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Determination of Biomass Potential From Field Products Waste in Tekirdağ Province

Tekirdağ İlinde Tarla Ürünleri Atıklarından Kaynaklanan Biyokütle Potansiyelinin Belirlenmesi

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ABSTRACT

In this study, the existing potential and amount of energy of biomass energy, which is a renewable energy originating from the harvest of field crops grown in Tekirdağ province, was investigated. While determining the current energy potential of the biomass, calculations were made by evaluating the production amount, heat value and waste product ratio of each product separately. For this purpose, data in the amount of production of field crops grown in Tekirdağ were obtained Turkey Statistical Institute (TUIK). Agricultural biomass; field wastes (wheat, barley, rye, sunflower, corn, paddy, oats and triticale) were evaluated. According to the data obtained, the three districts producing the most agricultural production in Tekirdağ districts were Hayrabolu, Malkara and Süleymanpaşa, respectively. As a result of agricultural production in Tekirdağ province in 2019, 735, 74 ktons of usable agricultural waste were exposed. The theoretical total energy value of these wastes is 3 049,88 GWh.

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ÖZET

Bu çalışmada, Tekirdağ ilinde yetiştirilen tarla bitkileri hasat artıklarından kaynaklanan ve yenilenebilir enerji olan biyokütle enerjisinin, mevcut potansiyeli ve enerji miktarı incelenmiştir. Biyokütlenin mevcut enerji potansiyeli belirlenirken, her bir ürüne ait üretim miktarı, ısıl değer miktarı ve atık ürün oranı ayrı ayrı değerlendirilerek hesaplamalar yapılmıştır. Bu amaçla, Tekirdağ ilinde yetiştirilen tarla bitkilerinin üretim miktarı ilişkin veriler Türkiye İstatistik Kurumu (TÜİK) 'ndan elde edilmiştir. Tarımsal kökenli biyokütle; tarla atıkları (buğday, arpa, çavdar, ayçiçeği, mısır, çeltik, yulaf ve tritikale) değerlendirilmiştir. Elde edilen verilere göre, Tekirdağ ilçelerinde en fazla tarımsal üretimi yapan 3 ilçe sırasıyla Hayrabolu, Malkara ve Süleymanpaşa olmuştur. Tekirdağ ilinde 2019 yılında yapılan tarımsal üretim sonucunda 735, 74 kton kullanılabilir tarımsal atık açığa çıkmıştır. Bu atıkların teorik toplam enerji değeri 3 049,88 GWh düzeyindedir.

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1. INTRODUCTION

Demand for energy is increasing rapidly with rapid population growth, technological developments and increasing production in the world. According to the statistics of 2016, the primary energy consumption in the world is around 13,147 million TEP. Approximately 86% of this consumption is covered by primary energy sources of fossil origin (coal, oil, natural gas). Countries that are foreign-dependent especially in energy spend a significant amount of foreign currency every year to meet this demand. Due to the fact that fossil fuels are non-renewable energy sources, increasing costs and the negative environmental conditions they create, developed and developing countries have turned to alternative energy sources and researches have intensified in this regard (Kayişoğlu and Diken, 2020).

Biomass, one of the renewable energy sources; It includes a wide range of organic wastes such as animal wastes, vegetable wastes, industrial wastes, forestry and city wastes. Biomass energy not only contributes to sustainable development, it also provides energy supply security and reduces greenhouse gas emissions. Besides, due to its always available feature and known conversion technologies, biomass is a candidate to be one of the important energy sources in the near future in order to ensure supply security and meet energy demand. The depletion of fossil resources and the rapid increase in world energy needs have put people in search of new energy resources (Ekpeni et al., 2014).

According to the biomass atlas prepared by the General Directorate of Renewable Energy, it is seen that a significant part of the energy potential is based on animal wastes and then vegetable wastes, urban wastes, and forest wastes respectively. According to the data of 2019; The annual total amount of these biomass resources produced is calculated as 292 170 712 tons and if all of this amount is used, the total annual energy equivalent that can be produced is 14 627 331 TEP (BEPA, 2019). Of this amount, approximately 170 thousand GWh of electrical energy based on biomass energy sources theoretically means can be produced in Turkey.

