ORIGINAL ARTICLE e-ISSN: 2349-0659 p-ISSN; 2350-0964

Phytochemical Characterization of *Mundulea sericea* Leaf Extracts and Analysis of Antioxidant and Antidiabetic Activities

S. Gangadevi[1], P. Viswanathan[1]*, K. Kalimuthu[1], V. Chinnadurai[2]

Abstract

Many developing countries are focusing on the plant-based drug for various human diseases for less or no side effects, low cost and are easily available. Hence, we need to find the new phytochemicals and their biological activities. For this reason, the present study was designed to screen the phytochemical constituents of various solvent-based leaf extracts of Mundulea sericea for antioxidant and antidiabetic activities. Through preliminary phytochemical qualitative screening, Fourier transform infrared (FTIR), and gas chromatography–mass spectrometry (GC–MS) spectrum analysis with standard procedures, phytochemical analysis of *M. sericea* leaf hexane (MSLH), *M. sericea* leaf petroleum ether (MSLPE), *M. sericea* leaf chloroform (MSLC), *M. sericea* leaf ethyl acetate (MSLEA), *M. sericea* leaf ethanol (MSLE), *M. sericea* leaf methanol (MSLM) extracts was studied. Further, MSLE extract was examined for free radical scavenging of DPPH, ABTS, nitric oxide, and hydrogen peroxide antioxidant methods and also evaluated antidiabetic activity by α-amylase and α-glucosidase assays. As a result of the phytochemical analysis, several phytochemical compounds were identified. Among the extracts, MSLE and MSLM extracts contain more secondary metabolites than other extracts. Furthermore, those secondary metabolites chemical compound constituents were identified through FTIR and GC–MS spectrum analysis. At a higher concentration, MSLE extract showed good antioxidant activity which is similar to the one found in standard antioxidant tests. The maximum antioxidant activity was reported in nitric oxide (79.37%) at 250 µg/ml concentration. Furthermore, MSLE extracts were showed good antidiabetic activity in α-glucosidase (70.70%) at 500 µg/ml concentration. As per the study, MSLE extract has effective phytochemical constituents and also acts as a novel antioxidant and antidiabetic activity. Further, investigation is needed to confirm ethanol extract as a novel therapeutic drug.

Keywords: Antidiabetic and inhibition, Antioxidant, Ethanol extract, *Mundulea sericea*, Phytochemical

Asian Pac. J. Health Sci., (2021); DOI: 10.21276/apjhs.2021.8.4.24

Introduction

Medicinal plants are a rich source of novel therapeutic drugs that form the ingredients in the traditional system of medicine, modern medicines, pharmaceutical intermediates, and lead compounds in synthetic drugs.[1] The reason for using them as medicine lies in the fact that they contain more valuable chemical components of therapeutic value.[2] These compounds found in medicinal plants leaves, vegetables, and roots and act as defense mechanisms and protect against various diseases. Some plant substances are beneficial to health, usually secondary metabolites that generate specific physiological effects in the body. In recent years, plant research has become a major concern across the globe, and a large collection of research has established the incredible potential of medicinal plants used in traditional systems worldwide[3] including treatment against hepatocellular carcinoma.[4] Plant-based medicines are being used by nearly about 80% of the world population, primarily in developing countries for primary health care.[5] According to current assessments of the health care system, synthetic drugs are likely to be more problematic in the future.

Mundulea sericea (Willd.) A. Chev. (*M. sericea*) is a medicinally important species belong to the Fabaceae family. This species is a shrub or small tree located in dry forests and rocky hills of West and South India. It is also widely distributed in central and southern tropical Africa.[6] The entire part of the plant contains various phytochemical constituents which are used for various human diseases. The entire parts of this plant such as bark, leaves, seeds, and roots are used as fish poison,[7] insecticide,[8] and an aphrodisiac.[9] The previous studies are reported that the isolated phytocompounds of rotenoids,[10] flavanones,[11] isoflavanones,[10] chalcones,[11] and an imidazole derivative[12] which are work as many biological activities. Furthermore, the whole plant has antimicrobial, analgesic, antioxidant, cytotoxic, and cancer chemopreventive activities. The current study was focused on the analysis of phytochemical constituents in various solvent extracts such as MSLH, MSLPE, MSLC, MSLEA, MSLE, and MSLM. Further, MSBE extracts alone evaluated to antioxidant and antidiabetic activities.

