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Research
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Determination of chemical compositions of two different Jute (*Corchorus capsularis*, *Corchorus olitorius*) species grown in Türkiye's ecological conditions via GC-MS technique*

Zeynep ÜRÜŞAN[1,2], Hasan ER[3,4], Ali SİNAN[2,3], Ramazan MERAL[5], Serhat KOÇYİĞİT[2,6]

[1]Bingöl University, Central Laboratory Application and Research Center, Bingöl, Türkiye
[2]Bingöl University, Rectorate, Bingöl, Türkiye
[3]Bingöl University, Bee and Natural Products R&D and P&D Application and Research Center, Bingöl, Türkiye
[4]Bingöl University, Faculty of Agriculture, Department of Biosystem Engineering, Bingöl, Türkiye
[5]Bilecik Şeyh Edebali University, Faculty of Agriculture and Natural Sciences, Department of Biosystem Engineering, Bilecik, Türkiye
[6]Bingöl University, Project Coordination Application and Research Center, Bingöl, Türkiye

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Sorumlu yazar: Zeynep ÜRÜŞAN, e-posta: zurusan@bingol.edu.tr

Abstract

Objective: In this study, it is aimed to introduce a new plant to Turkish agriculture and to determine its chemical composition by revealing can also be grown in Türkiye's ecological conditions of the Jute plant, which stands out with the use of fibers in the industrial field and the use of leaves as a food product.

Materials and Methods: The seeds used in the research were obtained from the Şanlıurfa Southeastern Anatolia Project Agricultural Research Institute. The trial was carried out in 2019 in the trial area of Bingöl University Agricultural Application and Research Center for the production of two different Jute (*Corchorus capsularis, Corchorus olitorius*) species. The drip irrigation method was used in the experiment. Water coming from the irrigation canal was applied with drip irrigation pipes with diameter as 16 mm pressure adjustment, exiting from pipes with a diameter of 75 mm. Some physical and chemical properties of the soil of the trial area were determined as a result of the analysis of the samples taken from the parcel. In the study, the extraction method created by the Bingöl University Central Laboratory Application and Research Center by revising the method of Hara and Radin (1978) was used and the chemical compositions of the leaves and stems of both species were analyzed by Gas Chromatography-Mass Spectrometry (GC-MS).

Results: According to GC-MS results, a total of 18 and 20 components were detected in the leaf parts of *Corchorus olitorius* and *Corchorus capsularis* species, respectively, and a total of 11 and 29 components (hydrocarbons, fatty acid methyl esters, essential fatty acids, phenolic/aromatic compounds) were also detected in the stem parts of these species, respectively.

Conclusion: It is of great importance to bring this plant bearing value in terms of crop fiber industry, nutrition and medicine, in our country and to increase the studies to be carried out in Türkiye. The results of this study we have done, will present the ground for future studies on the Jute plant in the similar regions of our country.

Keywords: Jute; Chemical compositions; Fiber crop

Türkiye ekolojik koşullarında damla sulama sistemi ile yetiştirilen iki farklı jüt (*Corchorus capsularis*, *Corchorus olitorius*) türünün kimyasal bileşimlerinin GC-MS tekniği ile belirlenmesi

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Öz

Amaç: Bu çalışmada özellikle endüstriyel alanda liflerinin kullanımı ve gıda ürünü olarak yapraklarının kullanımı ile ön plana çıkmakta olan jüt bitkisinin Türkiye ekolojik koşullarında da yetiştirilebileceğini ortaya koyarak Türk tarımına yeni bir bitkinin kazandırılması ve kimyasal kompozisyonunun belirlenmesi amaçlanmıştır.

