Rocznik Ochrona Środowiska

Volume 23 Year 2021 ISSN 1506-218X pp. 594-612

https://doi.org/10.54740/ros.2021.042 open access

Received: 19 July 2021 Accepted: 24 August 2021 Published: 06 December 2021

Alternative Evaluation of Olive Pomace (Pirina) as Production Waste

Atilgan Atilgan

Department of Biosystem Engineering, Faculty of Engineering, Alanya Alaaddin Keykubat University, Alanya/Antalya, Turkey
https://orcid.org/0000-0003-2391-0317

Roman Rolbiecki[*]

Department of Plant Irrigation and Horticulture, University of Science and Technology in Bydgoszcz, Poland
https://orcid.org/0000-0001-6230-4227

Burak Saltuk

Department of Biosystem Engineering, Faculty of Engineering, Alanya Alaaddin Keykubat University, Alanya/Antalya, Turkey
https://orcid.org/0000-0001-8673-9372

Hasan Ertop

Department of Agricultural Structures and Irrigation, Faculty of Agriculture, Isparta University of Applied Science, Turkey
https://orcid.org/0000-0003-0987-5885

Monika Markovic

Department for Plant Production and Biotechnology, Faculty of Agrobiotechnical Sciences, University of Osijek, Croatia
https://orcid.org/0000-0002-8742-6922

[*]*corresponding author's e-mail: rolbr@utp.edu.pl*

Abstract: With the increasing need for energy, energy studies to be obtained from waste gain importance. In this study, it has been tried to determine the amount of biogas energy that can be obtained from olive pomace (pirina), which is produced by processing oil olives. Numerical maps of pirina amounts and potential biogas energy values and location maps of the proposed pirina processing plant were created. The necessary calculations were made by comparing the obtained results with the relevant literature information. In the study, the current potential biogas energy amount was calculated, maps were created and the electricity and gasoline energy equivalent levels of this energy were tried to be calculated using the 2015-2019 data of the Mediterranean, Aegean and Marmara Regions. The total potential amount of pirina in the research area is 1853375.7 tons and the potential biogas energy amount that can be obtained is 33360762.4 MJ. Pirina, which is the production waste after pressing the olives for oil, can be used for energy production. By using pirina to obtain biogas energy, both the utilization of pirina and the development of the regions will be provided.

Keywords: biogases, map, olive, pirina, waste

1. Introduction

Olive; it is one of the agricultural products with significant economic value in terms of oil production and utilization of its fruit and waste. For many years, studies have been carried out to recycle the wastes originating from olive processing and olive oil producing facilities. Studies focus on the purification of the "black water" that comes out during oil extraction and the utilization of "pirina" for various purposes (Başkan 2010). Our country has an important potential in terms of biogas energy originating from animal or plant products. Researchers state that biogas can prevent environmental pollution as well as the financial contribution it will provide to the country's economy (Saltuk et al. 2016, Saltuk et al. 2017, Ertop et al. 2018). For, example, when animal wastes of the province of Isparta are included in biogas production, it is calculated that a greenhouse area of 3109.51 decares can be heated at a constant 10°C greenhouse temperature and 14 hours day^{-1} heating period during the 120-days vegetative growing period (Gökdoğan 2019). Biomass energy has an important potential among renewable energy sources. Solid wastes and agricultural residues with high organic content are used as fuel for energy production (Akın 2005). In this case, it reveals that countries with higher agricultural potential such as Turkey should properly utilize their plant and animal wastes and convert them into biomass energy (Ertop et al. 2019). Pirina, which is a solid waste consisting of olive seed and pulp remaining from olive oil production, is also an important biomass used in Mediterranean countries (Akın 2005).

During the olive oil that is made intensive production in Turkey occurs of a large amount of pirina at the end of production. Pirina has taken the oil in Turkey, almost all used as fuel, there are many areas of use in other Mediterranean countries. In Mediterranean countries, pirina can be used as fertilizer, fuel, feed for cattle, or even as an additive in road construction when mixed with bitumen. However, due to its energy content, it is increasingly used for fuel purposes (Görel et al. 2004, Öcal, 2005). Pirina is often used as animal feed, additive, cultivation of horticultural crops (Dermeche et al. 2013), as a fertilizer in soil strengthening (Paredes et al. 2001) and as an alternative fuel that does not contain sulfur (Çelen et al. 2015). The use of pirina for fuel is the most common use due to its high energy content. Depending on the type of olive trees, the structure of the soil, the climate and the nutrients in the soil, the energy value of pirina varies. In Turkey, even though the change from year to year depending on the average olive production of 200-250 thousand tons $year^{-1}$ of pirina is known to be obtained (Demirtepe 2008). Studies are carried out on the use of pirina as an organic input in agriculture, as a fertilizer, as a soil improver, to determine its effects on the soil, and to evaluate this potential in agriculture (Lopez-Pineiro et al. 2007, Gomez-Munoz et al. 2010, Diacano et al. 2012, Gomez-Munoz et al. 2013). How-

ever, the lignin in the oil and core of pirina, which has high organic matter content, cannot easily turn into humic substances. Since the pirina given to the environment increases the carbon source, a large amount of nitrogen (N) immobilization may be in question, which may have a negative effect on the nitrogen uptake required for the plants (Başkan 2010). In this case, it shows that the use of unprocessed pirina as fertilizer is limited, and if it is not used as fertilizer, it may create similar problems in the field of waste (Dermeche et al. 2013). For this reason, processing becomes a necessity as it is not possible to leave pirina directly to nature.

This study aims to map these potential energy fields by determining the amount of pirina and potential biogas energy generated as a result of olive oil production in the Mediterranean, Aegean and Marmara Regions. Also, it is to reveal the potential of an alternative energy source in order to meet the energy need by using the pirina in the production of biogas energy.

2. Materials and methods

In the calculation of oil olive biogas energy from waste the years 2015-2019 Turkey Statistical Institute of data are used. In the study, the Mediterranean, Aegean and Marmara regions were selected as the study area (Figure 1). It was taken into account that the production of olive oil production is in the forefront in selecting these regions as a study area. In the selection of olive for oil, which is an herbal product, it was taken into consideration that the amount of olive pirina that can be obtained after squeezing the olive is high.