[1]Department of Botany, Government Arts College (Autonomous), Coimbatore, Tamil Nadu, India, [2]Department of Botany, Sri Vidya Mandir Arts and Science College (Autonomous), Katteri, Uthangarai, Krishnagiri, Tamil Nadu, India

Corresponding Author: Dr. P. Viswanathan, Department of Botany, Government Arts College (Autonomous), Affiliated to Bharathiar University, Coimbatore, Tamil Nadu, India.
E-mail: rpviswanathan68@gmail.com

How to cite this article: Gangadevi S, Viswanathan P, Kalimuthu K, Chinnadurai V. Phytochemical Characterization of *Mundulea sericea* Leaf Extracts and Analysis of Antioxidant and Antidiabetic Activities. Asian Pac. J. Health Sci., 2021;8(4):137-144.

Source of support: Nil

Conflicts of interest: None

Received: 28/06/21 **Revised:** 29/07/21 **Accepted:** 21/08/21

Experiments

Plant Collection and Authentication

M. sericea was collected from Western Ghats region, Coimbatore, Tamil Nadu, India. The species name authenticated by BSI,

Coimbatore, India, and reference number is BSIS/RC/5/23/2017/Tech./455.

Phytochemical Extraction

Leaf explant was used for phytochemical extraction by successive extraction method through Soxhlet apparatus. One hundred grams leaf powder was subjected to 1000 ml various polar solvents such as hexane, petroleum ether, chloroform, ethyl acetate, ethanol, and methanol individually. After extraction, each solvent evaporated from respect solvent extract through rotary evaporator. Finally, the extracts were store at room temperature for further uses.

Preliminary Phytochemical Screening

M. sericea leaf six extracts were subjected to preliminary phytochemical screening to find out the secondary metabolites of alkaloids, flavonoids, terpenoids, tannins, glycosides, etc. For alkaloids test, four different screening tests such as Dragendorff's test, Mayer's test, Wagner's test, and Hager's test[13] were analyzed. Further, analysis of secondary metabolites such as flavonoids in 10% HCl and 5% NaOH test and alkaline test,[14] tannins used 5% $FeCl_3$ test,[13] steroids are Liebermann–Burchard test,[13] triterpenes using the Liebermann–Burchard test and Salkowski's test,[15] saponins foam test,[16] glycosides Killer and Kilian test,[17] gum and mucilages test,[18] fixed oils spot test,[16] and finally anthraquinones used in NH_4OH test[19] was studied by six solvent extracts of MSLH, MSLPE, MSLC, MSLEA, MSLE, and MSLM by standard procedure.

FTIR Spectroscopy Analysis

Fourier transform infrared (FTIR) analysis of *M. sericea* leaf extracts was carried out through the potassium bromide (KBr) pellet (FTIR grade) method in 1:100 ratio and spectrum was recorded using Jasco FT/IR-6300 Fourier transform infrared (IR) spectrometer.

Gas Chromatogram–Mass Spectroscopy (GC–MS) Analysis

GC–MS analysis of *M. sericea* extracts was analyzed to find out the phytochemical constituents of these extracts. The Clarus 680 GC worked with a fused silica column and packed with Elite-5MS (0.25 mm ID × 30 m length × 250 mm depth) and separated the components with helium at constant flow of 1 ml/min. The injector temperature was set at 260°C during the chromatographic run. The 1 µL of extract sample injected into the instrument with standard oven temperature and mass detector conditions. GC–MS NIST (2008) library had database of spectrums of known components, and so the spectrums of the components were compared with those stored in the database.

Antioxidant Activity

The *in vitro* antioxidant activity of MSLE extract was examined by standard methods. Four different antioxidant methods (DPPH radical scavenging activity, ABTS radical scavenging assay, hydrogen peroxide [H_2O_2], and nitric oxide [NO] radical inhibition activity) were studied by different concentration. Each antioxidant assay absorbance was measured by various wavelength and the percentage of inhibition was calculated using the following formula.