Materyal ve Yöntem: Araştırmada kullanılan tohumlar, Şanlıurfa Güneydoğu Anadolu Projesi Tarımsal Araştırma Enstitüsü Müdürlüğünden temin edilmiştir. Deneme 2019 yılında Bingöl Üniversitesi Tarımsal Uygulama ve Araştırma Merkezine ait deneme alanında iki farklı Jüt (*Corchorus capsularis, Corchorus olitorius*) türünün üretimi amacıyla yürütülmüştür. Denemede damla sulama yöntemi kullanılmıştır. Sulama kanalından gelen su 75 mm çapında borulardan çıkış yapan, 16 mm çapında basınç ayarlı damlatıcı sulama boruları ile uygulanmıştır. Deneme alanı toprağının bazı fiziksel ve kimyasal özellikleri parselden alınan örneklerin analizi sonucunda belirlenmiştir. Çalışmada Bingöl Üniversitesi Merkezi Laboratuvar Uygulama ve Araştırma Merkezi tarafından Hara ve Radin (1978) metodu revize edilerek oluşturulan ekstraksiyon metodu kullanılmış olup her iki türde de yaprak ve gövdelerin kimyasal bileşimleri Gaz Kromatografisi-Kütle Spektrometresi (GC-MS) ile analiz edilmiştir.

Araştırma Bulguları: GC-MS sonuçlarına göre *Corchorus olitorius* ve *Corchorus capsularis* türlerinin yaprak kısımlarında sırasıyla toplam 18 ve 20 bileşen, gövdelerinde de sırasıyla toplam 11 ve 29 bileşen tespit edilmiştir.

Sonuç: Beslenme ve tıbbi açıdan önemli olan bu bitkinin ülkemize kazandırılması ve ülkemizde yapılacak olan çalışmaların artırılması büyük önem arz etmektedir. Yapılmış olan bu çalışma, ülkemizde jüt bitkisi üzerine yapılacak olan diğer çalışmalara zemin hazırlayacaktır.

Anahtar Kelimeler: Jüt, Kimyasal kompozisyon, Lif bitkisi

Introduction

Medicinal plants have been considered important throughout human history. People used medicinal plants to meet their basic needs such as nutrition, shelter, clothing and treatment. Because the side effects of medicinal plants in the world are not too many and they are safe and not containing harmful chemicals in general, the demand for medicinal plants is increasing day by day (Islam, 2013).

In recent years, Jute (*Corchorus sp*.) has been widely used in many industries such as cosmetics, perfumery, food and medicine. Jute, which is the material of our study, is considered both as a fiber plant and a medicinal plant. Jute plant belongs to the Tiliacea (Linden) family and is of the genus Corchorus. This plant, which adapts to the tropical and subtropical seasons, has a length of 2 to 4 meters and a woody structure. It is produced mainly in the Asian continent (Furumoto et al., 2002; Bilgili et al., 2018).

Jute leaves are used as a food source in parts of Asia, the Middle East and Africa. In addition to being consumed as a spice to add flavor to dishes, Jute is also made in products such as soups and sauces. In Cyprus, a special dish called Molehiya is made with dried leaves (Calleja, 2010).

Jute fiber is mainly produced from two important types as White Jute (*Corchorus capsularis* L.) and Tossa Jute (*Crochorus olitorius* L.). Desirable outcomes of a good irrigation management in Jute cultivation include; increased yield, improved crop quality, controlled time of planting and harvesting, reduced damage by control high air temperature, increased efficiency of fertilizers and a increased farm income from jut cultivation. On the other hand, the excess water in the Jute fields, following problems arise: reduced growth of Jute plants, increased incidence of diseases and pests, increased toxicity of undesired elements, increased alkalinity and salinity of the soil, poor development of root system and reduced growth of beneficial mocroorganism (Dilip, 2016). Generally, drip irrigation method is preferred as irrigation water method while growing Jute plants. The basic principle in drip irrigation method is to apply low pressure and amounts of irrigation water in drops to the plant root area. Given water to the soil surface is infiltrated from here and enters into the soil. Then, the effect of gravity and capillarity forces disperses and wet the plant root area. In this method, the water needs of the plant were met with irrigations made at intervals of a couple days. Jute fibers are used in the world and in our country as sack, rope, rope, paper, carpet and rug manufacturing, handicraft, wall cover, pharmaceutical industry and packaging material. In addition, in some developed countries, highly absorbent Jute fibers are used in surgical dressings (Al-Snafi, 2016).