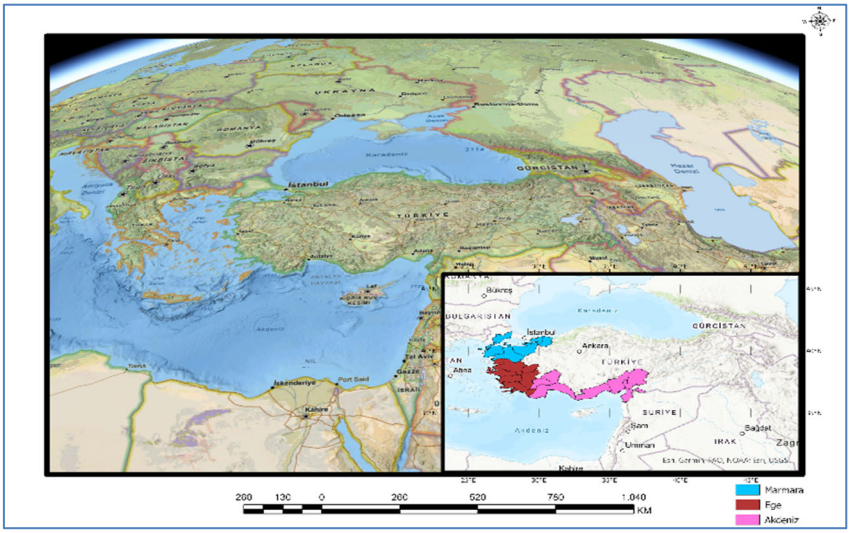

Fig. 1. General view of the study area

Pirina, which is an increased olive pulp after the pressed of olives, is an important biomass type seen in the Mediterranean countries. It can be obtained in quite large amounts at low cost. Although the amount of pirina to be obtained from olive varies depending on the cultivation technique, olive type and oil processing, on average, 15-22 kg olive oil and 35-45 kg pirina can be obtained from 100 kg olive (Kurtuluş 2003, Öcal 2005). The moisture and oil content of the obtained pirina also varies according to the production method. The production processes of the 2 phase system and the 3 phase system are the same. However, since hot water is not added to the olive paste in the 2-phase system, black water does not occur. Instead, the pirina obtained is more watery than the 3-phase system. The content of pirina produced in the 3-phase system contains 2-6% oil and 35-50% moisture. These values must be reduced to be used as a pirina fuel. According to the Communiqué on the Control of Solid Fuels, the oil ratio of fuel oil must be below 1.5% and humidity below 15%. Taking these values into account, the amount of pirina that can be evaluated as fuel can be determined by taking the pirina yield coefficient at an average of 0.3 (Karaca et al. 2005).

For the research area, the data obtained from the Turkish Statistical Institute multiplied by 0.3, which is the yield coefficient of pirina, and the potential of pirina that can be used as fuel was calculated. 18 MJ kg^{-1}, which is the lower thermal value of pirina with the calculated pirina potential (Karaca et al. 2005) multiplied by the total energy potential was determined. After determining the potential biogas energy that can be obtained from pirina, comparisons with electricity and gasoline equivalent energy have been made. Zan Sancak et al., 2014; Baran et al., 2017; Atilgan et al., 2020a; Atilgan et al., 2020b; they stated in their studies that the amount of energy obtained from 1 m^3 of biogas is equivalent to 4.7 kWh of electricity and 0.8 liters of gasoline. These values were used in calculations. In the selection of the provinces envisaged for the facility where the obtained pirina will be processed and the provinces where the pirina is located, the smallest locations in kilometers have been chosen to benefit from time, transportation, work and labor factors. While choosing these locations, the distance between provincial centers was taken into account (Anonymous 2021).

Geographic Information systems software ArcGIS Pro was used in the study. Maps were produced with GIS software for spatial interpretation and inferences and these parts were discussed. Classification method was used in the production of maps. "Potential Pirina Amount (tone) and Potential Energy Amount (MJ)" classification maps for each region were produced with the Geographical Information Systems software. The number of classes in each region is equal to the number of provinces. In this way, the province ranking of the region in terms of the criteria addressed was made. Thanks to these spatial bases, maps for the positioning of pirina facilities were created and interpreted (Aksoy & San 2019). In the study, nonparametric Kruskal Wallis test was applied to determine

the difference between provinces according to the number of olive trees for oil and the amount of olives. Dunn's multiple comparison test was used for statistically significant results (Cebeci 2019).

3. Results and discussion

The number of olive trees available in the Mediterranean Region for 2015-2019, the amount of olives collected from existing trees, the potential amount of pirina that can be obtained by squeezing the olives for oil and the potential energy amount that can be obtained are given in Table 1. The difference between provinces according to the number of olive trees for oil and the amount of olives was statistically significant ($p < 0.01$). The grouping obtained as a result of the application of Dunn's multiple comparison test is given in Table 1.

Table 1. The potential amount of pirina and energy that can be obtained in the Mediterranean Region

Province	Number of olive trees for oil (piece)	Olives for oil (tons)	Amount of potential pirina (tons)	Amount of potential energy (MJ)
Adana	8616832	147770	44331	797958
Antalya	12557916	294889	88466.7	1592400.6
Burdur	169926	1012	303.6	5464.8
Hatay	48353822	611161	183348.3	3300269.4
Isparta	19416	123	36.9	664.2
Kahramanmaraş	5104480	51969	15590.7	280632.6
Kilis	18605898	146679	44003.7	792066.6
Mersin	24625585	459131	137739.3	2479307.4
Osmaniye	7101696	187662	56298.6	1013374.8
Total	125155571	1900396	570118.8	10262138.4

When Table 1 is examined, it is seen that there are a total of 125155571 olive trees for olive oil production in the Mediterranean Region and a total of 1900396 tons of olives are collected for olive oil production. It was determined that the province of Hatay ranked first with 38.63% and Isparta province ranked last with 0.02% in the total tree presence in the region. Besides, it was determined that the province of Hatay ranked first with 32.16% in terms of the amount of olives grown in the region, and Isparta province ranked last with 0.006%. Although there are fluctuations in the number of trees and olive production on an annual basis, it can be said that the number of trees and olive production varies in proportion to the long period. However; it has been determined that the potential amount of pirina that can be obtained in the region is 570118.8 tons and the

potential energy amount that can be obtained from this amount of pirina is 10262138.4 MJ. It is seen that the amount of potential pirina and energy that can be obtained in the olive tree and olive production is in the first place in the province of Hatay and the last place in Isparta. There is 32.16% of the total amount of pirina in Hatay province and 0.006% in Isparta. It has been calculated that 32.16% of the potential energy amount that can be obtained is located in the province of Hatay and 0.006% in the province of Isparta. Therefore, it can be thought that the amount of olive production and the potential amount of pirina and energy that can be obtained show a proportional change. The map of the potential amount of pirina that can be obtained in the Mediterranean Region is shown in Figure 2 and the map of the potential energy amount is shown in Figure 3.

When figures 2 and 3 are examined; it is seen that the province of Hatay has the highest level of pirina amount and energy potential in the Mediterranean Region, while Mersin is the second in the region and Antalya is the third. It was determined that the province with the lowest pirina and energy level was Isparta. Ertop and Atilgan (2019) stated in their study that Antalya and Mersin provinces are at the forefront in potential biogas energy planning. It can be said that Antalya and Mersin provinces in the Mediterranean region are in parallel with this study in terms of their biogas energy potential.

