KSÜ Tarım ve Doğa Derg 27 (1), 92-100, 2024
KSU J. Agric Nat 27 (1), 92-100, 2024
https://doi.org/10.18016/ksutarimdoga.vi.1180716

Anatomical Characterization, Antimicrobial and Antimutagenic Properties of *Turgenia latifolia* (L.) Hoffm. (Apiaceae)

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ABSTRACT

The anatomical definition, antimicrobial, and antimutagenic activity of *Turgenia latifolia* (L.) Hoffm. (Apiaceae) were investigated in this research. The root cortex region of the plant is quite narrow and the cambium has 3-4 layers. Epidermis contains non-glandular trichrome in stem and leaf. Numerous secretory channels and collenchyma cells were reported in the stem cortex. Cells of palisade parenchyma were present on both sides of the leaf. Cells of spongy parenchyma were reduced to a thin layer in the center of the mesophyll and had 1–2 layers. Stomata were anomocytic. The antibacterial and antifungal activities of the methanolic leaf extract of *T. latifolia* were investigated against some selected pathogenic gram (+) (*Micrococcus luteus*, *Bacillus cereus*, *Staphylococcus aureus*, *Staphylococcus epidermis*), gram (-) bacteria (*Klebsiella pneumonia*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Salmonella typhi*, *Proteus vulgaris*, *Enterobacter aerogenes*) and yeast (*Candida albicans*). The extract exhibited varying degrees of inhibitory effects on the growth of the different pathogenic strains. In addition, methanol leaf extract of *T. latifolia* (TLm) was analyzed for mutagenic activity. The results showed that TLm exhibited antimutagenic activity at concentrations of 10, 25 and 50 µL.

Botany

Research Article

Article History
Received : 28.09.2022
Accepted : 03.08.2023

Keywords
Anatomy
Antimicrobial activity
Antimutagenic activity
Pathogenic microorganism
Turgenia latifolia

Turgenia latifolia (L.) Hoffm'un (Apiaceae) Anatomik, Antimikrobiyal ve Antimutajenik Özellikleri

ÖZET

Bu araştırmada, *Turgenia latifolia* (L.) Hoffm'un anatomik, özellikleri, antimikrobiyal ve antimutajenik aktiviteleri araştırılmıştır.Bitkinin kök korteks bölgesi oldukça daralmış olup kambiyum 3-4 katmanlıdır. Gövde ve yaprak, epidermis örtü tüylerine sahiptir. Gövde korteksinde çok sayıda salgı kanalı ve kollenkima hücresi belirlenmiştir. Yaprağın her iki yüzeyi palizat parankiması hücreleri içerir. Sünger parankiması hücreleri, mezofilin merkezinde ince bir tabaka halinde olup ve 1-2 sıralıdır. Stomalar anomositiktir. *T. latifolia*'nın metanol yaprak ekstraktının antibakteriyal ve antifungal aktivitesi, Gram (+) (*Micrococcus luteus*, *Bacillus cereus*, *Staphylococcus aureus*, *Staphylococcus epidermis*) ve Gram (-) (*Klebsiella pneumonia*, *Pseudumonas aeroginosa*, *Escherichia coli*, *Salmonella typhi*, *Proteus vulgaris*, *Enterobacter aerogenes*) bakterilerine ve mayaya (*Candida albicans*) karşı araştırıldı. Ekstrakt, farklı patojenik suşların gelişmesi üzerinde değişen derecelerde inhibisyon etkisi göstermiştir. Ek olarak, *T. latifolia*'nın metanol yaprak ekstresinin (TLm) mutajenik aktivitesi analiz edildi. Sonuçlar, TLm'nin 10, 25 ve 50 uL'lik konsantrasyonlarının antimutajenik aktiviteye sahip olduğunu gösterdi

Botanik

Araştırma Makalesi

Makale Tarihçesi
Geliş Tarihi : 28.09.2022
Kabul Tarihi : 03.08.2023

Anahtar Kelimeler
Anatomi
Antimikrobiyal aktivite
Antimutajenik aktivite
Patojenik mikroorganizma
Turgenia latifolia

To Cite : Ulcay, S., Öğütcü, H., Çeker, S., & Ağar, G., (2023). Anatomical Characterization, Antimicrobial and Antimutagenic Properties of *Turgenia latifolia* (L.) Hoffm. (Apiaceae). *KSU J. Agric Nat 27*(1), 92-100. https://doi.org/10.18016/ksutarimdoga. vi. 1180716