DPPH radical scavenging method

The DPPH radical scavenging activity of MSLE extract was evaluated by the method of Szabo *et al*. (2007)[20] Twenty-one milligrams of each sample extract or standard were dissolved individually in 1 ml DMSO to a solution of 21 mg/ml concentration. Ten microliters extracts or standard with 200 µl of 100 mM DPPH solution was mixed separately in 96-well microtiter plate and incubated at 37°C for 20 min. The each plate well absorbance was measured at 490 nm using ELISA reader and the percentage of inhibition was calculated.

ABTS radical scavenging method

13.5 mg of MSLE extract and ascorbic acid were dissolved in 2 ml of DMSO and this solution was serially diluted with dimethyl sulfoxide to get lower concentrations. 0.2 ml of each extract or standards mixed with 1 ml of DMSO and 0.16 ml of ABTS then it takes final volume of 1.36 ml. After 20 min, the absorbance was measured in ELISA reader at 734 nm.[21]

H_2O_2 assay

H_2O_2 scavenging activity was screened for MSLE extract by the method.[22] A test solution was prepared by 0.6 ml of 40 mM H_2O_2 with phosphate buffer in pH 7.4 and 3.4 ml of MSLE extract then it reacted with phosphate buffer. Finally, the solution was measured by absorbance at 230 nm.

Nitric Oxide radical inhibition activity

Forty-two milligrams of MSLE extract were separately dissolved in 2 mL of DMSO to get 21 mg/mL concentration. The reaction mixture 6 mL containing 4 mL of 10 mM SNP, 1 mL of DMSO, and 1 mL of sample were incubated at 25°C for 90 min. After incubation, 1 mL of sulfanilic acid reagent was added and allowed to stand for 5 min for completion of diazotization, then 1 mL of NEDD was added and another 1 time allowed to stand for 30 min at room temperature. The absorbance was measured at 540 nm using ELISA reader.[23,24]

Antidiabetic activity

α-amylase inhibition assay

Different concentrations of the MSLE extract and 500 µl of 0.02 M sodium phosphate buffer (pH 6.9 with 0.006 M NaCl) containing porcine pancreatic α-amylase enzyme (EC 3.2.1.1) (0.5 mg/ml) were incubated at 25°C for 10 min. After the incubation, 500 µl of 1% starch solution in 0.02 M sodium phosphate buffer (pH 6.9 with 0.006 M NaCl) was added to the reaction mixture. Subsequently, the reaction mixture was incubated at 25°C for 10 min followed by addition of 1.0 ml of dinitrosalicylic acid. After incubating in boiling water for 5 min, the reaction was finally stopped and cooled at room temperature. The reaction mixture was diluted with 10 ml distilled water, and the absorbance was measured at 540 nm in a spectrophotometer. The mixture of all other reagents and the enzyme except the sample was used as a control. The inhibitory activity of α-amylase was computed as a percentage.[25]

α-glucosidase inhibition assay

Various amounts of MSLE extract (200–500 µg/ml) and 100 µl of α-glucosidase (0.5 mg/mL) in 0.1 M phosphate buffer (pH 6.9)

solution were incubated at 25°C for 10 min. Then, 50 µl of 5M p-nitrophenyl-α-D-glucopyranoside in 0.1 M phosphate buffer (pH 6.9) solution was added. Reaction mixtures were incubated at 25°C for 5 min and the absorbance was taken at 405 nm by a spectrophotometer. The mixture of all other reagents and the enzyme except the sample was used as a control and the results of α-glucosidase inhibition activity were expressed in terms of inhibition percentage.[26]

Results

Phytochemical investigation

Preliminary phytochemical qualitative assay of *M. sericea* leaf various solvent extracts was screened through standard procedures. Secondary metabolites are present based on polar solvent extracts such as high polar solvent extracts contain more number of secondary metabolites. Table 1 shows the presence and absence of secondary metabolites of *M. sericea* leaf extracts. This study proved that high polar solvent extracts such as ethanol and methanol have more secondary metabolites than other solvent extracts. Those extracts contain alkaloids, flavonoids, tannins, steroids, triterpenoids, saponins, and fixed oil [Table 1].

After the preliminary phytochemical screening, extracts were subjected to IR spectroscopy to identify phytocompounds functional groups. IR spectroscopy of each extract was analyzed with a potassium chromite plate.