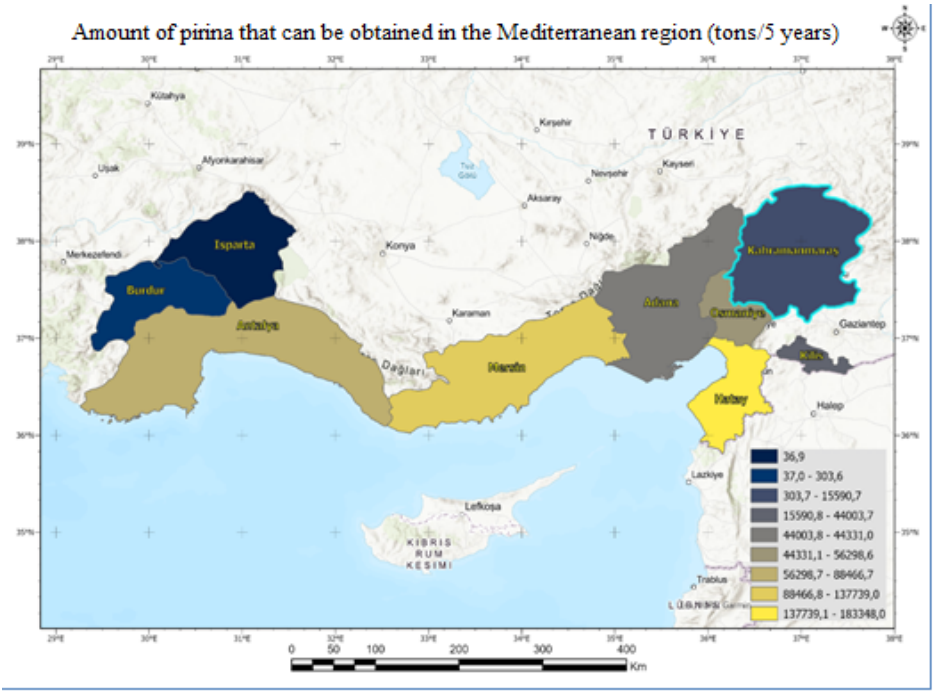

Fig. 2. Amount of pirina that can be obtained in the Mediterranean region (tons 5 years^{-1})

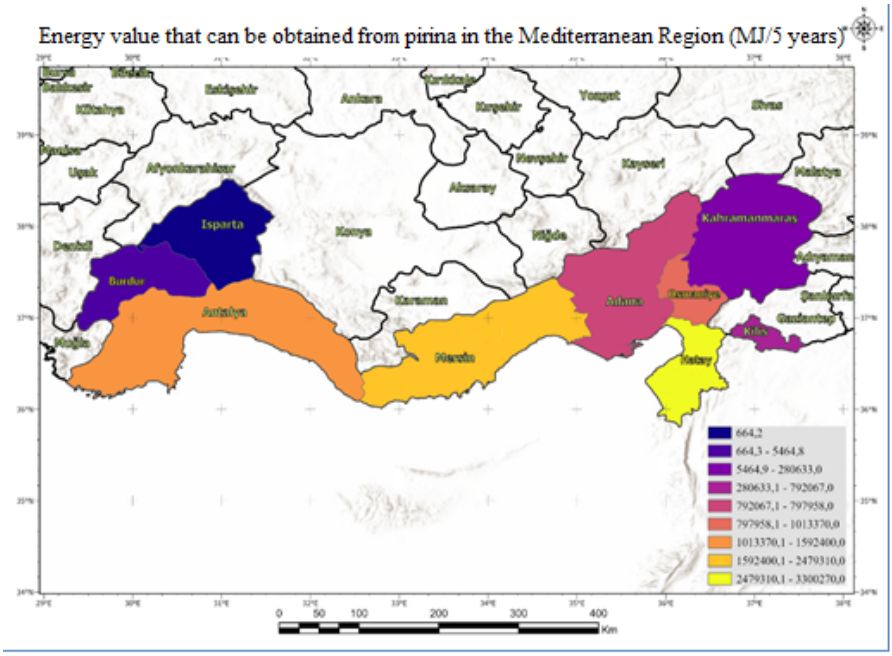

Fig. 3. Energy value that can be obtained from pirina in the Mediterranean Region (MJ 5 years^{-1})

In Table 2, the province where the olive pirina facility is proposed and the raw material capacities of the pirina plant and Figure 4 shows the location and distance of the proposed pirina facility in the region and provinces where raw materials can be supplied.

Table 2. Suggested pirina facilities for the Mediterranean Region and pirina capacity of the provinces

Province where pirina Facility is suggested	The province with pirina raw material	5-Year Pirina Capacity of Provinces (Tons)	The distance of the suggested pirina facility to the provinces (km)
Antalya	Antalya	88466.7	0
	Isparta	36.9	131
	Burdur	303.6	122
Osmaniye	Osmaniye	56298.6	0
	Mersin	137739.3	158
	Adana	44331	89
	Kahramanmaraş	15590.7	105
	Kilis	44003.7	145
	Hatay	183348.3	129

When Table 2 is examined; it can be thought that a pirina facility to be established in Antalya province may cover the provinces of Antalya, Isparta and Burdur. The total amount of pirina in these three cities is 88807.2 tons and the potential energy amount that can be obtained is 1598529.6 MJ. The amount of potential energy that can be obtained is equal to 7513089.12 kWh of electricity equivalent energy and 1278823.68 L of gasoline-equivalent energy. When Figure 4 is examined, it can be thought that Antalya is the province where the most suitable pirina facility will be built for Antalya, Isparta and Burdur provinces. It is seen that the closest cities where Antalya province can supply raw materials are Burdur, which is 122 km away, and Isparta, which is 131 km away. However, as seen in Table 2; it is seen that the raw material of pirina in Burdur and Isparta provinces is 340.5 tons in total. Therefore, considering the distance of Antalya province to other provinces in the region, it can be said that a facility for obtaining energy by processing pirina alone cannot be a profitable investment. Atilgan et al. (2020c) stated in their study in Antalya that greenhouse wastes can be used in the use of biogas energy. It may be thought that in Antalya, where greenhouse cultivation activities are carried out intensively, pirina should be used in greenhouse waste and energy planning.