Phytochemical screening of *Corchorus capsularis* leaves showed the presence of flavonoids, saponins, tannins, steroids and triterpenes. It is also rich in vitamins, carotenoids, calcium, potassium and dietary fiber. *C. capsularis* leaves contain two functional compounds; phytol (3,7,11,15 tetramethyl-2 hexadecen-1-ol) and monogalactosylacylglycerol (1,2-di-O-α-linolenoyl 3--D-galactopyranosyl glycerol). C*. capsularis* also contains capsin, a glycoside that gives its leaves a bitter taste (Zainul et al., 2007; Islam, 2013).

Phytochemical screening of *Corchorus olitorius* leaves showed the presence of flavonoids, saponins, tannins, steroids, terpenes, alkaloids, glycosides and phenolic compounds. While *Corchorus olitorius* leaves had higher protein amount, it was determined that crude oil ratio was higher in stem and fruit parts. In general, it has been observed that the analyzed leaves of *Corchorus olitorus* have higher mineral values than fruits and stems (Ndlovu and Afolayan, 2008). As a result of the GC-MS analysis, 3 Methyl-1-penten-4-yn-3-ol, 2,4-Decadienal and Ethanone, 1- (2,2-dimethylcyclo pentyl) were the compounds with the highest ratios for *Corchorus olitorus* (Orieke et al., 2018).

In this study, it was aimed to determine chemical composition in Jute and to bring it as a new plant to Turkish agriculture by putting forward that it can be grown in Türkiye's ecological conditions of Jute plant whose are especially used in the industrial and nutrition fields.

Materials and methods

Plant material

The Jute seeds used in the study were obtained from the Şanlıurfa GAP Agricultural Research Institute. The experiment was conducted in 2019 in the experimental area of Bingöl University Agricultural Application and Research Center for the production of Jute (*Corchorus capsularis, Corchorus olitorius*) species. The trial consists of 2 production parcels of 4x3.5 m length and it is planned to have 8 rows in each parcel. After a deep ploughing in the autumn, the trial area was plowed superficially in the spring and made ready for planting by pulling the disc harrow and rake. Sowing was done by hand as row sowing. Plant density is set as 0.5x0.10 m. Trial parcels were divided into 3 parts, namely the beginning, middle and end of the parcel, and a repetition of the trial was created. After the plants are 10 cm tall, Nitrogen fertilization was applied calculating 12 kg/da urea. The irrigation water used in the experiment was taken from the irrigation canal located close to the trial parcel. Drip irrigation method was used in the experiment. The water coming from the irrigation canal was applied by drip irrigation pipes with 16 mm pressure setting that exit from 75 mm diameter pipes. Each parcel has a 0.30 m dripper and 4 rows of lateral pipes with a row spacing of 0.50 m and a flow rate of 3.46 l/h. For weed control, two hoeing operations were carried out during the production season. All experiments were performed in triplicates and the data obtained from experiments were presented as mean values.

Climate and soil properties of the trial site

Although Bingöl has a harsh continental climate, the temperature can reach up to +39 °C in summer. The province, which is dry and hot in summer, receives abundant rainfall in spring, autumn and winter. The annual average rainfall can exceed 900 mm. The climate data of Bingöl province for the years 1961-2019 are given in Table 1. Average temperature in Bingöl is 12.1 °C. The coldest month is January with -2.4 °C and the hottest month is July with 26.6 °C. The annual precipitation amount is 949.1 mm, the maximum precipitation is 139.6 mm in January, and the least precipitation falls in August with 4.3 mm. The annual average relative humidity in Bingöl province is 45.6% (Avcı et al., 2018). The physical and chemical properties of the trial area soil are given in Table 2.

