bu kaynakların enerji eşdeğer potansiyelleri MW cinsinden belirlenmiştir. Çalışmanın sonuç kısmında ise belirtilen beş ana başlık için Aksaray ilinin ortalama tarımsal biyokütle enerji eşdeğeri toplam 39.027 MW olarak belirlenmiştir. Ayrıca, Aksaray ilinin son on yıldaki belirlenen enerji eşdeğerleri her bir başlık altında kendi içinde değerlendirilmiştir. Bütün bunlarla beraber, Aksaray ili tarımsal biyokütle enerji hesaplama işlemlerinin aynıları İç Anadolu ve Türkiye geneline de uygulanmış ve küçük, orta ve büyük ölçekli tablo üzerinde değerlendirmeler yapılmıştır. Elde edilen değerler ışığında pandemi sürecinin olumsuz etkilerinden Türkiye tarımsal faaliyetlerinin olumsuz etkilenmediği sonucu ortaya çıkmıştır.

1. INTRODUCTION

The increase in population and parallel to this continuous consumption of natural sources along with the developments in technology have negative effects on our world's ecosystem since excessive consumption of fossil fuels triggers global environmental problems (Koryś et al., 2019). Agricultural based biomass energy items can be a good alternative to minimize those bad effects.

Biomass is a clean, renewable energy source that can significantly improve our ecosystem, economy and energy security. Biomass has the potential to provide a cost-effective and sustainable energy supply compared to conventional fuels, while helping countries achieve their greenhouse gas reduction targets (Demirbas, 2006). Fossil fuels are the main greenhouse gas (GHG) sources. GHG is the main reason for climate change on earth. It's proven by numerous studies that the renewable energy sources such as biomass have the potential to reduce greenhouse gas emissions. As with all combustion reactions, CO2 is released during biomass combustion. However, these fuels are defined as carbon neutral since the same amount of carbon dioxide is absorbed from the atmosphere during the growth period. Thus, it has the ability to reduce greenhouse gas emissions and replace fossil fuels (Daniel et al, 2012).

Green energy production is one of the main elements that will contribute to the economic development of a developing country (Demirbas, 2006). It is important to determine the energy equivalent potential of agricultural origin in Türkiye since she has a huge variety of agricultural products. It is assumed that an average of 50 million tons/year of different types of agricultural product residues are obtained. This will meet 17% of our annual energy demand (Alibaş and Ünal, 1995).

According to the data received from the Turkish Statistical Institute, beverage and spice crops constitute 1% of the agricultural areas of Aksaray province, vegetable production 3%, cereals and other plant products cover the area covered by the province on a provincial basis. It is seen that the area covered by cereals and other herbal products on a provincial basis is 69% (Figure 1). Agricultural residue potential of Aksaray province was examined and it was compared with the general situation in Türkiye.

Considering the agricultural activities for Aksaray province, a significant amount of agricultural residues is released. In this study, it has been tried to determine the agricultural biomass potential and energy equivalent of the agricultural activities in Aksaray province. Agricultural biomass potential and energy equivalent in Aksaray as a result of agricultural activities were determined and compared with Turkey and the Central Anatolian Region where the province is located.