Atıf Şekli: Ulcay, S., Öğütcü, H., Çeker, S., & Ağar, G., (2023). *Turgenia latifolia* (L.) Hoffm'un (Apiaceae) Anatomik, Antimikrobiyal ve Antimutajenik Özellikleri. *KSÜ Tarım ve Doğa Derg 27*(1), 92-100. https://doi.org/10.18016/ksutarimdoga. vi. 1180716

INTRODUCTION

Apiaceae (Umbelliferae) is an economically important family and is a large family that includes 300–462 genera and 2,500–3,750 species around the world (Cronquist & Takhtadzhian, 1981; Heywood, 1993; Pimenov & Leonov 1993). The Apiaceae family is the eighth largest family in Türkiye and 451 species are represented (Davis, 1972). Of the 101 genera belonging to the family, 53 contain only one species. Four genera and 53 species were identified in recent studies about the flora in Türkiye. The endemism rate in Türkiye is 33%. 37 of 159 endemic species are endangered. There is a species belonging to the genus *Turgenia* identified in Türkiye (Güner et al., 2012). The Apiaceae family is the largest family utilized in conventional treatment in Türkiye. *Turgenia latifolia* (L.) Hoffm., known as Karaheci or Pıtrakin Turkish, is also distributed in Europe (Menemen, 2012), North Africa, Southwest Asia, Turkmenistan, Pakistan, and Kashmir (Cullen, 1972). The taxon is used in Iran to treat urinary tract problems (Mosaddegh et al., 2012). The species is used for rheumatism in Türkiye (Bulut et al., 2014).

Metcalfe and Chalk (1950) and Watson and Dallwitz (1992) clarified the anatomical characteristic features of the Apiaceae family. Members of the Apiaceae family, which are used as medicine (especially for antimicrobial properties), food and spice, landscape and ornamental plants, and animal feed due to the alkaloids and resins they contain, are among plant groups with economic value in the world (Shahsavari et al., 2008; Enez et al., 2016). Nowadays, herbs and herbal medicine raw materials constitute 25% of prescription medicines (Farnsworth et al., 1985). The inadequacy of synthetic drugs against increasing diseases in recent years and the detection of side effects have increased the necessity of using natural products. For this purpose, many plants were investigated in terms of microbiological pharmacological aspects and even in terms of plant defense mechanisms for biological warfare in recent years (Vanderbank, 1949).

Studies about the vegetative anatomy of *Turgenia* and its antimicrobial, antimutagenic and mutagenic features were not found in the literature. In this study, the aim was to investigate the *T. latifolia* species in Türkiye in detail in terms of anatomical, antimicrobial and mutagenic features. These findings will be presented for the first time and will serve as a resource for future studies about the species.

MATERIAL and METHOD

The samples of *T. latifolia*, selected as research subject, were collected from Kırşehir (Türkiye) in 2019. They were collected from the coordinates N 39°10′0.86″, E 34°26′15″ in May–July and converted to alcohol and herbarium samples. Species were identified according to Davis (1972).

Anatomical method

Sections were made into a permanent preparation according to the glycerin gelatin method (Vardar 1998). The cell types obtained from the root, stem and leaf sections of the species were determined by using Upright Microscope Eclipse Ni-U imaging system and photographed. Cell measurements were made from transverse and superficial sections of the taxa. Stomata and epidermis cell numbers per mm^2 were counted on the lower and upper surfaces of leaves of the same age and the stomata index was calculated (Meidner & Mansfield, 1968). Analysis of anatomical studies was made using 20 plant specimens. An average of 25 measurements was taken from tissues such as epidermis, periderm, parenchyma, collenchyma, and sclerenchyma (Table 1).