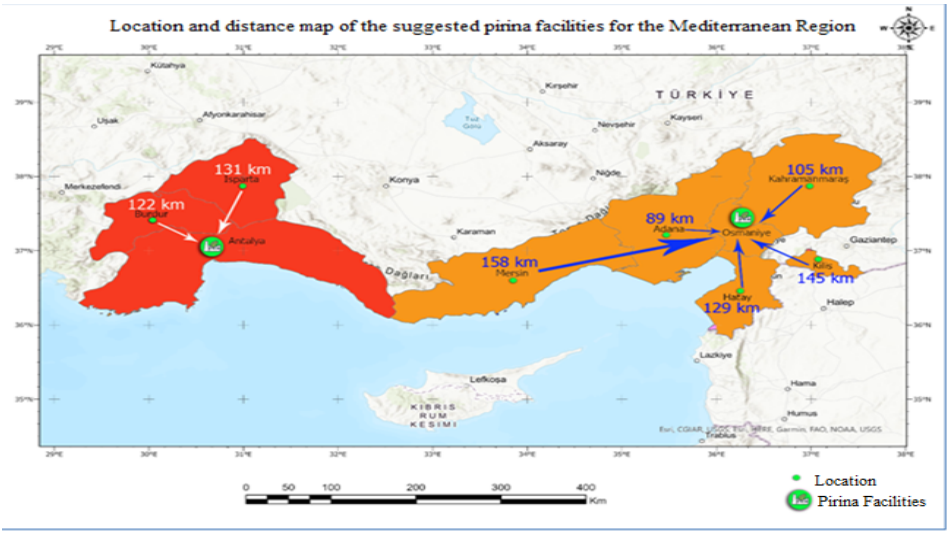

Fig. 4. Location and distance map of the suggested pirina facilities for the Mediterranean Region

Similarly, when Table 2 is examined, it is thought that a pirina facility to be established in Osmaniye province may cover the provinces of Osmaniye, Mersin, Adana, Kahramanmaraş, Kilis and Hatay. When Figure 3 is examined, the

closest city where Osmaniye can obtain raw materials is Adana with 89 km, while the furthest city for raw material supply is Mersin with 158 km. As seen in Table 2; it is seen that the city with the highest potential in terms of pirina amount is Hatay. However, since transportation and labor costs between cities may be high, it is predicted that it would be more beneficial to consider a pirina facility that will be planned to be established in the eastern part of the Mediterranean Region in Osmaniye, as shown in Figure 4. The five-year raw material processing capacity of a pirina processing plant to be established in Osmaniye province will be 481311.6 tons. The amount of biogas energy that can be obtained from this facility is 8663608.80 MJ and this potential energy amount is equal to 40718961.36 kWh electricity equivalent energy and 6930887.04 L gasoline-equivalent energy.

The number of olive trees available in the Aegean Region for 2015-2019, the amount of olives collected from existing trees, the potential amount of pirina that can be obtained by squeezing the olives for oil and the potential energy amount that can be obtained are given in Table 3.

Table 3. The potential amount of pirina and energy that can be obtained in the Aegean Region

Province	Number of olive trees for oil (piece)	Olives for oil (tons)	Amount of potential pirina (tons)	Amount of potential energy (MJ)
Aydın	88628736	1325366	397609.8	7156976.4
Denizli	2669196	33499	10049.7	180894.6
Manisa	28144477	468659	140597.7	2530758.6
Muğla	76185566	705996	211798.8	3812378.4
Uşak	4311	20	6	108
İzmir	73695974	733115	219934.5	3958821
Total	269328260	3266655	979996.5	17639937

When the values of the Aegean Region are examined, it is seen that there are 269328260 olive trees and a total of 3266655 tons of olives are collected for olive oil production (Table 3). It was determined that Aydın province ranks first with 32.91% of the total tree presence and Uşak province ranks last with 0.002%. Also, it was determined that Aydın was the first with 40.57% in terms of the amount of olives grown in the region, and Uşak was the last with 0.0006%. It is seen in Table 3 that the potential amount of pirina that can be obtained in the region is 979996.5 tons and the potential energy amount that can be obtained from this amount of pirina is 17639937 MJ. It was determined that the potential amount of pirina and energy that could be obtained was also the first place of Aydin province and the last place of Uşak province. 40.57% of the total amount of pirina is in Aydın province and 0.006% is in Uşak province. It was calculated

that 40.57% of total energy was in Aydın province and 0.0006% was in Uşak province. The map of the potential amount of pirina that can be obtained in the Aegean Region is shown in Figure 5 and the map of the potential energy amount is shown in Figure 6.

When Figure 5 and Figure 6 are examined; it is seen that Aydın Province has the highest level in Aegean Region in terms of pirina amount and energy potential and Izmir province is in second place in the region. It was determined that the province with the lowest pirina and energy level was Uşak. In Table 4, the province where the pirina facility is proposed and the raw material capacities of the pirina plant and Figure 7 shows the location and distance of the proposed pirina facility in the region and provinces where raw materials can be supplied.

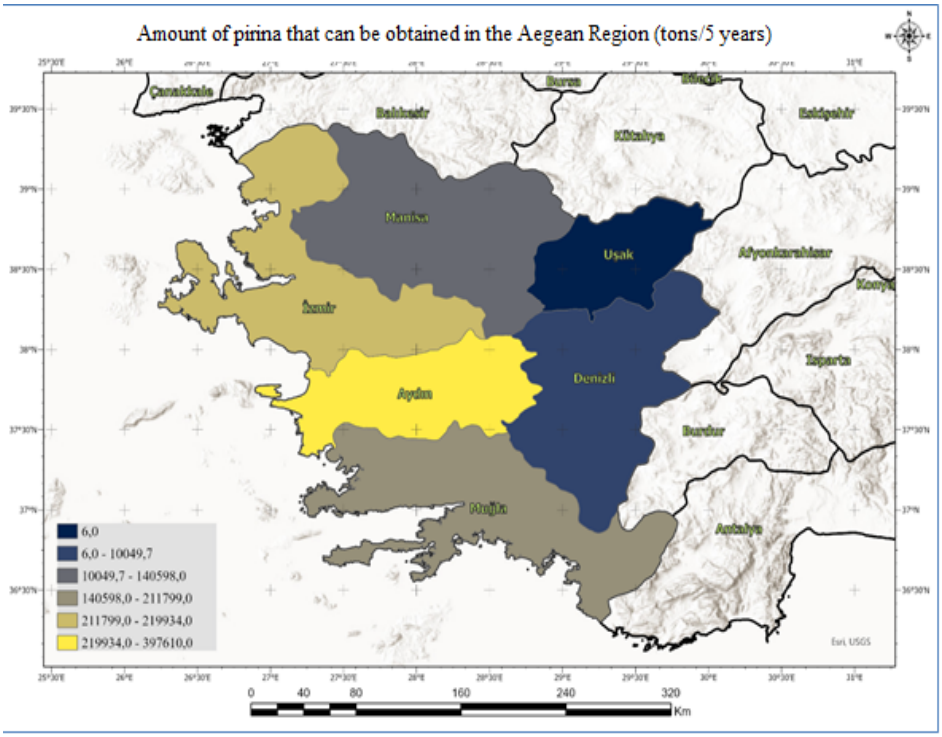

Fig. 5. Amount of pirina that can be obtained in the Aegean Region (tons 5 years^{-1})

