Black Sea Journal of Agriculture
doi: 10.47115/bsagriculture.1374533

Open Access Journal
e-ISSN: 2618 – 6578

Research Article
Volume 6 - Issue 6: 694-699 / November 2023

EVALUATION OF PLANT RESIDUES: SAMSUN PROVINCE

Cihat GEDİK[1], Gürkan Alp Kağan GÜRDİL[1]*, Bahadır DEMİREL[2]

[1]*Ondokuz Mayıs University, Faculty of Agriculture, Department of Agricultural Machineries and Technologies Engineering, 55139, Samsun, Türkiye*
[2]*Erciyes University, Faculty of Agriculture, Department of Biosystems Engineering, 38030, Kayseri, Türkiye*

Abstract: This study was carried out to determine the biomass potential, energy value, bio-composting material and composting possibilities produced from plant and animal residues in Samsun. Samsun is a province of Türkiye in the Black Sea region. Samsun province has 17 districts. Residue amounts of agricultural products grown in Samsun were calculated using the Turkish Statistical Institute (TUIK) 2021 and year product production data, Türkiye Biomass Energy Potential Atlas (BEPA) 2021 biomass data. The total amount of agricultural waste is approximately 877.812 tons wheat 254.154 tons, paddy 132,891 tons, maize 53.861 tons and oat 47.797 tons in cereals in fruits, hazelnut is 66.363 tons and peach is 125.065 tons. Total heating value was found as 5.439.003 GJ. Hazelnut was the highest contributor to this value with 27% as fruit for cereals, it was maize with 17.14%. The energy equivalents of the biomass amounts are respectively; 37.34% hazelnut, 24% paddy, 10% wheat, 17.4% maize and 11.26% other plants were found.

Keywords: Biomass, Sustainably energy, Agricultural residues, Bio-composite

***Corresponding author:** Ondokuz Mayıs University, Faculty of Agriculture, Department of Agricultural Machineries and Technologies Engineering, 55139, Samsun, Türkiye
E mail: ggurdil@omu.edu.tr (G. A. K. GÜRDİL)
Cihat GEDİK https://orcid.org/0000-0003-4955-2220
Gürkan Alp Kağan GÜRDİL https://orcid.org/0000-0001-7764-3977
Bahadır DEMİREL https://orcid.org/0000-0002-2650-1167

Received: October 11, 2023
Accepted: October 29, 2023
Published: November 01, 2023

Cite as: Gedik C, Gürdil GAK, Demirel B. 2023. Evaluation of plant residues: Samsun province. BSJ Agri, 6(6): 694-699.

1. Introduction

With the increase in the human population, the demand for energy sources is increasing. The main energy sources can be listed as oil, natural gas and coal. As it is known, natural energy sources cause global climate change and consequently an increase in greenhouse gas emissions. In addition, it is known that natural energy resources are starting to decrease day by day. In summary, the use of natural energy sources has increased climate change and CO2 emissions in the world, and economic solutions have begun to be sought for the energy need, which is the lifeblood of the country's economies. In order to get rid of these negative situations, the importance of renewable energy sources has increased day by day (Pirlogea and Cicea, 2012; Shilev et al., 2007).

Türkiye is a developing country with rich biomass potential. Due to the scarcity of natural energy resources, the tendency to biomass energy, which is also among alternative energy sources, is increasing day by day (Baran et al., 2017; Lüle, 2019).

In this study, a research was carried out on the conversion of plant and animal residues to energy, bio-compost and bio-composite material possibilities in Samsun, which is located in the Black Sea Region of Türkiye.

2. Material and Methods

Samsun province in Türkiye has located between 41° 20' 1" E longitudes and covering 9,352 km² areas. Samsun Province is a province of Türkiye on the Middle Black Sea coast. Samsun province is divied into 17 districts, four of which (Ilkadım, Canik, Atakum, Tekkeköy, Asarcık, Kavak and Yakakent) are inculded in the municipality of Samsun city (Center). Other districts include Alacam, Ayvacik, Bafra, Carsamba, Havza, Ladik, Ondokuzmayis, Salipazari, Terme and Vezirkopru.

2.1. Energy Equivalents of Agricultural Residue

The amounts of residues from the crops cultivated in Samsun province were calculated using production data of crops with Turkish Statistical Institute for the 2021 seasonal years. The annual gross potential of agricultural residues was determined by using residues to product ratio (RPR). The available of the agricultural residues in Samsun province was calculated based on the equation 1 (Karaca et al., 2017).