The important point in determining the real potential of vegetal wastes is the availability of access to these resources, which can be used for biomass production. For example, post-harvest product wastes are collected in piles, bales, stacked or spread. These are the most important factors affecting the ability of these products to be collected, transferred to energy production facilities and converted into energy fuels or various biomass forms. In rural areas, crop residues are not usually collected after harvesting and are widely left in the fields. These wastes are burned in the fields in many regions to prepare the soil for the next sowing season, and in areas where animal husbandry is carried out, these wastes are also used as animal feed and to meet some other needs such as warming (FAO, 2016).

Although there are large amounts of agricultural and vegetal residues in our country every year, these residues generally are assed using traditional methods. Therefore, not using it as a renewable energy source by using modern methods creates an extremely important loss for our country and in addition to this, environmental pollutants such as CO_2, NO_X ,SO_2 increase. In this study, the current potential and energy amount of biomass energy, which is a renewable energy source resulting from the harvest residues released as a result of the production of field crops grown in Tekirdağ province, was investigated.

2. MATERIAL AND METHOD

2.1. Geographical Position

Our city is Turkey's north-west, north of the Sea of Marmara, is located in the Thrace region, east of Istanbul, north of Kırklareli, Edirne, western, southern and is surrounded by the Sea of Marmara. Our province, which is located in a developed transportation network, has 3 important highways and is connected to Istanbul and neighboring European countries with a large foreign trade port and Istanbul-Europe railway line. Tekirdağ, which is located in the south of the Thrace Region, has a 2.5 km long coastline to 133 km from the Sea of Marmara (Figure 1) (URL-1, 2018).

Figure 1. Tekirdağ province map (URL-2,2020)

2.2. Agricultural Production In Tekirdağ

Tekirdağ province is a city for agricultural activity in 63% of the face measurement. It has an average of 580 mm annual precipitation and it is very suitable for animal and vegetable production of ecology URL-2 (2018). It has an important potential in agriculture. According to TUIK data for 2019 in Tekirdağ province, there is a total area planted in 3 912 215. Cereals and other herbal products comprise 3 758 867 decares of the cultivated areas of the province. The ratio of cereals and other crops to total cultivated agriculture is 96%. Fruit and spice production areas are at 121 460 decares and constitute only 3% of the agricultural lands (Figure 2) (TUIK, 2019). The distribution of the cultivated agricultural areas of Tekirdağ province by districts is shown in Table 1. The districts with the most agricultural land are Hayrabolu Malkara and Süleymanpaşa, respectively.

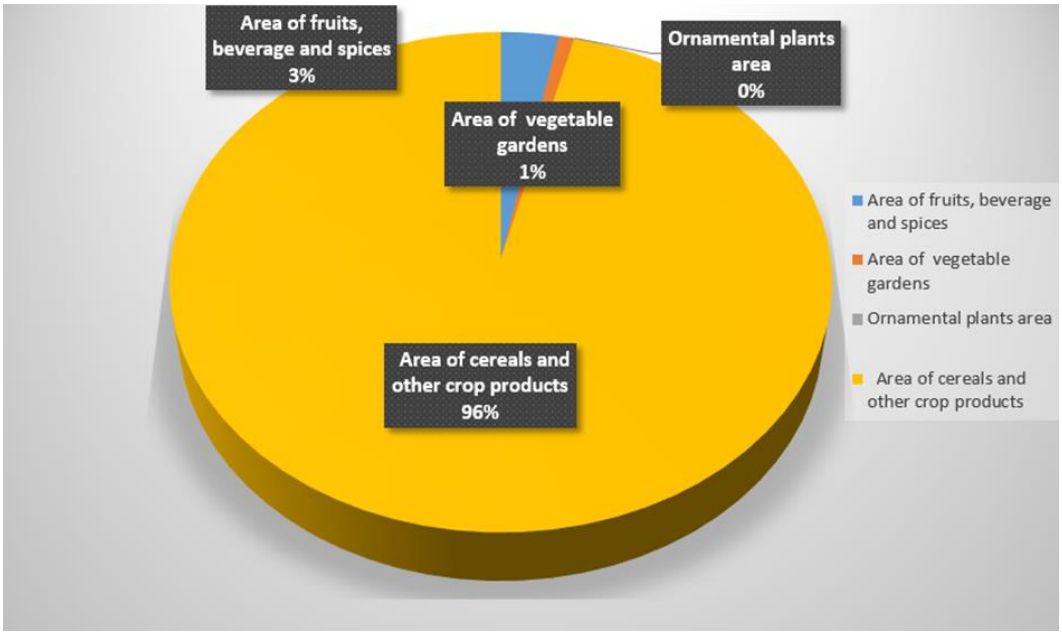

Figure 2. Cultivated area in Tekirdağ province (TUIK, 2019)