Antimicrobial method

Fresh leaves (100 g) were ejected with 1 L of methanol using a Soxhlet (ISOPAD, Heidelberg, Germany) device for 72 h at a temperature not exceeding the welding point of the solvent. The extract was filtered using Whatman filter paper (No. 1), and then concentrated in a vacuum at 60°C using a rotary evaporator (Buchi Labortechnik AG, Flawil, Switzerland). Leaf extracts were then freeze-dried and kept in the dark at + 4°C until experiments. Pathogenic bacterial cultures (*Staphylococcus aureus* ATCC25923, *Escherichia coli* ATCC1280, *Salmonella typhi* H NCTC901.8394, *Staphylococcus epidermidis* ATCC12228, *Micrococcus luteus* ATCC9341, *Bacillus cereus* RSKK863, *Enterobacter aerogenes, Klebsiella pneumonia* ATCC 27853, *Proteus vulgaris* RSKK 96026, *Pseudomonas aeruginosa* ATCC27853) and yeast (*Candida albicans* Y-1200-NIH) were used. Methanolic leaf extracts of *T. latifolia*, were analyzed for their antimicrobial activity using the well-diffusion method against pathogenic gram-positive bacteria (*S. aureus*, *S. epidermidis*, *M. luteus*, *B. cereus*), gram-negative bacteria (*S. typhi*, *E. coli*, *K. pneumonia*, *P. vulgaris*, *P. aeruginosa*, *E. aerogenes*), and one yeast (*C. albicans*) (Öğütcü et al., 2017; Rubab et al., 2021). Methanol was employed as resolvent for the extract and for control. In methanol, the organisms tested did not show antimicrobial activity. Then 1% (v/v) of 24-hour broth culture (selected pathogenic bacteria and yeast) containing 10^6 CFU/mL was placed in a sterile petri dish. Mueller-Hinton Agar (MHA) (15 mL) kept at 45°C was then poured into the Petri dishes and

allowed to solidify. Then, wells of 6 mm diameter were - carefully punched by employing a sterile cork borer and were entirely filled (20 µL) with extract. The plates were incubated for 24 h at 37 ^{0}C in the incubator. At the end of incubation, the average value obtained for two wells was employed to calculate the growth inhibition zone for each pathogenic bacteria and yeast (pathogenic bacteria and yeast were tested for resistance to four antibiotics (Kanamycin, sulfamethoxazole, ampicillin, amoxicillin) and one anticandidal (Nystatin) agent) (Nartop et al., 2020).

Table 1. Anatomical measurements of *T. latifolia*
Çizelge 1. T. latifolia'nın anatomik ölçüm sonuçları

Plant organ	Characteristic	Width (µm) Mean ± SE	Length (µm) Mean ± SE
Root	Periderm cells	23.75±1.88	40.89±1.80
	Diameter of trachea	25.73±1.05	
	Phloem cells	9.23±0.58	
	Cambium cells	4.12±0.36	
Stem	Epidermis	16.27±1.52	22.61±1.39
	Cortex cells	41.35±4.36	
	Cuticle	10.48±0,65	
	Sclerenchyma	9.25±1.00	
	Collenchyma	11.36±0.92	
	Diameter of trachea	21.46±1.17	
	Phloem	7.28±0.78	
	Pith cells	73.66±6.87	
Leaf	Upper epidermis cells	10.84±0.83	22.07±1.31
	Lower epidermis cells	16.35±1.29	27.92±1.79
	Lower epidermis cuticle	8.87±0.23	
	Upper epidermis cuticle	5.50±0.29	
	Spongy parenchyma cells	21.52±1.78	
	Palisade parenchyma cells	9.02±0.42	35.08±2.70
	Collenchyma	18.73±1.47	
	Diameter secretory channels	51.84±4.58	
	Trachea	18.73±1.47	

SE, Standard error.

Determination of Antimutagenic Activity: Micronuclei Test

The antimutagenic activity of methanol leaf extract from *T. latifolia* (TLm) was studied against sodium azide (NaN_3) in human lymphocyte cells with the micronuclei (MN) test. Eight culture media were created in the study. The 1st culture medium was negative control (pure water), 2nd culture medium was positive control (5 µM NaN_3), and the 3rd culture medium was only TLm (25 µL). TLm was added to other tubes (4-8) along with NaN_3 (5 µM) at concentrations of 10, 25, 50, 75 and 100 µL, respectively. The concentrations used in the study were determined based on preliminary studies.

For the determination of micronuclei, the procedure previously described by Fenech (2000) was used. Forty-four after the initiation of incubation at 37 °C, cytochalasin-B was added to each tube at a final concentration of 3 µg/mL to prevent cytoplasmic division. After 72 h, cells were removed from the incubator. Samples were centrifuged at 1000 rpm for 10 min. After removing the supernatant, a hypotonic solution (6 mL -0.075 M KCl) was added and samples were replaced in the incubator (7 min.). Cells were then immediately centrifuged and fixed three times with cold methanol/glacial acetic acid (3:1). The fixed cells were dropped onto slides and allowed to dry at room temperature (72 h). The preparations were stained with 6% Giemsa (Merck, Darmstadt, Germany) for 10 min. For MN analysis, bi-nucleated cells were evaluated under a light microscope (magnification 1000x) and scored (Nartop et al., 2020).