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

Where (AAR)i is the available amount of agricultural residues of i'th crop in tons, (AAP)i the amount of agricultural product in tons or number of tree or planting area for pruning residues, (RPR)i residue-to product ratio of the i'th crop and (A)i the availability of residues.

The energy potential of residues for each district was calculated by multiplication of the heating values of a

selection of agricultural residues which was taken heating value per each residue (Table 1) with the available residue amount (equation 2).

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

Where; (THV)i the total heating value of agricultural residues of i'th crop in GJ, (AAR)i is the available amount of agricultural residues of i'th crop in tons and (LHV)i lower heating value of air dry residues of i'th crop in $MJkg^{-1}$.

Table 1. The ratio of product to residue, availability, heating value and ash of selected agricultural residues (Karaca et al, 2017)

Field Crops	Residues	Ratio of Product to Residuce (RPR)	Availability (A) (%)	Heating Value (LHV)	Ash (%)	Referans
Wheat	Straw	0.8	15	17.9	4.91	(Mijailovic et al, 2014)
Barley	Straw	0.9	15	17.5	2.71	(Gümüs and Bayır, 2020)
Rye	Straw	1.5	15	17.5	5.7	(Wang et al, 2014)
Oats	Straw	1.5	15	17.4	3.25	(Gümüs and Bayır, 2020)
Maize	Stalks	1	60	18.5	6.49	(Mijailovic et al, 2014)
	Cob	0.64	60	18.4	3.83	(Mijailovic et al, 2014)
Paddy(rice)	Straw	0.7	60	16.7	14.65	(El-Sayed, 2006)
	Husks	0.27	80	13	22.15	(El-Sayed, 2006)
Tobacco	Stalks	1100*	60	16.1	8.6	(Wu et al, 2019)
Sunflower	Stalks	0.6	60	14.2	4.06	(Demirbas, 2002)
Soybeans	Straw	0.75	60	19.4	5.86	(Liu et al, 2015)
Cannabis	Stems and Leaves	2.50	-	26.7	14.36	(Nakkliang et al, 2022)
Fruit Crops						
Hazelnut	Shell	0.3	80	19.3	1.36	(Demirbas, 2002)
	Husks	0.3	80	16	1.16	(Demirbas, 2002)
	Pruning	1500*	80	18.8	-	
Walnut	Pruning	13.00**	50	19	-	
Almonds	Pruning	7.40**	80	18.4	-	
Peach	Pruning	8.00**	80	18	-	
Kiwi	Pruning	8.00**	80	18	-	
Vineyard	Pruning	6.00*	80	18	-	

*Per planting area ($kg.ha^{-1}$), **Per number of trees ($kg.tree^{-1}$)

2.2. Evaluation of Agricultural Residues as Bio-Compost

Compost is defined as the conversion of different organic materials into biodegradable, stabilized and mineralized humus under suitable conditions (Uygun, 2012). It is widely used to change the elemental composition during composting and the C:N ratio is one of the main factors affecting this process. Because carbon and nitrogen elements are two essential nutrients required for the growth of microorganisms involved in the composting process (Ravindran et al., 2014). It has been determined that the C:N ratio in compost mixtures is generally between 20-50 (Wu et al., 2014).

2.3. Possibilities of Agricultural Residues to Produce Bio-Composite Materials

Today, in green chemistry, the use of sustainable and biodegradable biopolymers has increased due to the environmental risks posed by conventional petroleum-based polymers. Biopolymers can be produced from renewable resources, including agriculture, microbial resources and biomass. In addition, toxic or dangerous substances are not released during the degradation of biopolymers. Therefore, there are many studies focusing on the replacement of petroleum-based polymers with biopolymers.

Boonmee et al., in their study in 2016, found that a bio-composite material made from PLA (polylactic acid) can degrade 90% when it is under the ground for 90 days. Considering the physical properties of PLA, its important advantages include its strong sealing properties, low temperature adhesion, heat sealing on paper or cardboard, stability, transparency, thermoplastic and easy processing.

3. Results and Discussion

3.1 Energy Equivalent Results of Agricultural Residues

The energy equivalents of agricultural residues in Samsun and the usable amounts of agricultural residues are given in Table 2. According to the table, the amount of

plant residues that can be used in Samsun province and its districts are respectively; 35.3% hazelnut, 26.92% paddy, 9.72% wheat, 16.35% maize, 4.68% sunflower and 7.03% other plants. The energy equivalents of the residue amounts are respectively; 37.34% hazelnut, 24% paddy, 10% wheat, 17.4% maize and 11.26% other plants.