Figure 1 shows that various bonds such as strong, sharp, broad, and medium of individual extracts. This result reported the various bonds such as O-H stretch, C-N stretch, C=O stretch, C-H stretch, C-H wag, C-O stretch, C-O stretch, N-H stretch, H-C=H, N-H bend, C-H bend, and C-N bend which are indicated the functional groups of alcohols, phenols, alkanes, ketones, aromatics, alkyl halides, carboxylic acid, aliphatic amines, 1, 2 amines, amides, alkynes, amines, alkenes, and aromatic amine [Table 2].

Further, *M. sericea* leaf extracts were examined to gas chromatography–mass spectrometry spectroscopy for the identification of phytochemical constituents. The result of each extract is observed a different kind of phytochemicals with molecular formula and molecular weight at different retention times. Gas chromatographic analysis of each extract revealed broad, high, and sharp peak compounds [Figure 2]. Table 3 shows the various phytochemical constituents of MSLH, MSLPE, MSLC, MSLEA, MSLE, and MSLM extracts. 55, 24, 37, 82, 163, and 53 phytocompounds were presented in MSLH, MSLPE, MSLC, MSLEA, MSLE, and MSLM extract, respectively. Some of high peak compounds given in Table 3 that are N-Decanoic acid in MSLH extract, 2R-Acetoxymethyl-1,3,3-trimethyl-4t-(3-methyl-2-buten-1-yl)-1t-cycloh in MSLPE extract, Inositol 1-deoxy in MSLC, 2R-Acetoxymethyl-1,3,3-trimethyl-4t-(3-methyl-2-buten-1-yl)-1t-cycloh in MSLEA extract, tritetracontane in MSLE extract, and cyclotrisiloxane, hexamethyl in MSLM extract. Some of the phytocompounds of each extract are reported various bioactive uses such as antioxidant property antimicrobial, anti-inflammatory, and anticancer [Table 3].

Antioxidant Activity

A series of free radical scavenging assays have been conducted on MSLE extract to investigate its antioxidant activity. Based on the result observed, free radical scavenging percentage is based on sample concentration which means that the maximum percentage of inhibition was reported at a higher concentration of 250 µg/ml. Table 4 shows the inhibition percentage of DPPH, ABTS, H_2O_2, and NO. It was observed that NO (79.37%) had the highest level of free radical scavenging at 250 g/ml, resulting close to the value of standard ascorbic acid (87.87%). The second leading free radical inhibition percentage (75.20%) is observed in H_2O_2. Other antioxidant assays (DPPH and ABTS) also have good free radical scavenging inhibition activity.

Anti-diabetic Activity

Antidiabetic activity of MSLE extract was analyzed through α-amylase and α-glucosidase methods. Antidiabetic ability is calculated by inhibition of both enzymes by MSLE extract. Table 5 displays the inhibition percentage of α-amylase and α-glucosidase by different concentration like 100 µg/ml–500 µg/ml MSLE extract. The inhibition percentage was gradually increased when concentration increases [Table 5]. The maximum percentage of inhibition was noticed in α-glucosidase that result is 70.70% which almost similar to standard of acarbose (81.78%).

Table 1: Preliminary phytochemical screening of leaf various solvent extracts of *M. sericea*

Compounds	*Tests*	*MSLH*	*MSLPE*	*MSLC*	*MSLEA*	*MSLE*	*MSLM*
Alkaloids	Dragendorff's test	+	−	−	+	+	+
	Mayer's test	−	−	+	−	+	+
	Wagner's test	+	+	−	+	+	−
	Hager's test	−	−	−	−	+	+
Flavonoids	10% HCl and 5% NaOH test	−	+	+	−	+	+
	Alkaline test	+	−	−	+	+	+
Tannins	5% $FeCl_3$ test	−	−	−	−	+	+
Steroids	Liebermann–Burchard test	+	+	+	+	+	+
Triterpenoids	Liebermann–Burchard test	+	+	+	+	+	+
	Salkowski's test	+	+	−	+	+	+
Saponins	Foam test	−	−	−	−	+	−
Glycosides	Killer and Kilian test	+	−	+	+	−	−
Gum and mucilages	Whistler and BeMiller test	+	+	−	+	+	−
Fixed oils	Spot test	+	−	+	−	+	+
Anthraquinones	NH_4OH test	−	−	−	−	−	−