Oil extraction and preparation of fatty acid methyl esters (FAME)

In the study, the extraction method created by the Bingöl University Central Laboratory Application and Research Center by revising the Hara and Radin, (1978) method was used. 1 g plant sample was weighed, 5 ml hexane / isopropanol (3:2) added and vortexed. It was centrifuged at 4500 rpm, centrifuged 10 minutes, the supernatant was removed and filtered and transferred to test tubes. 2.5 ml of 2% (v/v) methanolic sulfuric acid was added and vortexed. This mixture was allowed to be methylated at 50 °C for 15 hours. At the end of 15 hours, the tubes were taken out and cooled down to room temperature, 2.5 ml of 5% (w/v) NaCl was added and vortexed. Fatty acid methyl esters formed in tubes were extracted with 2.5 ml hexane. The hexane phase was taken from the top with a passor pipette and treated with 2.5 ml of 2% Na2CO3 (w/v) and the supernatant was taken and placed in the test tubes and the mixture containing methyl esters was

evaporated under nitrogen at 45 °C. Fatty acids in the test tubes were dissolved with 1 ml of hexane and put into vials and made ready for analysis.

GC-MS analys conditions

In the analysis, BPX90 column (100m x 250 µm x 0.25 µm) and Agilent brand 7890A model GC, 5975C model MS and FID detector were used simultaneously. Helium (He) was used as carrier gas in GC-MS analysis and the flow rate was determined as 1 mL / min. Starting from 40 °C, the MS temperature reaches 150 °C at a rate of 4 °C / min and waits here for 5 minutes. Later, it reaches 255 °C at 4 °C / min and waits here for 10.5 minutes.

The total analysis time was set as 70 minutes. The injection volume is 1 µl and the splitless mode is selected. MS results were determined by comparing the Whiley and NIST libraries in the memory of the device.

Table 1. Climatic values of the study area

BİNGÖL	**MONTHS**												
	1	2	3	4	5	6	7	8	9	10	11	12	Yearly
Average Temperature (°C)	-2.4	-1.1	4.1	10.7	16.1	21.9	26.6	26.4	21.2	14.1	6.6	0.5	12.1
Average Highest Temperature (°C)	2.1	3.7	9.4	16.5	22.8	29.3	34.5	34.6	29.7	21.5	12.5	5.0	18.5
Average Lowest Temperature (°C)	-5.9	-5.0	-0.1	5.7	10.1	14.7	18.9	18.6	13.5	8.2	2.1	-2.8	6.5
Average Sunshine Time(Hour)	3.3	4.4	4.9	5.5	7.0	9.1	9.4	9.0	8.1	6.0	4.4	3.1	74.2
Average Number of Rainy Days	12.9	12.4	13.9	15.1	13.9	5.5	1.7	1.3	2.5	8.5	9.2	12.8	109.7
Total Monthly Precipitation (mm)	139.6	130.5	127.4	117.6	76.4	21.1	7.2	4.3	12.9	66.0	107.7	138.4	949.1
Highest Temperature	13.3	16.2	22.3	30.3	33.4	38.0	42.0	41.3	37.8	32.1	25.5	22.8	42.0
Lowest Temperature	-23.2	-21.6	-20.3	-9.2	1.0	3.5	8.8	7.8	4.2	-2.4	-15.0	-25.1	-25.1

The Highest Total Daily Precipitation Amount		**The Fastest Wind Daily**		**Highest Snow**	
03.01.2010	142.7 mm	02.05.2008	153.7 km/sa	07.02.1992	200.0 cm

Table 2. Physical and chemical properties of the soil of the trial area

Soil Depth (cm)	**Soil texture**	**Soil salinity (%)**	**Organic Matter (%)**	**Lime (%)**	**K_2O (kg/da)**	**P_2O_5 (kg/da)**	**pH**	**Field Capacity (%)**	**Wilting Point(%)**	**Bulk Density (gr/cm³)**
0-30	Loam	0.0315	1.905	0.36	24.51	7.9	6.57	18.63	9.44	1.37

Results and discussion

A determinative study was carried out in terms of chemical compositions on samples taken from the leaf and stem parts of *Corchorus olitorius* and *Corchorus capsularis* species. The compositions belonging to the leaf part are included in Table 3, while the components belonging to the stem part are included in Table 4.