Table 1. Distribution of cultivated agricultural lands according to districts (da) (TUIK, 2019)

Districts	***Area of cereals and other crop products***	***Area of fruits, beverage and spices***	***Area of vegetable gardens***	***Fallow land***	***Ornamental plants area***	***Under cover***	***Total land***
Süleymanpaşa	678674	16583	16536	-	85	135	712013
Çerkezköy	48089	251	35	-	-	-	48375
Çorlu	291180	3641	1003	-	10	24	295858
Şarköy	78820	83646	1588	-	-	5	164059
Saray	314831	791	1059	-	-	4	316685
Muratlı	320015	1750	505	-	-	6	322276
Marmaraereğlisi	146230	1533	1485	-	-	-	149248
Malkara	737605	5742	7167	-	5,4	16,5	750535,9
Kapaklı	97793	369	159	-	-	3	98324
Hayrabolu	747008	4248	957	-	-	25	752238
Ergene	298622	2906	978	-	-	98	302604
Cultivated area	**3 758 867**	**121 460**	**31 472**	-	**100,4**	**316,5**	**3 912 215,9**

As it can be seen in Table 2, it is noteworthy that wheat production is quite high and sunflower and barley production is also high. Biomass can be used as a direct energy source, and it is also evaluated by obtaining products such as biogas, ethanol, synthesis gas, etc. by using chemical and thermochemical methods. Especially, the utilization of the wastes of the products and their use as an energy source are important in terms of both recycling these wastes and eliminating environmental problems.

Table 2. Distribution of agricultural products with waste potential according to districts in Tekirdağ (TUIK, 2019)

Districts	***Field crops and production quantities in 2019 (ton/year)***							
	Wheat	**Barley**	**Rye**	**Sunflower**	**Maize**	**Paddy**	**Oats**	**Triticale**
Süleymanpaşa	150382	9104	12	58989	112	-	241	76
Çerkezköy	10824	269	-	3755		-	256	392
Çorlu	58538	7945	-	21407	8	-	241	36
Şarköy	14254	2235	261	4855	27	-	275	45
Saray	74350	10428	-	32679	80	-	310	135
Muratlı	80787	4324	-	27387	29	-	25	7
Marmaraereğlisi	42285	5128	-	7149	25	-	13	-
Malkara	170372	17670	96	64394	43	1297	172	128
Kapaklı	22047	745	-	8616		-	-	88
Hayrabolu	161856	4487	-	81616	117	37147	539	495
Ergene	71325	2690	-	31452	10	-	129	60
Total	**857 020**	**65 025**	**369**	**342 299**	**451**	**38 444**	**2 201**	**1 462**

2.3. Calculation of Waste Amount and Biomass Energy Potential

The amount of field wastes was calculated by multiplying the product production amount and proportional coefficients determined as the rate of waste product. By multiplying the determined waste amount and the usability rate of the wastes for energy production, the potential that can be evaluated for energy production is determined (Karaca, 2018) (Table 3).The available potential of the agricultural residues and energy potential of residues are calculated by the following equations (Eq.1, 2):

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

Where;

A :the availability of residues (%)

AAP : the amount of agricultural product (ton)

RPR : residue-to product ratio

$$HV = AAR\ x\ LHV \quad (2)$$

Where;

AAR : the available amount of agricultural residues of crop (ton)

LHV : Heating Value (MJ/kg)

Table 3. Field crops waste product rate usability values and lower heat values (Başçetinçelik et al.,2005) (Karaca,2018)

Crops	***Residues***	***Residue rate***	***Availability (%)***	***LHV(MJ/kg)***
Wheat	Straw	0,98	15	17,9
Barley	Straw	0,95	15	17,5
Rye	Straw	0,78	15	17,5
Sunflower	Stalks	2,80	60	14,2
Maize	Stalks	2,10	60	18,5
	Cob	0,30	60	18,4
Paddy	Straw	0,66	60	16,7
	Husks	0,27	80	13,0
Oats	Straw	0,75	15	17,4
Triticale	Straw	1,10	60	17,8

3. RESEARCH RESULTS AND DISCUSSION

The amount of biomass of vegetable origin and energy potential released as a result of agricultural production in Tekirdağ province are given in Table 4. Plant biomass of agricultural origin; wheat, barley, rye, sunflower, corn, oats, triticale and paddy were evaluated as field wastes. The amount of usable field wastes is 735, 74 ktons and the energy potential is 3049,88 GWh.