Statistical analysis

In this study, three replicates of all experiment groups were used for the reliability of data. The data in each experiment group were analyzed with SPSS 18.0 version using a one-way analysis of variance. Significance was determined by Duncan's test. In statistical calculations, the significance level was taken as $p<0.05$.

RESULTS and DISCUSSION

Anatomical results

Periderm was 5-8 layers on the outer surface of the root. The cortex had very few layers and parenchymatic cells were crushed in some parts (Table 1). Phloem elements were located in the large region of

the root, and were polygonal shaped with 10–15 layers. Cambium cells had 3–4 layers and were undulating. Xylem covered a large area, composed of trachea and sclerenchyma cells. Trachea differed in size (Figure 1 A, B).

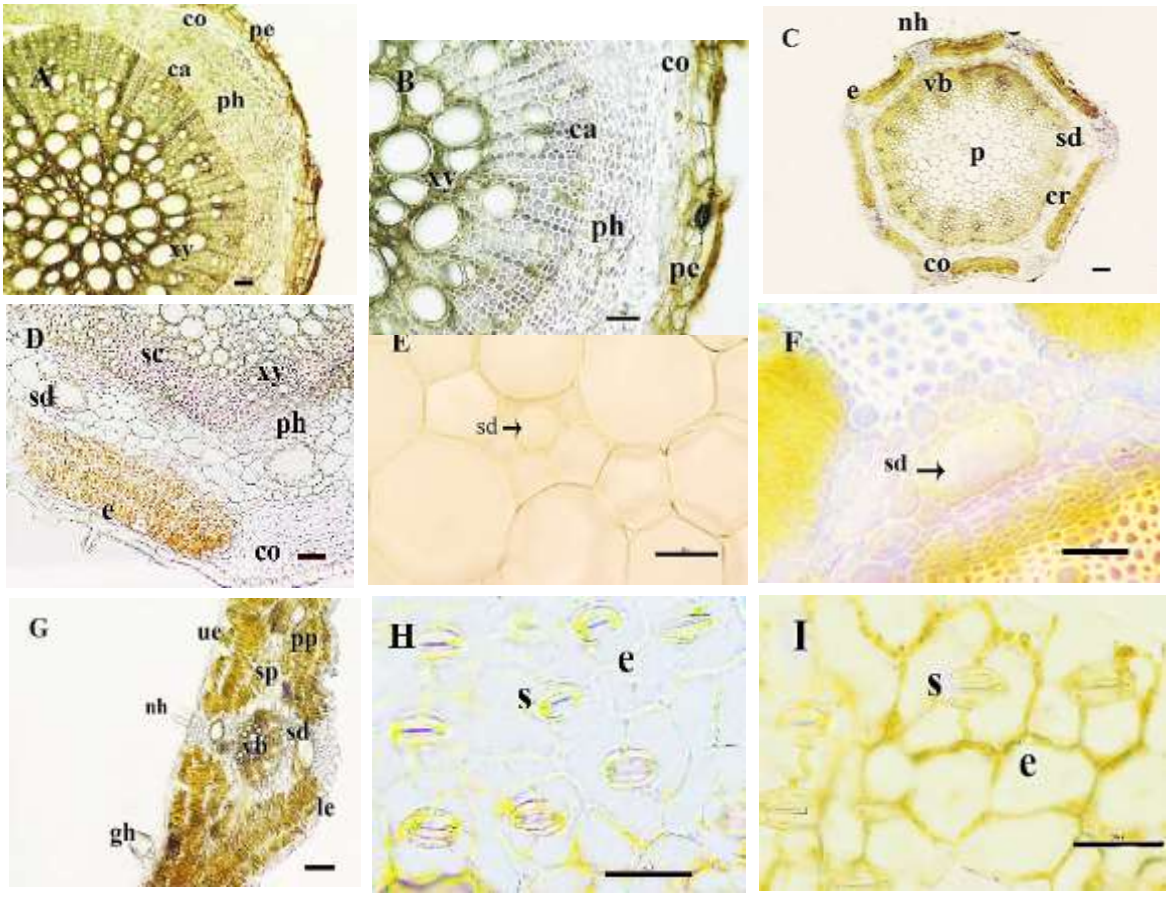

Figure 1. *T. latifolia* A, B root transverse section; C, D, E, F stem transverse section; G leaf transverse section; H leaf lower superficial section; I upper leaf superficial section. ca, cambium; cr, cortex; co, collenchyma; e, epidermis; gh, glandular hair; le, lower epidermis; nh, non-glandular hair; p, pith; pe, periderm; ph, phloem; pp, palisade parenchyma; xy, xylem; s, stomata; sc, sclerenchyma; sd, secretory duct; sp, spongy parenchyma; ue, upper epidermis; vb, vascular bundle (Scale 50 µm)