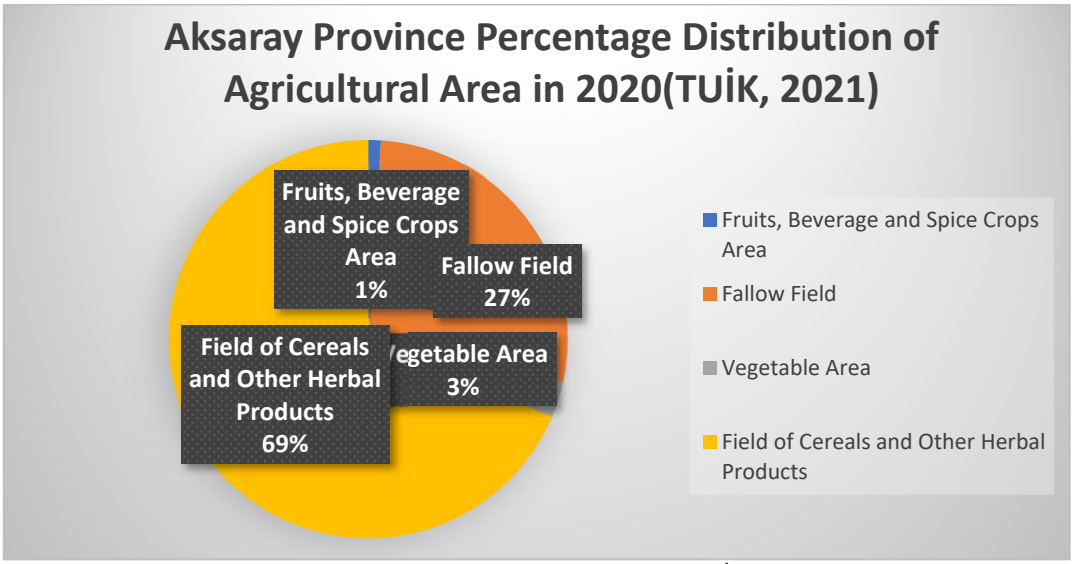

Figure 1. Distribution of Agricultural Area (TUİK, 2021)

2. MATERIALS AND METHODS

This study was carried out to determine the agricultural biomass energy potential of Aksaray province and to compare the obtained values with the energy equivalents of the Central Anatolia region and Turkey in general. Data from. Turkish Statistical Institute between the years 2011-2020 were taken into consideration. Agricultural biomass resources are divided into five groups: Fruits, beverage and spice crops, Vegetables, Cereals and other herbal products, Clover and Sugar beet. Annual average dry biomass amounts were calculated by considering the production area amounts of the groups. An average of 25 to 30 tons of dry biomass is obtained from one hectare of agricultural land (Balat, 2005). Dry biomass calorific value is 3800-4300 kilocalories per kilogram

(kcal/kg) (Koçer and Ünlü, 2007). In addition, the equivalences of 1 kcal = 1x10-6 TEP (tonne equivalent oil) and 1 kcal = 0.001163 kW were used (Topal and Arslan Topal, 2012). With the help of the data, calculations were made using the thermal values of agricultural biomass that can be obtained in a year in the equations.

$$okbm = (25 + 30) \div 2 \times A$$

$$obıd = okbm \times (3800 + 4300) \div 2$$

$$obed = obıd \times 1.10^{-7}$$

okbm: Average dry biomass amount, ton

obıd : Average dry biomass heating value, kcal/kg

obed : Average dry biomass energy equivalent, TEP

A : Area, ha

3. RESULTS AND DISCUSSION

According to the list created for Aksaray province clover and sugar beet crops took the first two places as strategic agricultural in 2019 activity report. In addition, Aksaray province is at the top of the table for those products in Turkey. Since sugar beet and clover are so important and serve as the locomotive for that region special titles have been opened within the general titles of scientific research.

Central Anatolia Region and Aksaray province fruits, beverage and spice plants, vegetables, cereals and other herbal products, clover and sugar beet between 2011 and 2020 on hectare basis are given in Table 1. While there is an increase in the hectare area of fruits, beverages and spice plants throughout Turkey and Central Anatolia, a decrease has occurred in Aksaray. There has been a meltdown of more than one-third over the 10 year period.

67.8% of the sugar beet agricultural area in Turkey is in the Central Anatolia region. 6.5% sugar beet area of Central Anatolia Region is provided by Aksaray province. However, it should be taken into account that there has been a decrease of 1.4% in the Central Anatolian denominator in the last 10 years of sugar beet performance in Aksaray province. Cereals and other herbal products, however, similar changes occurred in all three regions in the 10 year period in the titles of vegetables. The agricultural production area of clover, which is widely used as fodder in livestock, has a fluctuating image throughout the 10 year period in Turkey. There is an upward trend in the Central Anatolia Region, but there is a significant increase in the Aksaray province.

Table 1. Agricultural area amounts (ha) of Aksaray province, Central Anatolia Region and Turkey in general (ETKB, 2021).