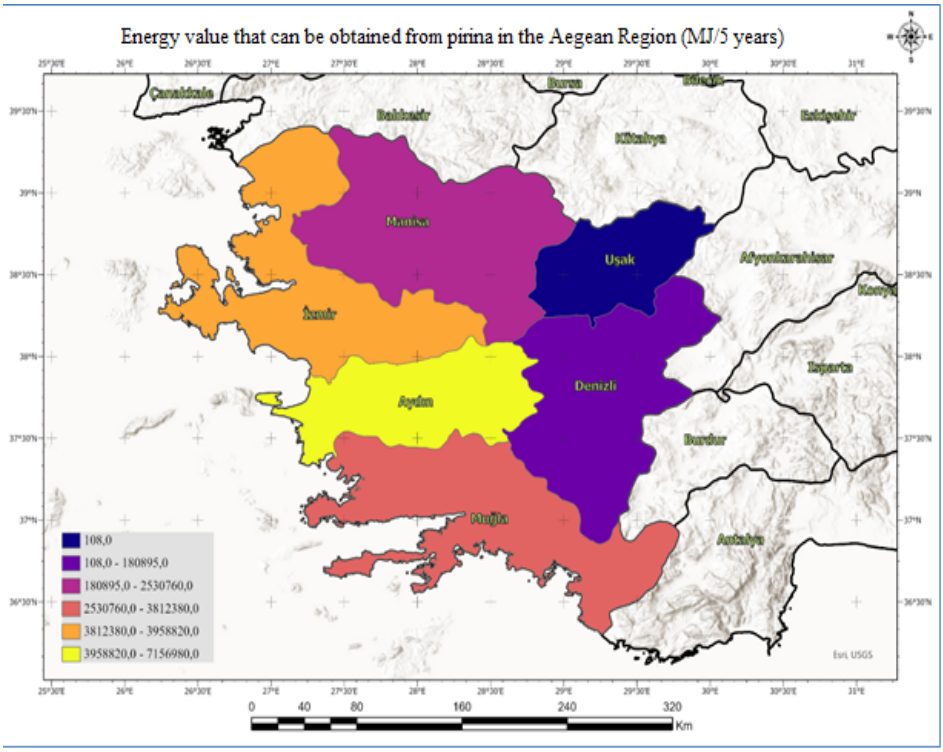

Fig. 6. Energy value that can be obtained from pirina in the Aegean Region (MJ 5 years^{-1})

Table 4. Suggested pirina facilities for the Aegean Region and pirina capacity of the provinces

Province where pirina facility is suggested	Province with pirina raw material	5-Year Pirina capacity of provinces (Tons)	The distance of the suggested pirina facility to the provinces (km)
Aydın	Aydın	397609.8	0
	Muğla	211798.8	98
	İzmir	219934.5	128
	Denizli	10049.7	124
	Manisa	140597.7	152
	Uşak	6	216

When Table 4 is examined, it can be thought that a pirina facility to be established in Aydın province may include Aydın, Muğla, Izmir, Denizli, Manisa and Uşak provinces. However, considering the very low amount of pirina in Uşak and its distance to Aydın, it can be said that there may be problems in raw material

supply and therefore, the province of Uşak may not benefit from the facility to be established. When Figure 7 is examined, it can be said that Aydın is the most suitable province for the establishment of the Aegean Region pirina facility. In raw material supply for Aydın, it is seen that the closest province is Muğla with 98 km and the farthest province is Uşak with 216 km. However, it may be thought that it will not be economical to choose it due to the scarcity of raw materials in Uşak. For this reason, it can be said that the furthest raw material supply for Aydın province is Manisa, 152 km away. The total amount of pirina for the facility planned to be built in Aydın is 979996.5 tons and the potential energy amount that can be obtained is 17639937 MJ. The amount of potential energy that can be obtained is equal to 82907703.9 kWh of electrical energy and 14111949.6 L gasoline equivalent energy.

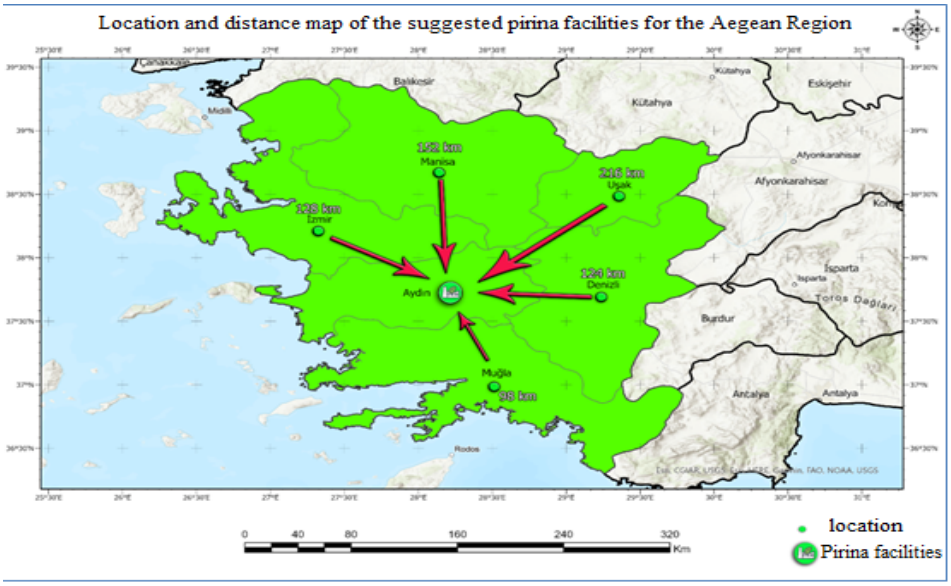

Fig. 7. Location and distance map of the suggested pirina facilities for the Aegean Region

The number of olive trees available in the Marmara Region for 2015-2019, the amount of olives collected from existing trees, the potential amount of pirina that can be obtained by squeezing the olives for oil and the potential energy amount that can be obtained are given in Table 5.