Şekil 1. T. latifolia A, B kök enine kesiti; C, D, E, F gövde enine kesiti; G yaprak enine kesiti; H yaprak alt yüzeysel kesiti; I yaprak üst yüzeysel kesiti. ca, kambiyum; cr, korteks; co, kollenkima; e, epidermis; gh, salgı tüyü; le, alt yüzey epidermis; nh, örtü tüyü; p, öz; pe, peridermis; ph, floem; pp, palizat parankiması; xy, ksilem; s, stoma; sc, sklerenkima; sd, salgı kanalı; sp, sünger parankiması; ue, üst epidermis; vb, vasküler demet (Skala 50 µm)

According to the stem transverse section of *T. latifolia*, the stem was wavy shaped. Epidermis cells were circular and rectangular and covered with cuticles. In addition, non-glandular hairs were observed on the epidermis (Table 1). There was collenchyma in groups in the cortex consisting of polygonal cells (Figure 1 C). Cortex parenchyma cells were polygonal and cylindrical shaped, with 2-3 layers. In the cortex, 14–16 secretory channels were seen (Figure 1 D, E). Vascular bundles also continued in the intervascular space. Cambium cells were distinguishable and had 1–2 layers. Sclerenchyma cells were located around the bundles. The large pith region was composed of parenchymal cells. As in the cortex, secretory canals were observed in the pith region (Figure 1 F).

According to the leaf transverse section, epidermis cells on the upper and lower surfaces had one order. Epidermis cells were generally oval and rectangular in shapes. Non-glandular and glandular hairs were observed on the epidermis. The cuticle was observed on the lower and upper epidermis. One vascular bundle was observed in the midrib region. The leaf was in isolateral type. On the upper and lower surfaces, there were 2–3 layers of thin, long, cylindrical palisade parenchyma containing plenty of chloroplasts. Spongy parenchyma had 1–2 layers. A secretory channel was

observed on the leaf. Stomata were present on the abaxial and adaxial surface (Figure 1 G, H, I). The number of upper surface stomata cells was 79 and was 160 for epidermis. Again, the number of lower surface stoma cells was 40 and was 133 for epidermis. The stomata index on the leaf upper surface was 33.05. The stomata index on the leaf lower surface was 22.98.

Antimicrobial activity

The antibacterial and antifungal activity of methanolic leaf extracts from *T. latifolia* were investigated against some microorganisms causing disease including gram-positive and gram-negative bacteria and yeast. These extracts demonstrated changing inhibitive efficacies (19 mm-30 mm). (19 mm-30 mm) when a dose of 20 mg/ml was used with the tested pathogenic species. The antibacterial activity of *T. latifolia* was compared with five commercial antibiotics and methanol leaf extracts that were as effective as the afore mentioned antibiotics (Figure 2, Table 2).