+ Indicates presence phytocompounds; – indicates absent phytocompounds. *M. sericea: Mundulea sericea*

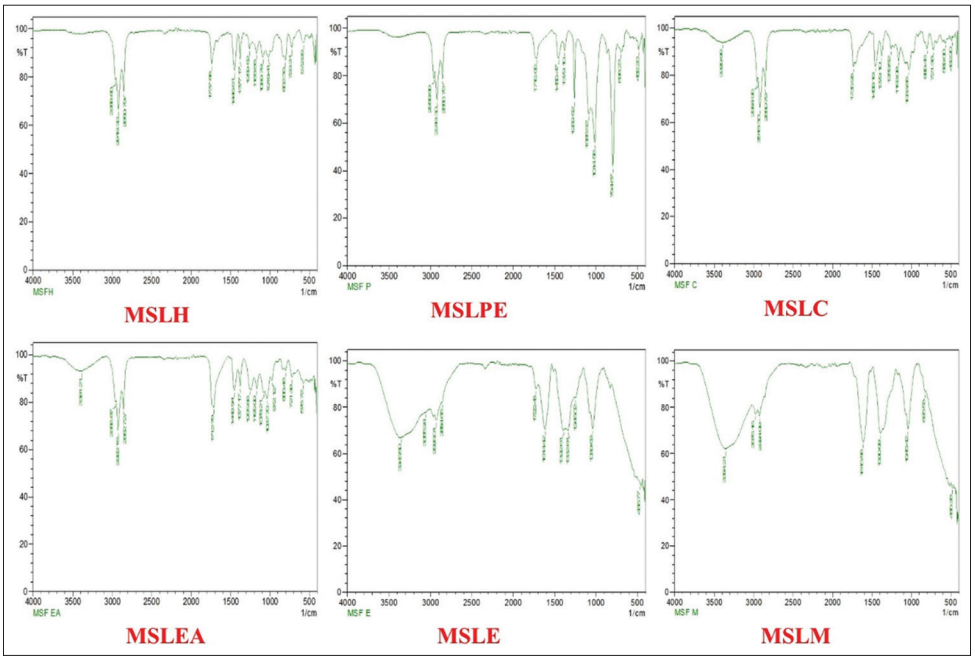

Figure 1: Fourier transform infrared spectrum of leaf various solvent extracts of *Mundulea sericea*

Table 2: FTIR functional group of various solvent extracts of *M. sericea*

S. No.	*Functional groups name*	*Bond*	*Test samples and its functional group presence*					
			MSLH	*MSLPE*	*MSBC*	*MSBEA*	*MSBE*	*MSBM*
1	Alcohols, phenols	O-H stretch	+	+	+	+	+	+
2	Alkanes	C-N stretch	–	+	+	+	+	–
3	Ketones	C=O stretch	+	–	–	–	–	–
4	Aromatics	C-H stretch	+	–	–	–	–	–
5	Alkyl halides	C-H wag	–	+	+	+	+	+
6	Alcohol ester	C-O stretch	–	–	+	+	–	–
7	Carboxylic acid	C-O stretch	–	–	+	+	+	–
8	Aliphatic amines	C-O stretch	+	+	+	+	+	–
9	1, 2 amines, amides	N-H stretch	+	–	–	–	–	+
10	Alkynes	H-C=H	–	–	–	–	–	–
11	Amines	N-H bend	–	+	+	–	+	–
12	Alkenes	C-H bend	+	–	–	+	–	–
13	Aromatic amine	C-N bend	–	–	–	+	+	+

M. sericea: Mundulea sericea, FTIR: Fourier transform infrared

Discussion

Medicinal plants contain several clinically important bioactive constituents, most of which are recognized as pharmacologically significant bioactive compounds.[27] Most of these bioactive secondary metabolites of plants are the key sources of natural antioxidants and are ideal than the synthetic versions because of less associated side effects.[28] There is evidence that pharmacologically important secondary metabolites affect the rate of development of a wide range of diseases, including cardiovascular disease, cancer, hormonal imbalances, and neurological disorders.[29] Several studies on phytochemicals derived from plants have demonstrated their effectiveness at protecting against acute, chronic, and degenerative diseases.[30-32]