	Years	Fruits, beverage and spice plants	Vegetables	Cereals and other herbal products	Clover	Sugar beet
TURKEY	**2011**	3.091.135	851.462	17.304.332	559.037	297.265
	2012	3.200.960	871.993	16.933.164	676.172	281.892
	2013	3.232.034	855.986	17.061.840	630.463	292.361
	2014	3.242.811	846.446	17.220.415	693.794	289.758
	2015	3.283.848	848.542	17.141.889	664.064	275.585
	2016	3.329.216	847.459	16.881.052	652.259	323.394
	2017	3.348.100	839.639	16.968.440	661.017	340.081
	2018	3.456.909	820.668	16.910.741	636.954	293.556
	2019	3.518.759	827.870	16.866.684	644.215	314.953
	2020	3.563.518	821.758	16.959.423	665.774	339.297
CENTRAL ANATOLIA	**2011**	190.289	146.049	5.062.944	90.764	183.611
	2012	198.499	165.303	4.968.492	113.302	185.553
	2013	199.764	161.802	5.107.539	109.010	199.594
	2014	204.130	164.791	5.213.521	125.212	194.038
	2015	207.785	172.280	5.254.551	119.012	197.308
	2016	207.060	177.535	5.297.417	119.397	228.374
	2017	206.079	178.658	5.262.304	122.152	227.354
	2018	219.314	181.904	5.395.962	122.284	196.789
	2019	224.533	184.666	5.504.277	127.886	222.071
	2020	208.366	193.382	5.600.591	133.133	230.153
AKSARAY	**2011**	6.158	9.180	253.527	10.833	14.457
	2012	5.072	9.872	241.243	14.581	14.647
	2013	4.617	9.294	238.080	13.064	14.658
	2014	4.261	9.882	252.947	16.357	14.246
	2015	3.939	10.631	262.650	16.954	14.708
	2016	3.977	10.828	258.120	17.509	16.918
	2017	3.841	10.692	259.637	19.933	16.692
	2018	3.969	11.271	260.065	20.456	14.338
	2019	3.867	10.436	258.698	21.751	14.614
	2020	3.902	10.994	262.929	24.491	14.999

The data of the dry biomass energy equivalent potential that can be obtained from Fruits, Beverage and Spice plants for the years 2011-2020 are given in Table 2. When the obtained values are examined, it has been determined that the dry biomass energy equivalent potential in Aksaray province in 2011 was 796 MW, and decreased to 504 MW by showing a great decrease in 2020.

It has been observed that the energy potential of the vegetables group of Aksaray province, which was 1.186 MW in 2011, reached 1.420 MW in 2020. Despite the increase in the vegetables group in the Central Anatolia region, The decrease draws attention in Turkey. Considering the Cereals and other herbal products group, there were similar changes in the vegetables category. It reached 33.969 MW in 2020 while it was 32.754 MW in 2011 in Aksaray.

It has been determined that the energy equivalent potential of the clover group reached 3.164 MW in 2020, compared to 1.399 MW in Aksaray province in 2011. The same upward trend continued in the Central Anatolia region, relatively losing its degree of influence. Although not exponentially, an increase has been observed throughout Turkey. In the sugar beet category, there was no significant change in the province of Aksaray in the 10 year period, and the dry biomass energy equivalent potential in 2011 increased from 1.867 MW to 1.937 MW in 2020. However, these values have decreased from the values of 2.100 compared to 2016 and 2017. Significant increase in the transition from 2015 to 2016 in Central Anatolia draws attention.

According to the data of the Ministry of Energy and Natural Resources, as of the end of September 2019, the installed power of our country is 90.720 MW. Distribution of our installed power by resources; 31.4% hydraulic energy, 28.6% natural gas, 22.4% coal, 8.1% wind, 6.2% solar, 1.6% geothermal and 1.7% in the form of other sources. According to Table 1, it has been determined that the 10 year average of total biomass energy equivalents in Turkey is 2.861.398 MW. 26.95% of this value belongs to the Central Anatolia Region. The contribution of Aksaray province to the Central Anatolia Region is 5.05%, which corresponds to a total energy potential of 39,027 MW (ETKB, 2021).