The amount of vegetable residue belonging to Samsun province and its districts is given in Table 3. Looking at Table 3, the highest amount of annual plants is seen in Bafra, Vezirköprü and Havza, respectively. The highest amount of residues from fruit trees is from Çarşamba, Terme and Salipazarı towns, respectively.

Table 2. The amount of agricultural product, available residues and Total heating value of residues in Samsun Province

Field Crops	Amount of Agricultural Product in tons or Planting Area (AAP) (tons) or (ha)	Residues	Available Residues (AAR) (tons)	Percentage Distribution (AAR) (%)	Total heating Value (THV) (GJ)	Percentage Distribution (THV) (%)
Wheat	254.154	Straw	30.498,50	9.72	545.923.15	10.04
Barley	16.955	Straw	2.289	0.73	40.057.5	0.74
Rye	651	Straw	146,4	0.05	2.562	0.05
Oats	47.797	Straw	10.754	3.43	187.119.6	3.44
Maize	53.861	Stalks	28.678	9.14	530.543	9.75
		Cob	22.621,60	7.21	416.237.44	7.65
Paddy	132.891	Straw	55.814	17.78	932.093.8	17.14
		Husk	28.704,50	9.14	373.158.5	6.86
Tobacco	6.897	Stalks	4.552	1.45	73.287.2	1.35
Sunflower	40.806	Stalks	14.690	4.68	208.598	3.84
Soybeans	7.714	Straw	3.471	1.11	67.337.4	1.24
Fruits Crops						
Hazelnut	66.363	Shell	15.927	5.07	30.7391.1	5.65
		Husks	15.927	5.07	254.832	4.69
	116.714,3*	Pruning	78.972	25.16	1.484.673.6	27.30
Walnut	2.903	Pruning	18,9	0.01	359.1	0.01
Peach	125.065	Pruning	791,6	0.25	14.248.8	0.26
Kiwi	5.041	Pruning	32,3	0.01	581.4	0.01
Total	877.812,30	-	313.887,80	100	5.439.003,59	100

*Per planting area ($kg.ha^{-1}$)

Table 3. The amount of agricultural residues in district of Samsun

District	Crops Residues (tons)	Fruit Crops Residues (tons)	Total Residues (tons)
Alacam	39.608	350	389.608
Ayvacik	3.196	13.431	16.627
Bafra	219.618	3.33	222.948
Carsamba	30.243	69.212	99.455
Center	66.781	20.334	87.115
Havza	91.246	32	123.246
Ladik	34.338	77	111.338
Ondokuz Mayıs	12.668	4.135	16.803
Salipazari	129	21.161	150.161
Terme	29.332	41.254	70.586
Vezirkopru	109.826	395	504.826
Total	765.856	1.026.857	1.792.713

3.2. Composting

In general, it is possible to make a higher quality compost by reducing the C:N ratio of organic materials for composting (Tripetchkul, et al., 2012; Balasubramani and Mnkeni, 2016). In Table.4, the C:N ratios of vegetable and animal residues in Samsun province and its districts are given. The agricultural residues with the lowest C:N ratio were oats (straw), chicken (manure), tobacco (stalks)

and sheep (manure), respectively. Hazelnut husk agricultural residue combined with animal manure could be a promising source for composting since hazelnut production is very common in Samsun region and Türkiye is the largest producer of hazelnut on all over the world.

3.3. Bio-composite Material

PLA, a renewable polymer that can be produced from plant sources of corn, potato, molasses, tapioca, sugarcane and rice, is biodegradable and biocompatible (Gupta et al., 2007). Cellulose nanocrystals are one of the most attractive natural fillers for developing all-green nanocomposites due to their high specific surface area, high aspect ratio, high modulus, biocompatibility, non-toxicity and low density (Mariano et al., 2014).

According to the results of this research, the vegetable residue amount of wheat, corn and rice plants to be produced from PLA for the potential of plant residue bio-composite materials in Samsun province is 517 tons in total.

It is seen that PLA packaging is used in products such as beverage glasses, fresh pasta, bread and salad bags, thermoform containers for bakery products, agricultural covers and boxes (Cha and Chinnan, 2004). In addition, PLA materials are preferred because they do not steam in bread and bakery products (Ayhan, 2012). In addition, Almenar et al., (2008) stated that the shelf life of strawberries packed with packaging material produced from PLA extends.