Table 3. Leaf components of the *Corchorus olitorius* and *Corchorus capsularis* species

	Structure Type	***Corchorus olitorius***		***Corchorus capsularis***	
Name		**RT**	**Area (%)**	**RT**	**Area (%)**
Hexadecane		-	-	25.58	4.61
Octadecane		19.40	1.61	26.81	0.86
Undecane		-	-	19.46	1.08
Dodecane		-	-	19.42	1.08
Eicosane	Hydrocarbons	31.25	4.69	31.25	4.06
Docosane		29.35	3.89	37.03	3.35
Tricosane		25.58	2.94	30.52	0.77
Tetracosane		58.03	2.86	-	-
Pentacosane		56.83	0.23	52.96	2.70
Tetradecanoic acid (Myristic Acid)		38.72	1.49	38.72	1.07
Hexadecanoic acid (Palmitic acid)	Fatty Acid Methyl Esters (FAME)	43.86	23.45	43.87	26.11
Octadecanoic acid (Stearic acid)		48.70	16.42	48.70	17.01
Cis-9,12-ctadecadienoic acid (Linoleic acid)		50.14	7.03	50.12	6.16
alpha-9,12,15-octadecatrienoic acid (Linolenic acid)	Essential Fatty Acids	51.61	10.50	51.61	5.14
Phenol, 2,4-bis(1,1-dimethylethyl)		45.34	8.81	45.33	9.95
Methyl Ester of 3-(3,5-Dı-Tert-Butyl-4-Hydroxyphenyl)-Propionic Acid	Phenolic Compounds	53.77	2.71	53.76	1.89

According to GC-MS results, the components detected with an area of more than 1% were given in Table 3 and Table 4. The leaf part of *Corchorus olitorius* and *Corchorus capsularis* species were seen in Table 3, the stem part of *Corchorus olitorius* and *Corchorus capsularis* species were seen in Table 4. These results showed that a total of 13 components were detected in the leaf part of *Corchorus olitorius* species, while a total of 15 components were found in the leaf part of *Corchorus capsularis* species. The number of common components in the leaf for both species was determined as 12 in total. Hexadecanoic acid (23.45% -26.11%) was the component with the highest area of FAME in *Corchorus olitorius* and *Corchorus capsularis* leaves, respectively. The percent areas of total FAMEs were 41.36 and 44.19, total essential fatty acids were 17.53 and 11.30, total hydrocarbons were 16.22 and 18.51, total phenolic compounds were 11.52 and 11.84 in *Corchorus olitorius* and *Corchorus capsularis* leaves, respectively. These values were compared with literature values and the results showed that the ratio of total fatty acids, hydrocarbons and phenolic compounds was lower than the literature values (Islam, 2013; Hassan et al., 2019). Especially, the ratio of essential fatty acid was found as more than

the literature values (Islam, 2013; Hassan et al., 2019). Also, linoleic acid was determined as common in all studies, but linolenic acid was detected only in this study.

Considering the results obtained from the stem parts, a total of 9 chemical components were detected in the stem of *Corchorus olitorius* species, while 16 chemical components were detected in the stem of *Corchorus capsularis* species. While the fatty acid components with the highest area in *Corchorus olitorius* stems are hexadecanoic acid (23.89%) and octadecanoic acid (16.37%), the fatty acid components with the highest area in *Corchorus capsularis* stems are also hexadecanoic acid (20.37%) and octadecanoic acid (16.20%). The percent areas of total FAMEs were 40.26 and 36.57, total essential fatty acids were 0 and 4.52, total hydrocarbons were 26.77 and 18.05, total phenolic compounds were 6.82 and 16.12 in *Corchorus olitorius* and *Corchorus capsularis* stems, respectively.