Table 5. The potential amount of pirina and energy that can be obtained in the Marmara Region

Province	Number of olive trees for oil (piece)	Olives for oil (tons)	Amount of potential pirina (tons)	Amount of potential energy (MJ)
Balıkesir	43886559	644068	193220.4	3477967.2
Bursa	3524076	44655	13396.5	241137
Kocaeli	3964	37	11.1	199.8
Sakarya	709012	10794	3238.2	58287.6
Tekirdağ	600935	8990	2697	48546
Yalova	12073	82	24.6	442.8
Çanakkale	22831281	302242	90672.6	1632106.8
Total	71567900	1010868	303260.4	5458687

It has been determined that there are a total of 71567900 olive trees for olive oil production in the Marmara Region and a total of 1010868 tons of olives are collected for olive oil production (Table 5). It is seen that Balıkesir province ranks first with a rate of 61.32% in terms of total tree presence in the region. In addition, it has been determined that Balıkesir is in the first place with 63.72% in terms of the amount of olives grown in the region and Kocaeli province is in the last place with 0.004%. However; It has been determined that the potential amount of pirina that can be obtained in the region is 303260.4 tons and the potential energy amount that can be obtained from this amount of pirina is 5458687 MJ. It is seen that the amount of potential pirina and energy that can be obtained in olive tree and olive production is in the first place in the province of Balıkesir and similarly in the last place in Kocaeli (Figure 8). There is 63.71% of the total amount of pirina in Balıkesir province and 0.004% in Kocaeli. It has been calculated that 63.71% of the potential energy amount that can be obtained is in Balıkesir and 0.004% is in Kocaeli. The map of the potential amount of pirina that can be obtained in the Marmara Region is shown in Figure 8 and the map of the potential energy amount is shown in Figure 9.

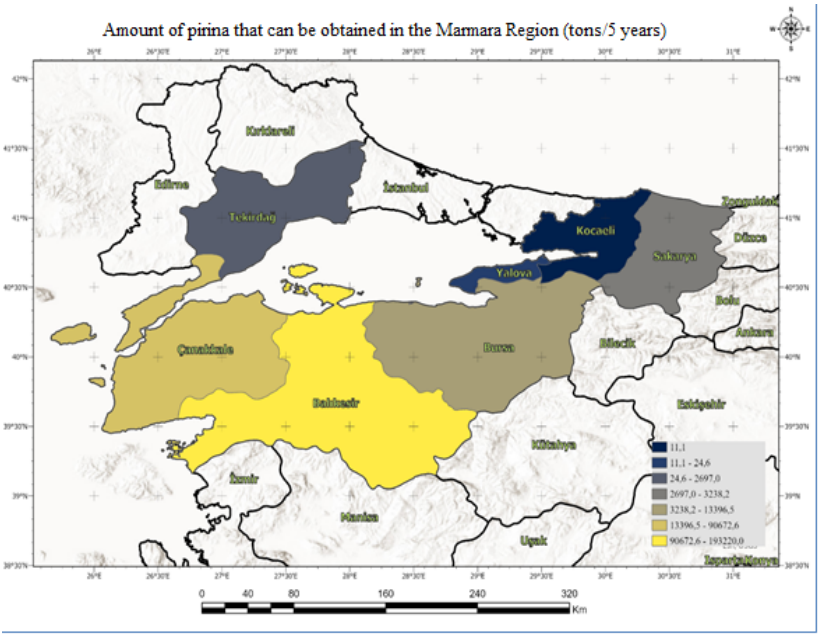

Fig. 8. Amount of pirina that can be obtained in the Marmara Region (tons 5 years^{-1})

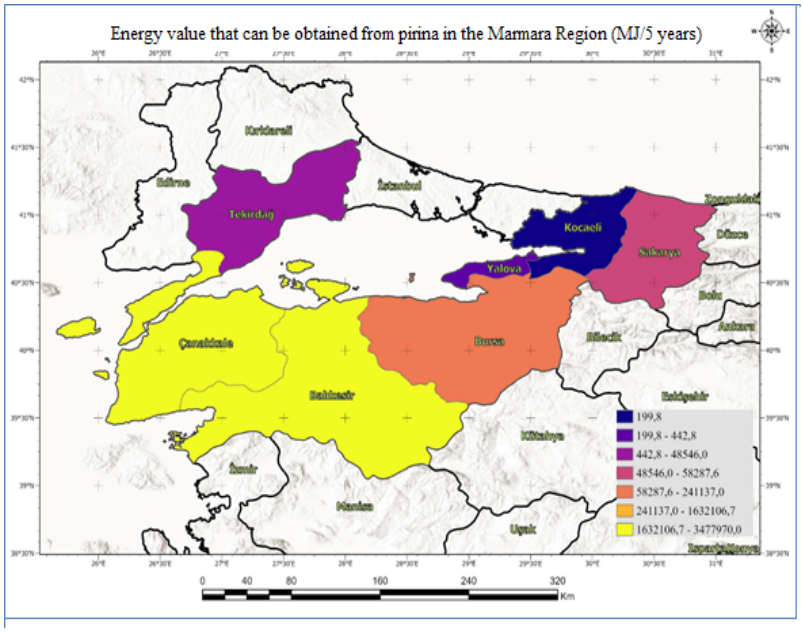

Fig. 9. Energy value that can be obtained from pirina in the Marmara Region (MJ 5 years^{-1})

When figures 8 and 9 are examined; It is seen that the pirina amount and energy potential of Balıkesir Province, which is expressed in yellow, is at the highest level, while Çanakkale is the second in the region. In Table 6, the province where the pirina facility is proposed and the raw material capacities of the pirina plant and Figure 10 shows the location and distance of the proposed pirina facility in the region and provinces where raw materials can be supplied.

Table 6. Suggested pirina facilities for the Marmara Region and pirina capacity of the provinces

Province where pirina Facility is suggested	The province with pirina raw material	5-Year Pirina Capacity of Provinces (tons)	The distance of the suggested pirina facility to the provinces (km)
Balıkesir	Balıkesir	193220.4	0
	Bursa	13396.5	152
	Kocaeli	11.1	275
	Sakarya	3238.2	308
	Tekirdağ	2697	370
	Yalova	24.6	212
	Çanakkale	90672.6	221

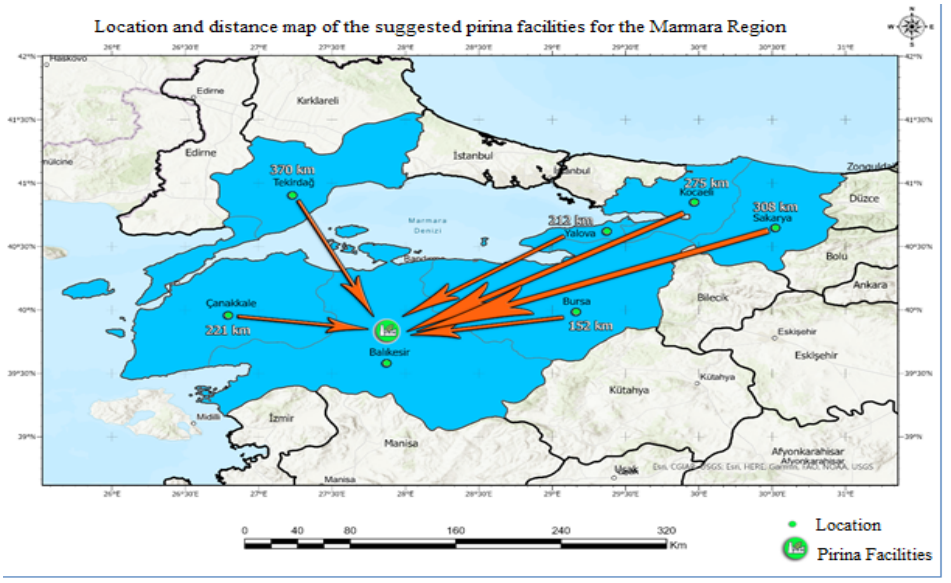

Fig. 10. Location and distance map of the suggested pirina facilities for the Marmara Region