In the light of the information received from the Cannabis Research Institute in Samsun Ondokuz Mayıs University, 250 tons of cannabis stem products were obtained for 2020. Approximately 60 tons of hemp fiber was obtained from the hemp stem produced. In addition, 1250 kg of cannabis seeds were produced. The oil content and caloric values of the produced seed are respectively; It is 35% and 3400 cal (Acar and Dönmez, 2019). Concerning the agricultural product pattern of Samsun region the products like rice, maize, hemp and hazelnut are compromising sources of PLA and good potentials for bio-composites.

Tablo 4. C:N ratios of agricultural residues in Samsun region

Field Crops	Residues	Ratetion of C:N	Referans
Rye	Straw	114.12	(Gümüs and Bayır, 2020)
Oat	Straw	12.3	(Solowiej et al, 2017)
Maize	Stalks	67.13	(Gümüs and Bayır, 2020)
	Cob	34.97	(Gümüs and Bayır, 2020)
Paddy (rice)	Straw	113.95	(Gümüs and Bayır, 2020)
	Husks	73.15	(Liou and Wu, 2009)
Tobacco	Stalks	19.7	(Kopcic et al, 2014)
Sunflower	Stalks	23.25	(Gümüs and Bayır, 2020)
Soybeans	Straw		
Fruit Crops			
Hazelnut	Shell	32.25	(Demirbas, 2002)
	Husks	39.23	(Demirbas, 2002)
Animal			
Chicken	Manure	14.41	(Ravindran and Mnkeni, 2016)
Cattle	Manure	19.72	(Suthar, 2008)
Sheep	Manure	17.07	(Tabrika et al, 2019)
Goat	Manure	17.97	(Zhang et al, 2013)

4. Conclusion

Since Türkiye is a foreign-dependent country in terms of energy, it is important to search for alternative energy sources. In addition, bio-composite materials and compost produced from plant residues are gaining more importance day by day in terms of environmental friendliness and sustainability. The amounts of plant and animal residue belonging to Samsun province and its districts are given in tables.

Among the main products grown in Samsun, products such as hazelnut, paddy and wheat have high heat value and the amount of product is higher than other products, it is important in terms of biomass use.

Total biomass, renewable energy, bio-composite materials and compost production in Samsun province have great potential. However, this potential needs to be adequately evaluated. According to the results of the study, it was concluded that the high potential of plant residue in Samsun is important in terms of bioenergy, bio-composite materials and composting.

Author Contributions

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

	C.G.	G.A.K.G.	B.D.
C	52	25	50
D	60	20	20
S		100	
DCP			100
DAI	50	30	20
L	50	25	25
W		50	50
CR		50	50
SR	10	60	30
PM	20	50	30
FA	20	50	30

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 authors 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

Acar M, Dönmez A. 2019. Kenevire farklı bir bakış. Karadeniz Tarımsal Araştırma Enstitüsü Yayınları, Samsun, Türkiye, ss: 1-5.

Almenar E, Samsudin H, Auras R, Harte B, Rubino M. 2008. Postharvest shelf-life extension of blueberries using a biodegradable package. Food Chem, 110(1): 120-127.

Ayhan Z. 2012. Gıda mühendisliğinde ısıl olmayan teknolojiler. In: Baysal T, İçier F, editors. Gıda mühendisliğinde ısıl olmayan teknolojiler, Nobel Yayınları, İstanbul, Türkiye, ss: 43-77.

Balasubramani R, Mnkeni P. 2016. Identification and fate of antibiotic residue degradation during composting and vermicomposting of chicken manure. Inter J Environ Sci Technol, 14: 263–270.

Baran MF, Lüle F, Gökdoğan O, 2017. Adıyaman ilinin hayvansal atıklardan elde edilebilecek enerji potansiyeli. Türk Tarım Doğa Bilim Derg, 4(3): 245-249.

Boonmee C, Kositanont C, Leejarkpai, T. 2016. Degradation of poly (lactic acid) under simulated landfill conditions. Environ Nat Res J, 14(2): 1–9.

Cha DS, Chinnan MS. 2004. Biopolymer-based antimicrobial packaging: A review. Critical Rev Food Sci Nutr, 44(4): 223-237.

Demirbas A. 2002. Relationships between heating value and lignin, moisture, ash and extractive contents of biomass fuels. Energy Explorat Exploit, 20(1): 105-111.

El-Sayed MA. 2006. Physical and chemical properties of rice straw ash and its effect on the cement paste produced from different cement types. J King Saud Univ, 19: 21-30.

Gupta JJ, Doley S, Bujarbaruah KM. 2007. Evaluation of forage based feeding system for rabbit production in northeastern region of India. Indian J Anim Nutr, 24 (4): 216-218.