Table 4. Stem components belonging to *Corchorus olitorius* and *Corchorus capsularis* species

		Corchorus olitorius		***Corchorus capsularis***	
Name	**Structure Type**	**RT**	**Area (%)**	**RT**	**Area (%)**
Tetradecane	Hydrocarbons	19.30	0.05	25.63	4.34
Octadecane		-	-	29.37	5.66
Undecane		25.59	2.67	19.46	1.62
Eicosane		25.54	2.69	32.50	0.64
Docosane		31.27	11.47	-	-
Tricosane		57.90	6.55	57.38	2.19
Tetracosane		53.73	3.34	54.14	3.60
Hexadecanoic acid (Palmitic acid)	Fatty Acid Methyl Esters (FAME)	43.84	23.89	43.85	20.37
Octadecanoic acid (Stearic acid)		48.66	16.37	47.68	16.20
Trans-9,12-octadecadienoic acid (Linoleic acid)	Essential Fatty Acids	-	-	50.13	3.03
alpha-9,12,15-octadecatrienoic acid (Linolenic acid)		-	-	51.60	1.49
Methyl Ester of 3-(3,5-Dı-Tert-Butyl-4Hydroxyphenyl) - Propionic Acid	Phenolic/Aromatic Compounds	-	-	53.76	2.92
Phenol, 2,5bis (1,1-dimethylethyl)		45.34	6.82	-	-
Phenol, 2,4-bis(1,1-dimethylethyl)		-	-	45.33	6.31
Benzoic-acid,4-chloro-,1-(4-ethoxyphenyl)hydrazide		-	-	62.92	1.32
4-Chloro-N-(4-Methoxyphenyl) Benzohydrazide		-	-	63.71	1.60
4,5.Alpha.-Epoxy-3-Methoxy-17-Methyl7.Alpha.-(4-Phenyl-1,3-Butadienyl)-6.Beta.,7.Beta.-(Oxymethylene) Morphinan		-	-	69.35	2.26
2-(((6-Fluoro-4H-1,3-benzodioxin-8yl)methyl)sulfanyl)-1H-benzimidazole		-	-	68.37	1.71

In the findings of the literature studies in Türkiye there is limited studies conducted on Jute are limited and it has not seen studies on volatile components.

However, looking at the studies on Jute around the world, it has been observed that the studies on fiber are more intense. Among the *Corchorus* species, it has been observed that there are more studies on *Corchorus olitorius* than studies on *Corchorus capsularis*. Hanan et al., (2017) examined the leaf and stem components of *Corchorus olitorius* species in their study.

In the results of the study, a total of 4 fatty acid components were detected in the leaves, while a total of 5 fatty acid components were detected in the stem. A parallelism was observed between the study and our study in terms of fatty acid components. Hassan et al., (2019), the chemical compositions of *Corchorus capsularis* and *Corchorus olitorius* species were examined.While some of the fatty acids (palmitic acid, stearic acid and linoleic acid) determined as a result of the study show parallels with our study. Similarly, in another study, Hasan and Kadhım, (2018) determined the components of the leaves and seeds of the *Corchorus olitorius* species and obtained similar results with our study

Conclusion

Corchorus capsularis and *Corchorus olitorius* species are known as medicinal plants besides being fiber plants. Particularly the leaf parts are used both as a vegetable and medicinally. Generally, Jute leaf contains more than 17 active nutritional compounds, including many minerals, vitamins and amino acids. In this study, hydrocarbons, fatty acid methyl esters, essential fatty acids, phenolic/aromatic compounds were determined as active nutritional compounds in *Corchorus capsularis* and *Corchorus olitorius* species.

It is of great importance to bring this plant, which is important in terms of nutrition and medicine, to our country and to increase the studies to be carried out in our country. The current study we have conducted will lay the groundwork for other studies on Jute plant specifically in our country.

Statement of Conflict of Interest

The authors declare that they have no conflict of interest.

Authors' Contributions

ZÜ, HE and RM, research design; ZÜ, HE, AS, RM and SK, data collection, evaluation of the article, conducting other studies. All authors have read and approved the last article.

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