We can easily say that a pirina facility to be established in Balıkesir province may include Balıkesir, Bursa, Kocaeli, Sakarya, Tekirdağ, Yalova and Çanakkale provinces. It can be said that in Kocaeli and Yalova provinces there may be problems in the supply of pirina raw materials and it may be appropriate to process different agricultural wastes and prina together in these provinces due to the long distance to Balıkesir (Table 6). When Table 6 and Figure 10 are examined together, it can be said that the distance of Tekirdağ to the facility planned to be built in Balıkesir is 370 km and it will not be a profitable investment due to the geographical location of Tekirdağ province. Also; Aktaş et al. (2015) stated in their study that using animal wastes would be beneficial in the biogas energy potential of Tekirdağ province. It is thought that this benefit will increase if animal wastes and pirina are processed together in Tekirdağ province. It can be said that there is a similar situation in the province of Sakarya as in Tekirdağ. Karabaş (2019) stated that different agricultural wastes should be used in the biogas energy potential of Sakarya. It has been concluded that in Sakarya, as in Tekirdağ, processing pirina together with different agricultural waste will increase the benefit rate. Therefore, it is seen that Balıkesir province can serve Bursa and Çanakkale provinces more beneficially as a pirina processing facility in the Marmara Region. The amount of pirina that can be processed in this facility is 297325.2 tons and the potential energy amount that can be obtained is 5351853.6 MJ. The amount of potential energy that can be obtained is equal to 25153711.92 kWh of electricity and 4281482.88 L of gasoline-equivalent energy. Turkey, which is an important agricultural country with high potential in terms of both crop production and animal production. Despite the high potential of organic waste, biogas management, known as the energy production method, is not used properly. When biogas management is implemented correctly, an economical input will be provided in terms of energy, and rural development can be achieved by providing a sustainable quality environment by reducing harmful wastes in terms of environment.

4. Conclusions

Organic waste material, which will be obtained from olive oil in the research area and is called pirina, has been taken into consideration. In this context, maps were created by revealing potential biogas energy. In which provinces the biogas plants to be planned in the future will be advantageous, it has been examined and the most suitable scenarios have been created. The total amount of potential biogas energy that can be obtained from pirina is 33360762.4 MJ. In the regions; it has been determined as 10262138.4 MJ in the Mediterranean Region, 17639937 MJ in the Aegean Region, and 5458687 MJ in the Marmara Region. It has been calculated that the highest energy amount that can be obtained in the regions is Hatay with 3300269.4 MJ in the Mediterranean Region, Aydın with 7156976.4 MJ in

the Aegean Region and Balıkesir with 3477967.2 MJ in the Marmara Region. In our country where olive consumption is high, it has been concluded that the use of pomace produced from olives as a raw material source for biogas production instead of using it as a fuel can be used both in the utilization of organic materials and in obtaining energy. Thanks to these studies, by drawing attention to the utilization of agricultural wastes, this study was carried out to protect our environment as well as to evaluate the wastes as the biggest energy sources in the future.

References

Acaroğlu, M. (2007). Alternative Energy Sources. *Nobel Yayın, 1253*, 609, Ankara (in Turkish).

Akbulut, A., Dikici, A. (2004). *E Biogas Potential of Elazıg Province and Cost Analysis*. Doğu Anadolu Bölgesi Araştırmaları (in Turkish).

Akın, S. (2005). *Using Pomace as Biomass in Energy Production*. Balıkesir Üniversitesi Fen Edebiyat Fakültesi Kimya Bölümü, Balıkesir (in Turkish).

Aksoy, E., San, B. T. (2019). Geographical Information Systems (GIS) and Multi-Criteria Decision Analysis (MCDA) Integration for Sustainable Landfill Site Selection Considering Dynamic Data Source. *Bulletin of Engineering Geology and the Environment, 78*(2), 779-791.

Aktaş, T., Özer, B., Soyak, G., Ertürk, M.C. (2015). Determination of the Electricity Generation Potential from Animal Biogas in Tekirdag City. *Tarım Makinaları Bilimi Dergisi, 11*(1), 69-74 (in Turkish).

Anonymous, (2006). Turkey's Renewable Energy Resources. *Türkiye Çevre Vakfı*, *Yayın 175*, 368, Ankara (in Turkish).

Anonymous, (2021). *General Directorate of Highways*. Distance Inquiry, Distance from District to District. https://www.kgm.gov.tr/Sayfalar/KGM/SiteTr/Uzakliklar/ilcedenIlceyeMesafe.aspx (Date of Access 24.01.2021) (in Turkish).

Atilgan, A., Saltuk, B., Ertop, H., Yücel A. (2020a). *Determination of Potential Biogas, Electricity and Natural Gas Energy Value That Can Be Obtained From Animal Wastes*. 4. Asia Pacific International Congress on Contemporary Studies, December 12-13, Montesorri, 1-14.

Atilgan, A., Saltuk, B., Ertop, H., Aksoy E. (2020b). *Determination of Potential Energy Values That Can Be Obtained From Cereal Residues*. 4. Asia Pacific International Congress on Contemporary Studies, December 12-13, Montesorri, 15-31.

Atilgan, A., Saltuk, B., Ertop, H., Aksoy, E., (2020c). Determining the Biogas Energy Potential from Greenhouse Wastes and Creating Maps: The Case of Antalya Province. *Euroasia Journal of Mathematics, Engineering, Natural & Medical Sciences*, 7(12), 19-30. International Indexed & Refereed ISSN: 2667-6702 (in Turkish).

Baran, M.F., Lüle, F., Gökdoğan O. (2017). Energy Potential Can Be Produced by Animal Waste of Adiyaman Province. *Türk Tarım ve Doğa Bilimleri Dergisi, 4*(3), 245-249 (in Turkish).

Başkan, A.E. (2010). *Waste and Evaluation Ways in Olive Oil Enterprises*. T.C. Güney Ege Kalkınma Ajansı, Denizli (in Turkish).