Table 4. Agricultural waste potential and energy values

Crops	*Residues*	*Production (kton/year)*	*Residues (kton/ year)*	*Available Residues (kton/ year)*	*Total Energy Value (GWh)*
Wheat	Straw	857,02	839,88	126,00	626,41
Barley	Straw	65,03	61,77	9,30	45,04
Rye	Straw	0,37	0,29	0,04	0,21
Sunflower	Stalks	342,30	958,44	575,10	2268,30
Maize	Stalks	0,45	0,95	0,57	2,92
	Cob	0,45	0,14	0,08	0,41
Paddy	Straw	38,44	25,37	15,20	70,62
	Husks	38,44	10,38	8,30	29,99
Oats	Straw	2,20	1,65	0,25	1,20
Triticale	Straw	1,46	1,61	0,96	4,77
Total			**1 900,47**	**735,74**	**3 049,88**

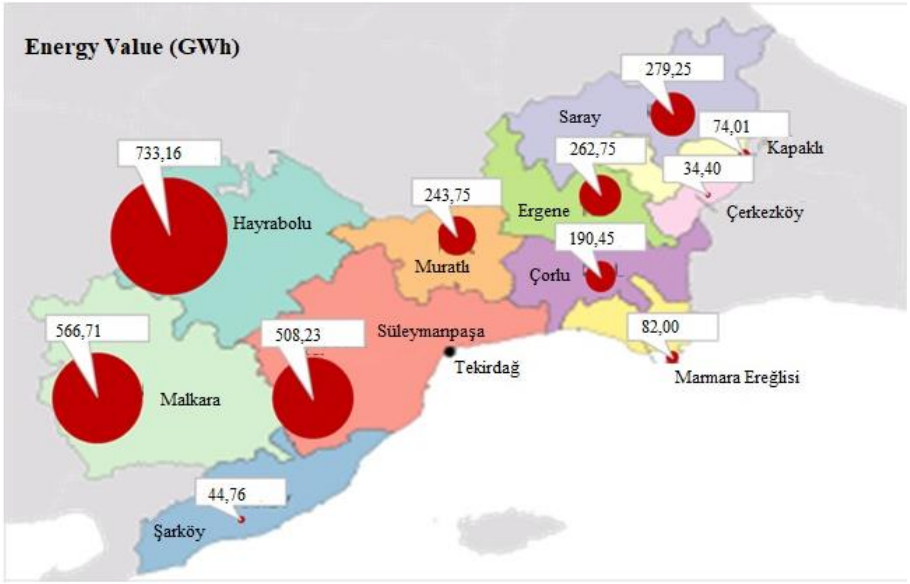

Figure 2. Energy value based on agricultural residues according to districts

This map showed that the potential of agricultural residues concentrated in the Hayrabolu, Malkara and Süleymanpaşa districts (Figure 2). In particular, it is observed that the type and distribution of residues in Hayrabolu district, the distribution of agricultural residues according to energy value is ranked as sunflower (74%), wheat (16%) and paddy (9%) respectively.

4. CONCLUSION

In this study, it is aimed to determine the distribution of agricultural residues in Tekirdağ districts. Especially the fact that our country is both foreign-dependent in terms of energy and inadequate use of biomass energy increases the importance of this study.

There is a total area planted in 3 912 215 decares. Cereals and other herbal products comprise 3 758 867 decares of the cultivated areas of the province. The ratio of cereals and other crops to total cultivated agriculture is 96%. Fruit and spice production areas are at 121 460 decares and constitute only 3% of the agricultural lands. The districts with the most agricultural land are Hayrabolu Malkara and Süleymanpaşa, respectively.

The distribution of annual biomass energy potential (GWh) from field wastes in 2019 according to districts, respectively; Hayrabolu>Malkara> Süleymanpaşa> Saray> Ergene> Muratlı> Çorlu and their energy values are 733,16 GWh > 566,71 GWh>508,23 GWh > 279,25 GWh > 262,75 GWh > 243,75 GWh>190,45 GWh determined as.

The amount of usable field wastes is 735, 74 ktons and the energy potential is 3049,88 GWh.

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