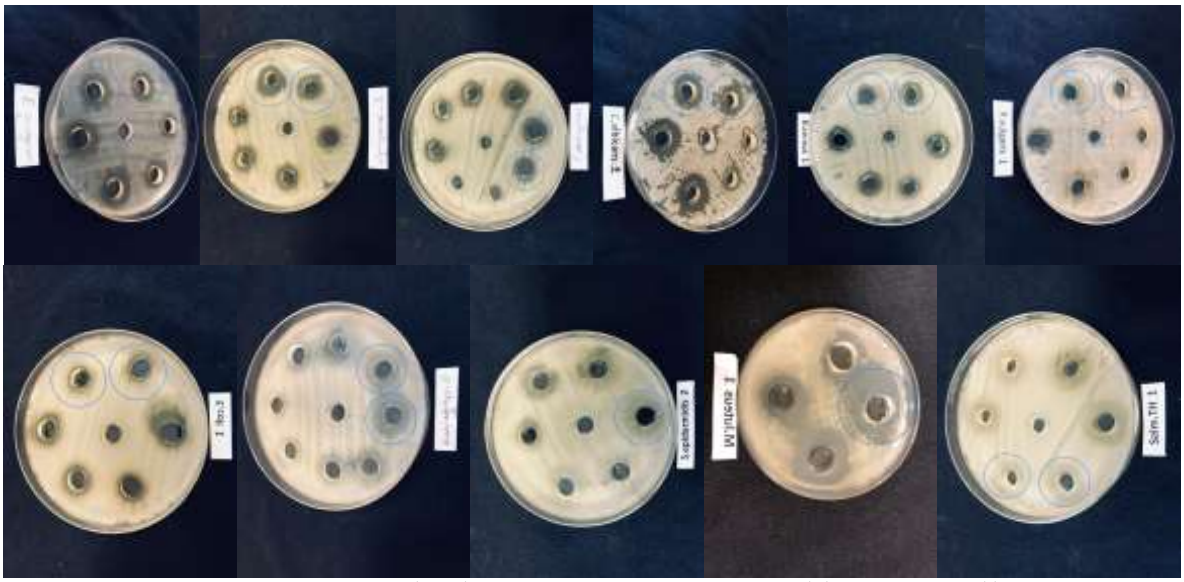

Figure 2. Photographs of inhibition zones (mm) of some pathogenic Gram (+) and Gram (-) bacteria and yeast.
Şekil 2. Bazı patojenik Gram (+) ve Gram (-) bakteri ve mayaların inhibisyon bölgelerinin (mm) fotoğrafları.

Table 2. Antimicrobial activities of leaf extract of *T. latifolia*
Çizelge 2. T. latifolia'nın yaprak ekstraktının antimikrobiyal aktiviteleri

Microorganism		Leaf extract	AMP 10*	SXT 25	AMC 30	K 30	NYS 100
Gram (+)	*M. luteus*	30	22	21	25	23	N
	S. epidermis	19	26	25	27	25	N
	S. aureus	20	30	24	30	25	N
	B. cereus	21	23	25	20	28	N
Gram (-)	*E. aerogenes*	22	21	19	20	24	N
	P. aeruginosa	21	8	18	15	14	N
	K. pneumonia	20	21	20	21	23	N
	S. typhi H	24	11	17	19	20	N
	E. coli	20	10	18	14	25	N
	P. vulgaris	21	17	19	20	21	N
Yeast	*C. albicans*	30	N	N	N	N	20

*Standard reagents (Diameter of zone inhibition (mm). SXT25, Sulfamethoxazole; AMP10, Ampicillin; NYS100, Nystatin; K30, Kanamycin; AMC30, Amoxycillin; N, Not tried.

Antimutagenic activity

We analyzed MN after treatment with different concentrations of TLm (10, 25, 50, 75 and 100 µL) against sodium azide (NaN_3). When the results in Table 3 are evaluated, TLm exhibited antimutagenic activity at concentrations of 10, 25 and 50 µL and was particularly effective at a concentration of 50 µL. However, increasing concentrations of TLm (75 and 100 µL) increased the mutagenic effect of NaN_3 in a dose-dependent manner.

In addition, we investigated the antimutagenic effects of leaf extracts of *T. latifolia* against mutagenicity of NaN_3. As seen in Table 3, leaf extracts of *T. latifolia* exhibited antimutagenic activity against the mutagenicity of NaN_3 at certain concentrations (10, 25 and 50 µL).

Table 3. Effects of NaN_3 and TLm on MN in human peripheral lymphocytes

Çizelge 3. NaN_3 ve TLm'nin insan periferik lenfositlerinde MN üzerindeki etkileri

Test Item	Concentration	MN numbers ± SE
Control		1.76 ± 0.62[a]
NaN_3	5 µM	3.20 ± 0.38[de]
TLm	25 µL	1.92 ± 0.65[a]
NaN_3+ TLm	5 µM + 10 µL	3.94 ± 0.83[cd]
NaN_3+ TLm	5 µM + 25 µL	2.80 ± 0.67[c]
NaN_3+ TLm	5 µM + 50 µL	2.36 ± 0.62[b]
NaN_3+ TLm	5 µM + 75 µL	3.35 ± 0.92[e]
NaN_3+ TLm	5 µM + 100 µL	3.68 ± 0.72[e]

[a-e]Mean ± SE, Values within each column not sharing a common superscript are significantly different ($p<0.05$) as determined by Duncan test.