Table 2. Dry biomass energy equivalent potential, MW (TUIK, 2021)

	Years	Fruits, beverage and spice plants	Vegetables	Cereals and other herbal products	Clover	Sugar beet
TÜRKİYE	**2011**	399.359	110.005	2.235.633	72.224	38.405
	2012	413.548	112.657	2.187.680	87.358	36.419
	2013	417.563	110.589	2.204.304	81.452	37.771
	2014	418.955	109.357	2.224.792	89.634	37.435
	2015	424.257	109.627	2.214.646	85.793	35.604
	2016	430.118	109.487	2.180.948	84.268	41.780
	2017	432.558	108.477	2.192.238	85.400	43.936
	2018	446.615	106.026	2.184.783	82.291	37.925
	2019	454.606	106.957	2.179.091	83.229	40.690
	2020	460.389	106.167	2.191.073	86.014	43.835
CENTRAL ANATOLIA	**2011**	24.584	18.869	654.107	11.726	23.721
	2012	25.645	21.356	641.904	14.638	23.972
	2013	25.809	20.904	659.869	14.083	25.786
	2014	26.373	21.290	673.561	16.176	25.068
	2015	26.845	22.258	678.862	15.375	25.491
	2016	26.751	22.937	684.400	15.425	29.504
	2017	26.624	23.082	679.863	15.781	29.373
	2018	28.334	23.501	697.131	15.798	25.424
	2019	29.009	23.858	711.125	16.522	28.690
	2020	26.920	24.984	723.568	17.200	29.734
AKSARAY	**2011**	796	1.186	32.754	1.399	1.867
	2012	655	1.275	31.167	1.883	1.892
	2013	596	1.201	30.759	1.687	1.893
	2014	550	1.277	32.679	2.113	1.840
	2015	509	1.373	33.933	2.190	1.900
	2016	514	1.399	33.348	2.262	2.185
	2017	496	1.381	33.544	2.575	2.156
	2018	513	1.456	33.599	2.642	1.852
	2019	500	1.348	33.422	2.810	1.888
	2020	504	1.420	33.969	3.164	1.937

Table 3. Average dry biomass energy amounts and their proportional distribution

Dry Biomass Energy Amount (MW)				Proportional Comparison (%)		
Years	**Türkiye**	**Central Anatolia**	**Aksaray**	**Aksaray/Türkiye**	**Aksaray/CA**	**CA/Türkiye**
2011	2.855.627	733.008	38.003	1.33	5.18	25.66
2012	2.837.662	727.516	36.874	1.29	5.06	25.63
2013	2.851.680	746.451	36.138	1.26	4.84	26.17
2014	2.880.173	762.469	38.460	1.33	5.04	26.47
2015	2.869.928	768.831	39.906	1.39	5.19	26.78
2016	2.846.603	779.018	39.708	1.39	5.09	27.37
2017	2.862.609	774.724	40.153	1.40	5.18	27.06
2018	2.857.642	790.189	40.063	1.40	5.07	27.65
2019	2.864.574	809.204	39.969	1.39	4.93	28.24
2020	2.887.479	822.407	40.996	1.41	4.98	28.48
Average	2.861.398	771.382	39.027	1.36	5.05	26.95

4. CONCLUSION

It has been determined that the total biomass energy potential that can be obtained from fruits, beverage and spice plants, vegetables, cereals and other herbal products, clover and sugar beet in Aksaray province is 40.996 MW from an area of 317.315 ha. The agricultural production area of the clover plant has increased significantly in Aksaray and has not been affected by the covid-19 pandemic. In fact, when all the data of 2018, 2019 and 2020 are evaluated, no negative impact from the Covid-19 process on agricultural activity was directly observed. As of the significant contribution of Aksaray province Central Anatolia region has become the sugar beet warehouse of Turkey. When agricultural products are considered, it has been observed that the highest dry biomass energy equivalent is in Aksaray. In areas where agricultural products are not produced, agricultural biomass should be evaluated in order to increase energy potential. The results of this study, in which the potential to contribute to the country's economy even in the waste generated as a result of agricultural activities is revealed, it has been revealed that agricultural biomass with high potential should be evaluated properly in the Aksaray and Central Anatolia Region.

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