As part of the present study, secondary metabolites of various solvent leaf extracts of *M. sericea* were analyzed by standard procedures. The results of this study reported that most of the secondary metabolites are presented in these extracts. MSLE and MSLM extract, in particular, contain medicinally important secondary metabolites such as alkaloids, terpenoids, flavonoids, tannins, and steroids. Secondary metabolites act against many diseases, along with alkaloids that have antimicrobial properties,[33] flavonoids and tannins act as antioxidants and anti-inflammatory, anti-carcinogenic, and anti-mutagenic activities,[33] triterpenoids possess as antipyresis, hepatoprotective, cardiotonic, soothing, tonic impacts, and also have hypocholesterolemic and antidiabetic properties,[34] and saponin has antimicrobial action.[35]

In a mixture of plants extracts, FTIR has been shown to be an efficient tool for the characterization and identification of compounds and functional groups. The most common plants with the spectrum of an unknown compound can be identified by comparison to a library of known compounds.[36] FTIR analysis of these extracts was observed in the various functional groups such as alcohols, phenols, alkanes, ketones, aromatic compounds, amines, alkanes, and aliphatic compounds. The results show that the active groups of the sample under study are aliphatic chains

Table 3: Phytochemical constituents of various solvent leaf extracts of *M. sericea* by GC–MS

Sample	*Compound name*	*Formula*	*Weight*	*Uses*
MSLH	N-Hexadecanoic acid	$C_{16}H_{32}O_2$	256	Antioxidant, hypocholesterolemic, nematicide, pesticide, lubricant activities, and hemolytic 5-alpha are a reductase inhibitors (Jegadeeswari et al., 2012; Upgade and Anusha, 2013).
	Tridecanoic acid	$C_{13}H_{26}O_2$	214	Antibacterial and antifungal activities (Chandrasekaran et al., 2011).
	Pentadecanoic acid	$C_{15}H_{30}O_2$	242	Antioxidant activity (Vijisaral Elezabeth and Arumugam, 2014).
	Octadecanoic acid	$C_{18}H_{36}O_2$	284	Anti-inflammatory activity (Rajeswari et al., 2012; Vasudevan et al., 2012).
	Dodecanoic acid	$C_{12}H_{24}O_2$	200	Antibacterial, antiviral and antifungal activities (Özçelik et al., 2005).
	Eicosanoic acid	$C_{20}H_{40}O_2$	312	Vasodilator
MSLC	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	256	Antioxidant, hypocholesterolemic, nematicide, pesticide, lubricant activities, and hemolytic 5-alpha are a reductase inhibitors (Jegadeeswari et al., 2012; Upgade and Anusha, 2013).
MSLEA	N-Hexadecanoic acid	$C_{16}H_{32}O_2$	256	Antioxidant, hypocholesterolemic, nematicide, pesticide, lubricant activities, and hemolytic 5-alpha are a reductase inhibitors (Jegadeeswari et al., 2012; Upgade and Anusha, 2013).
	Octadecanoic acid	$C_{18}H_{36}O_2$	284	Anti-inflammatory activity (Rajeswari et al., 2012; Vasudevan et al., 2012).
	Pentadecanoic acid	$C_{15}H_{30}O_2$	242	Antioxidant activity (Vijisaral Elezabeth and Arumugam, 2014).
	L-(+)-Ascorbic acid 2,6-dihexadecanoate	$C_{38}H_{68}O_2$	652	Antioxidant, anti-inflammatory, and anti-nociceptive properties (Akinmoladun et al., 2007; Okwu and Emenike, 2006).
	Tetradecanoic acid	$C_{14}H_{28}O_2$	228	Antioxidant, cancer preventive, nematicide, hypocholesterolemic, and lubricant (Karthika Krishnamoorthy and Paulsamy Subramanian, 2014).
	Tridecanoic acid	$C_{13}H_{26}O_2$	214	Antibacterial and antifungal activities (Chandrasekaran et al., 2011).
	Dodecanoic acid	$C_{12}H_{24}O_2$	200	Antibacterial, antiviral, and antifungal activities (Özçelik et al., 2005).
	Oleic acid	$C_{18}H_{34}O_2$	282	Cancer preventive, anemiagenic, insectifuge, antiandrogenic, and dermatitigenic activity (Vijisaral Elezabeth and Arumugam, 2014).
	cis-11-Eicosenoic acid	$C_{20}H_{38}O_2$	310	Antimicrobial activity (Arumugham Suresh et al., 2014).
	CIS-10-Nonadecenoic acid	$C_{19}H_{36}O_2$	296	Antitumor activity (Fukuzawa et al., 2008).
	6-Octadecenoic acid, (Z)-	$C_{18}H_{34}O_2$	282	Cancer preventive and insectifuge (Vijisaral Elezabeth and Arumugam, 2014).
	9-Eicosene, (E)-	$C_{20}H_{40}$	280	Essential oil.
	9-Nonadecene	$C_{19}H_{38}$	266	Antimicrobial and antifungal activities (Pauline Fatima Mary and Sagaya Giri, 2016).
	Cyclohexane, 1-(1,5-dimethylhexyl)-4-(4-methylpentyl)-	$C_{20}H_{40}$	280	Antimicrobial, antioxidant and antibacterial (Nazia Khatoon and Rajinder Gupta, 2015).
	Lupeol	$C_{30}H_{50}O$	426	Anticancer, anti-inflammatory, and antioxidant activities (Maruthupandian and Mohan et al., 2011).
	3-O-Acetyl-6-methoxy-cycloartenol	$C_{33}H_{54}O_3$	498	Anti-inflammatory and anticonvulsant activities (Sugumar and Karthikeyan 2015).
MSLE	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	256	Antioxidant, hypocholesterolemic, nematicide, pesticide, lubricant activities, and hemolytic 5-alpha are a reductase inhibitors (Jegadeeswari et al., 2012; Upgade and Anusha, 2013).
	Tridecanoic acid	$C_{13}H_{26}O_2$	214	Antibacterial and antifungal activities (Chandrasekaran et al., 2011).
	Dodecanoic acid	$C_{12}H_{24}O_2$	200	Antibacterial, antiviral and antifungal activities (Özçelik et al., 2005).
	Octadecanoic acid	$C_{18}H_{36}O_2$	284	Anti-inflammatory activity (Rajeswari et al., 2012; Vasudevan et al., 2012).
	Pentadecanoic acid	$C_{15}H_{30}O_2$	242	Antioxidant activity (Vijisaral Elezabeth and Arumugam, 2014).