In this research, the anatomical, antimicrobial, mutagenic and antimutagenic properties of the *T. latifolia* taxon, which is naturally found in Kırşehir (Türkiye) and surroundings, were investigated. No anatomical information on *T. latifolia* was available in the literature except for general taxonomic properties. The *T. latifolia* taxon had a secondary root structure. In roots, the cortex was narrowed and the central cylinder was filled with xylem elements. The tracheas in the center had larger diameters. Numerous secretory channels were observed in the stem cortex of *T. latifolia*. In *Scandix iberica* Bieb. species belonging to Apiaceae family, secretory cells in stem cortex were also mentioned (Demirpolat et al., 2019). The presence and location of collenchyma on the stem of Apiaceae famlya has taxonomic value. Stesevic et al. (2016) stated that the presence of collenchyma varies in some species belonging to the family. Collenchyma in the stem of *T. latifolia* is located in clusters just below the epidermis. In an anatomical study conducted with three genera belonging to the family, the differences of collenchyma cells between the genera are mentioned and their distinctive features are emphasized (Idman et al., 2019). In our study, secretory cells were also seen in the pith region. The Apiaceae species have special fragrances as they contain secretory cavities, which are schizogenous oil channels containing resin, oil, or mucilage. They were found in roots, petioles, stems, leaves, and fruits (Metcalfe & Chalk, 1979; Plunkett et al., 2014). The nature of the secretory elements and their contents is taxonomically important (Metcalfe, 1944). In our study, secretory canals were found in the stem, cortex and pith of the species. The number of secretory channels in the cortex especially may be characteristic for the species. Sclerenchyma cells were seen between vascular bundles based on the stem cross-section. Esau (1977) reported that in members of the Apiaceae family, the stem inter fascicular cambium sometimes produces more sclerenchyma cells towards the xylem side. The epidermis cells of the leaf of the species consisted of oval- and rectangular-shaped cells. Anisocytic stomata were scattered on both the lower and upper surfaces. Two to three epidermis cells formed around the stoma cells. The leaf was isolateral type. Metcalfe and Chalk (1972) reported that the number of epidermis cells with stomata in members of the Apiacaeae family, which mostly had isolateral leaf structure, could be very variable.

Methanol leaf extract of *T. latifolia* was examined against ten bacterial and one fungal pathogenic strain. It was concluded that this extract was more effective against gram (-) bacteria than gram (+) bacteria (Table 2). The possible reason for this may be the presence of an external impermeable membrane, fine peptidoglycan monolayer, presence of periplasmic cavity and cell wall in the composition of gram (-) bacteria (Afzal et al., 2017). *M. luteus* is considered a profiteering pathogen that may be responsible for hospital infections. It can also cause skin disease and septic shock in immunocompromised patients. This extract showed higher inhibitory activity (30 mm) against *M. luteus* than all standard antibiotics tested (Table 2) (Gül et al., 2020).

Leaf extract of *T. latifolia* exhibited higher activity (21mm) than standard antibiotic AMP10 (20mm) against *B. cereus* (Table 2). *Salmonella serovars* cause many different clinical symptoms, ranging from asymptomatic infection to severe typhoid-like syndromes in infants or in some high-sensitivity animals (Karadeniz et al., 2019; Karakılıç et al., 2020). Leaf extract of *T. latifolia* showed higher inhibition activity (24mm) than all standard antibiotics against this important pathogen of *S. typhi* (Table 2).

Leaf extract showed significantly higher inhibition activity (21 mm) than all canonical antibiotics against *P. aeruginosa* (Table 2). The genus *Pseudomonas* is widespread in nature, and causes opportunistic, and nosocomial infections. *P. aeruginosa* is a leading cause of nosocomial infections, may improve resistance to various antibiotics and cause high mortality and morbidity because of infections (Pollack, 1995; Hanberger et al., 1999). It is responsible for 10–25% of nosocomial infections (Günseren et al., 1999). As this bacteria is generally resistant to multiple antibiotics, it also causes trouble for treatment. *P. aeruginosa* septicemia occurs particularly in debilitated and immunocompromised patients and the mortality rate is 10–20% (Nadaroglu et al., 2020).