Boztepe, E., Karaca, A., (2009). *Agricultural Wastes as a Renewable Energy Source*. Enerji Kongresi. 21-23 Ekim 2009. İzmir (in Turkish).

Cebeci, Z., (2019). Non-Parametric Statistical Analysis with R. Abaküs Kitap Yayın Evi. İstanbul (in Turkish).

Çelen, S., Aktaş T, Karabeyoğlu S, Akyıldız A. (2015). Drying of Prina Using Microwave Energy and Determination of Appropriate Thin Layer Drying Model. *Journal of Tekirdag Agricultural Faculty. 12*(2), 21-31 (in Turkish).

Demirtepe, M. (2008). Studies on using of olive pomace and olive pomace oil in fish feeding MSc. Thesis, Ege Üniversitesi, Fen Bilimleri Enstitüsü, İzmir. (in Turkish)

Dermeche, S., Nadour, M., Larroche, C., Moulti-Mati, F., Michaud, P. (2013). Olive Mill Wastes: Biochemical Characterizations and Valorization Strategies. *Process Biochemistry, 48,* 1532-1552.

Diacono, M., Donato, F., Corrado, C., Tittarelli, F., Ceglie, F., Verrastro, V., Ventrella, D., Vitti, C., Montemurro, F. (2012). Bioassays and Application of Olive Pomace Compost on Emmer: Effects on Yield and Soil Properties in Organic Farming. *Acta Agriculturae Scandinavica, Section B-Soil & Plant Science. 62*(6), 510-518.

Ertop, H., Atilgan, A., Yücel, A., Saltuk, B. (2018). Management and Potential Biogases Quantities of Waste from Animal Breeding Enterprises Antalya Case. *Scientific Works. Series C. Veterinary Medicine, 2*(LXIV), 97-104.

Ertop, H., Atilgan A. (2019). *Determination of Potential Biogas Energy Values of Wastes Generated in Crop Production: Greenhouse Cultivation Case*. 3. Uluslararası Tarım, Hayvancılık ve Kırsal Kalkınma Kongresi 20-22 Aralık, Van, 961-971 (in Turkish).

Ertop, H., Atilgan A., Yücel A. (2019). *Determination of Biogas and Electricity Generatıon Potential Obtained From Animal Wastes: The Case of Layıng Hens.* 3. Uluslararası Tarım, Hayvancılık ve Kırsal Kalkınma Kongresi 20-22 Aralık, Van, 948-960 (in Turkish).

Fanchi, J. R., Fanchi, C. J. (2011). *Energy in the 21st Century*. World Scientific Publishing Co. Pte. Ltd. 5 Toh Tuck Link, Singapore 596224.

Gomez-Munoz, B., Hatch, DJ., Bol, R., Garcia-Ruiz, R. (2013). Agrochemical Characterization, Net N Mineralization and Potential N Leaching of Composted Olive-mill Pomace Currently Produced in Southern Spain. *J. Plant Nutr. Soil Sci., 176*, 655-664.

Gomez-Munoz, B, Hatch, DJ, Bol, R, Dixon, ER, Garcia-Ruiz, R. (2010). Gross and Net Rates of Nitrogen Mineralization in Soil Amended with Composted Olive Mill Pomace. *Rapid Communications in Mass Spectrometry, 25*, 1472-1478.

Gökdoğan, O. (2019). Greenhouse heating with the Energy that can be Acquired from Isparta Province's Animal Waste. *Akademia Doğa ve İnsan Bilimleri Dergisi, 5*(1), 27-34 (in Turkish).

Görel, Ö., Doymaz, İ., Akgün, N.A (2004). *Energy Use of Olive Oil Factory Wastes*, Yıldız Teknik Üniversitesi, Kimya Mühendisliği Bölümü, İstanbul (in Turkish).

Karaca, C., Bozoğlu, B., Polat., O, (2015). Mapping of Waste Quantity and Energy Potential of Olive Oil Cake in Hatay Province. *Uludağ Üniversitesi Ziraat Fakültesi Dergisi, 29*(2), 55-60 (in Turkish).

Karabaş, H., (2019). Investigation of Waste Amount and Energy Potential of Sakarya Province by Vegetative Biomass. *Ulusal Çevre Bilimleri Araştırma Dergisi, Sayı 2*(1), 35-43 (in Turkish).

Kurtuluş, E., (2003). *The Use and Production of Pirina as a Fuel*. Yeni ve Yenilenebilir Enerji Kaynakları Sempozyumu ve Sergisi Bildiriler Kitabı, Kayseri, 3-4 Ekim, 105-108 (in Turkish).

Lopez-Pineiro, A., Murillo S., Barreto C., Munoz A, Rato JM, Albarran A, Garcia A. (2007). Changes in Organic Matter and Residual Effect of Amendment with Two-phase Olive-mill Waste on Degraded Agricultural Soils. *Science of the Total Environment, 378,* 84-89.

Öcal, A, (2005). *Investigation on Using Olive Oil Wastewater and Prina for The Purpose of Plant Growing*. MSc. Thesis, Çukurova Üniversitesi, Fen Bilimleri Enstitüsü, 58 (in Turkish).

Öztürk, H. H., (2008). Renewable Energy Sources and Uses. *Teknik Yayınevi, 367*, Ankara (in Turkish).

Paredes, C., Bernal, M.P., Roig, A., Cegarra, J. (2001). Effects Of Olive Mill Wastewater Addition in Composting Of Agro-Industrial and Urban Wastes. *Biodegradation, 12*, 225-234.

Saltuk, B., Atilgan, A., Aydın, Y., Koca, Y. K., Köse, N. (2016). Manure from Livestock Farming in the Euphrates Basin and Its Potential Environmental Impact on Water Resources. Scientific Papers. Series D. *Animal Science, 59*(1), 251-257.

Saltuk, B., Artun, O., Atilgan, A. (2017). Determination of the Areas Suitable for Biogas Energy Production by Using Geographic Information Systems GIS Euphrates Basin Case. *Scientific Papers-Series E-Land Reclamation Earth Observation Surveying Environmental Engineering, 6*(1), 57-64.

Yürük, F., Erdoğmuş, P., (2015). Bıogas Potentıal of Düzce Whıch Can Be Produced by Animal Waste and Determination of Optimum Plant Location With K-Means Clustering. *Fen Bilimleri Enstitüsü, İleri Teknoloji Bilimleri Dergisi 4*(1), 47-56 (in Turkish).

Zan Sancak, A., Sancak, K., Demirtaş, M., Dönmez, D., Kalanlar, Ş., Arslan, S. (2014). *The Biogas Production Potential Produced From Bovine Animal Waste in Turkey*. 11. Tarım Ekonomisi Kongresi, 3-5 Eylül, Samsun (in Turkish).