(*Contd*....)

Table 3: (*Continued*)

Sample	*Compound name*	*Formula*	*Weight*	*Uses*
	Tetradecanoic acid	$C_{14}H_{28}O_2$	228	Antioxidant, cancer preventive, nematicide, hypocholesterolemic, and lubricant (Karthika Krishnamoorthy and Paulsamy Subramanian, 2014).
	Octadecanal	$C_{18}H_{36}O$	254	Alkane-lyase activity (Sunita Arora and Sonam Meena, 2017).
	Oleic acid	$C_{18}H_{34}O_2$	226	Cancer preventive, anemiagenic, insectifuge, antiandrogenic, and dermatitigenic activity (Vijisaral Elezabeth and Arumugam, 2014).
	Pentadecanal	$C_{15}H_{30}O$	240	Nutrient, stabilizers, surfactants, and emulsifier (Varsha Jadhav et al., 2014).
	Tetradecanal	$C_{14}H_{28}O$	212	Anticancer and antioxidant (Uma et al., 2010; Chandrasekar et al., 2015).
	1,2-15,16-Diepoxyhexadecane	$C_{16}H_{30}O_2$	254	Anti-microbial.
	9-Octadecenal, (Z)-	$C_{18}H_{34}O$	266	Anti-alopecic, antitumor, choleretic, dermatitigenic, immunostimulant, anti-leukotriene, anti-androgenic, hemolytic, hypercholesterolemic, lubricant, nematicide, pesticide, irritant, flavor, 5 α reductase inhibitor, percutaneous stimulant, and anemiagenic activities (Revathi et al., 2014).
	Tritetracontane	$C_{43}H_{88}$	604	Anti-inflammatory (Isaiah et al., 2016).
	Tetratriacontane	$C_{34}H_{70}$	478	antibacterial agent
	Heptacosane	$C_{27}H_{56}$	380	Anti-corrosive and antioxidant activities (Dandekar et al., 2015).
	Hentriacontane	$C_{31}H_{64}$	436	Anti-inflammatory (Kim et al., 2001), antifungal against fungal spores germination, antioxidant, antitumor, and antibacterial (Dandekar et al., 2015).
	Tetratetracontane	$C_{44}H_{90}$	618	Hypoglycemic and antioxidant activities (Sivakumar and Gayathri, 2015).
	Pentatriacontane	$C_{35}H_{72}$	492	Antioxidant and anti-inflammatory activities (Sivakumar and Gayathri, 2015).
	Nonacosane	$C_{29}H_{60}$	408	Antibacterial activity (Vladimir Mihailovi et al., 2011).
	Lupeol	$C_{30}H_{50}O$	426	Anticancer, anti-inflammatory, and antioxidant activities (Maruthupandian and Mohan et al., 2011).
MSLM	1,2-Benzenedicarboxylic acid, diisooctyl ester	$C_{24}H_{38}O_4$	390	Antimicrobial and antifouling (Maruthupandian and Mohan, 2011).
	Octasiloxane, 1,1,3,3,5,5,7,7,9,9,11,11,13,13,15,15-hexadecamethyl	$C_{16}H_{50}O_7Si_8$	578	Antimicrobial activity (Kumaradevan et al., 2015).