In *K. pneumonia*, leaf extract showed similar degree (20 mm) of inhibition activity as the antibiotic SXT25 (Table 2). Also, this extract had higher inhibitory effect than standard antibiotics SXT25 (18 mm), AMP10 (10 mm) and AMC 30 (14 mm) against *E. coli* (20mm) (Table 2). The extract showed higher inhibition activity (21 mm) against *P. vulgaris* than the canonical

antibiotics AMP10 (17 mm) SXT25 (19 mm) and AMC 30 (20 mm). It had the same inhibitory activity as the K30 (21 mm) standard antibiotic (Table 2). *P. vulgaris* is easily isolated in long-term care facilities and hospitals and patients with underlying diseases or patients with weak immune systems. Patients with recurrent infections, those with structural abnormalities of the urinary tract, those with urethral instrumentation, and those with hospital infections have increased intensity of infections caused by *Proteus* spp. and other microorganisms. In the case of *E. aerogenes*, this extract (22 mm) showed high inhibition activity compared to the standard antibiotics, except for K30 (24 mm) (Table 2).

Systemic fungal infections, including *C. albicans*, have emerged as significant causes of morbidity and mortality in immunosuppressed patients (Cancer chemotherapy, tissue or organ transplantation, AIDS) (Sarı et al., 2013; Nartop et al. 2014). Leaf extract of *T. latifolia* showed higher inhibitory effect (30 mm) than the commercial antifungal (20 mm) (Table 2). Also, other reports indicated that total plant extract of *T. latifolia* exhibited anticandidal effect against *C. albicans,* but stimulating effects for other *Candida* species (Sardari et al., 1998).

Bazzaz and Haririzadeh (2003) found that total plant extract of *T. latifolia* did not have any effect on *C. albicans*, *E.* coli and *S. typhi*, but its effect was insignificant against *B. subtilis*, *Morganella morgani*, *P. aeruginosa* and *S. aureus*. However, in our study, methanol leaf extracts of *T. latifolia* showed higher inhibitory activity than standard antibiotics and anticandidal agents against *P. aeruginosa*, *S. typhi*, *E. coli* (except K30) and *C. albicans* (Table 2).

This study is the first record of antimicrobial activity of methanolic leaf extract of *T. latifolia* and high antimicrobial activity was observed against the bacteria and yeast tested.

To our knowledge, there is no previous studies about the antimutagenic and mutagenic activities of *T. latifolia*. However, some species belonging to the Apiaceae family were reported to have antimutagenic effects, mutagenic effects, cytotoxic activities, and apoptosis properties (Abdelwahed et al., 2008). The antimutagenic effect of *T. latifolia* leaf methanol extracts at certain concentrations can be explained by the polyphenols (for example, flavonoids and tannins) and sesquiterpene coumarins. Actually, in previous studies, it was determined that some species belonging to the Apiaceae family contained polyphenols and sesquiterpene coumarin compounds These compounds are known to exhibit antimutagenic activity (Edenharder & Tang, 1997; Besaratinia & Pfeifer, 2004; Abdelwahed et.al., 2008; Kasaian & Mohammadi, 2018). Moreover, it was stated that polyphenolic compounds, especially flavonoids, can induce DNA damage depending on concentration and time, and that their genotoxic effects may be due to their prooxidant activities (Rusak et al., 2010; Ceker et al., 2019). In this study, the increased MN frequency at high concentrations of TLm (75 and 100 µL) may be related to the prooxidant activities of phenolic compounds. In the future, analysis of these compounds will help to clarify the cause of the biological activities of *T. latifolia*.

CONCLUSION

The root of *T. latifolia* is thickened and secondary. The shape of the stem is undulate. The stem has collenchyma and sclerenchyma tissue, non-glandular and glandular hair. Anisocytic stomata are distributed on both surfaces of the isolate leaf. A large number of secretory ducts form in the root, stem and leaf.

Microbial pathogens are a universal health concern and therefore new or alternative antibiotics are ingreat demand to combat infections and infections caused by resistant pathogens. Natural products are still recognized as unique resources.

Due to antimutagenic and antimicrobial properties, *T. latifolia* might be important as a medicinal herb. Because *T. latifolia* has the potential to be used as a new antimicrobial agent, it is thought that this study will help with the treatment of many diseases and guide future studies. Therefore, this study may provide a different perspective for pharmacological studies about the treatment of bacterial and fungal infections.

ACKNOWLEDGMENT

This study was supported by Kırşehir Ahi Evran University Scientific Research Projects Unit with Project Number: ZRT.A4.21.002.

Researchers' Contribution Rate Statement

The authors contributed equally to the article.

Conflicts of Interest Statement

The article authors declare that they do not have any conflict of interest.

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