Gümüs H, Bayır AH. 2020. Hasılmatikte üretilen arpa ve yulaf yeşil hasılının farklı günlerdeki besin madde değerleri. MAKU J Health Sci Inst, 8(2): 30-36.

Karaca G, Gurdil AK, Ozturk H. 2017. The Biomass Energy from Agricultural Production in the Black Sea Region of Turkey. 3. Inter Conference on Environmental Sci Technol. 184-189.

Kopcic N, Domanovac MV, Kucic D, Briski F. 2014. Evaluation of laboratory-scale in-vessel co-composting of tobacco and apple waste. Waste Manage, 34 (2): 323-328.

Liou T, Wu S. 2009. Characteristics of microporous/mesoporous carbons prepared from rice husk under base- and acid-treated conditions. J Hazardous Mater, 171(1–3): 693-703.

Liu Z, Wang Z, Cao Y, Ren H. 2015. The utilization of soybean straw. I. fiber morphology and chemical characteristics. BioResources, 10 (2): 2266-2280.

Lüle F. 2019. Güneydoğu Anadolu bölgesinin hayvansal atıklardan elde edilebilecek enerji potansiyeli. ÇOMÜ Zir Fak Derg, 7(1): 145-150.

Mariano M, El Kissi N, Dufresne A. 2014. Cellulose nanocrystals and related nanocomposites: Review of some properties and challenges. J Polymer Sci Part B-Polymer Phys, 52: 791-806.

Mijallovic I, Radojicic V, Ecim-djuric O, Stefanovic G, Kulic G. 2014. Energy potential of tobacco stalks in briquettes and pellets production. J Environ Protect Ecol, 15(3): 1034–1041.

Nakkliang K, Areesantichai C, Rungsihirunrat K. 2022. Assessment of pharmacognostic specification of Cannabis sativa leaves in Thailand. J Adv Pharm Technol Res, 13: 226-231.

Pirlogea C, Cicea C. 2012. Econometric perspective of the energy consumption and economic growth relation in European Union Renew. Sustain Energy Rev, 16: 5718-5726.

Ravindran B, Contreras-Ramos SM, Wong JWC, Selvam A, Sekaran G. 2014. Nutrient and enzymatic changes of hydrolysed tannery solid waste treated with epigeic earthworm Eudrilus eugeniae and phytotoxicity assessment on selected commercial crops. Environ Sci Pollut Res, 21(1): 641–651.

Shilev S, Naydenov M, Vancheva V, Aladjadjiyan A. 2007. Composting of food and agricultural wastes. In: Oreopoulou V, Russ W, editors. Utilization of By-Products and Treatment of Wastes in the Food Industry. Springer, London, UK, pp: 283-301.

Solowieja P, Neugebauera MJ, Dachb Czekałab W, Janczak D. 2017. The influence of substrate C:N ratios on heat generation during the composting process of sewage sludge. Inter J Smart Grid Clean Ener, 6 (1): 61-66.

Suthar S. 2008. Bioconversion of postharvest crop residues and cattle shed manure into value-added products using earthworm Eudrilus eugeniae Kinberg. Ecol Engin, 32(3): 206-214.

Tabrika K, Azim Mayad EH, Zaafrani, M 2019. Composting of tomato plant residues: improvement of composting process and compost quality by integration of sheep manure. Organic Agri, 10: 229–242.

Tripetchkul S, Pundee K, Koonsrisuk S, Akeprathumchai S, 2012. Co-composting of coir pith and cow manure: initial C/N ratio vs physico-chemical changes. Inter J Recycling Organic Waste Agri, 1(15): 2-8.

Uygun S, 2012. Evaluation of the mechanization applications in some compost production facilities in Turkey. MSc. Thesis, Institute of Sciece, Ankara University, Ankara, Türkiye, pp: 87.

Wang L, Skreiberg Q, Becida M, Li H. 2014. Sintering of rye straw ash and effect of additives. Energy Procedia, 61: 2008-2011.

Wu C, Luo Fan X, Wang W, Wen Y. 2019. Evaluation of the potential of tobacco stalk pulp to substitute hardwood pulp for tobacco sheet preparation. Cellulose Chem Technol, 53(9-10): 1009-1015.

Wu TY, Lim SL, Lim PN, Shak KPY. 2014. Biotransformation of biodegradable solid wastes into organic fertilizers using composting or/and Vermicomposting. Chem Eng Trans, 39: 1579–1584.

Zhang T, Liu L, Song Z, Ren G, Feng Y, Han X, Yang G. 2013. Biogas production by co-digestion of goat manure with three crop residues. PLoS One, 8(6): e66845.