GC–MS: Gas chromatography–mass spectrometry

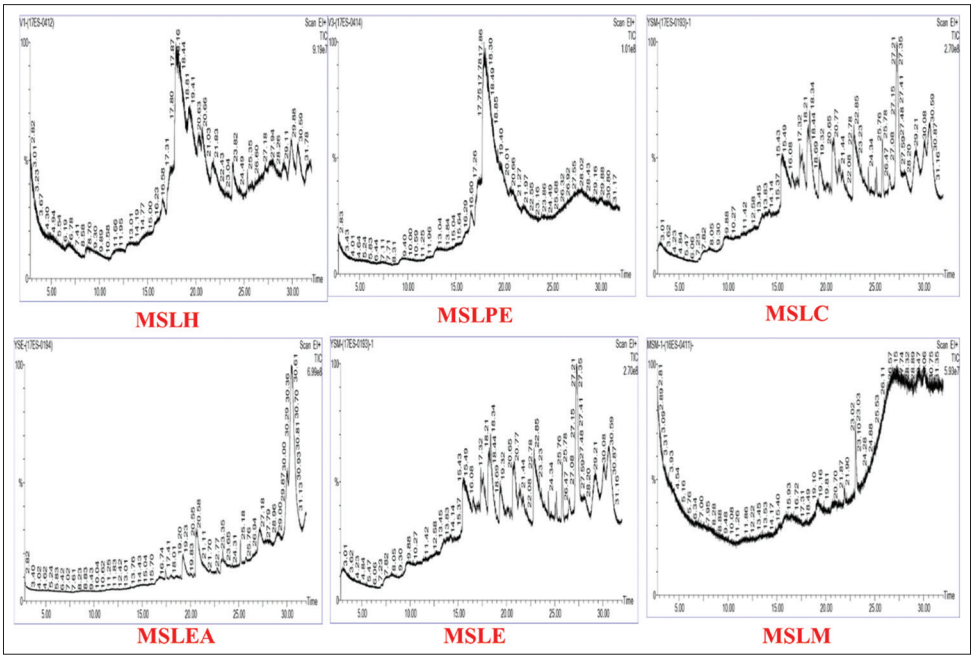

Figure 2: Gas chromatogram of leaf various solvent extracts of *M. sericea*

Table 4: Antioxidant activities of MSLE leaf extract of *M. sericea*

Assay	*Percentage of inhibition*				
	50 µg/ml	*100 µg/ml*	*150 µg/ml*	*200 µg/ml*	*250 µg/ml*
DPPH	31.53±0.29	44.12±0.67	54.37±0.71	61.85±1.3	72.33±0.98
Ascorbic acid	35.27±0.12	43.31±0.05	58.81±0.52	72.20±0.73	87.87±0.14
ABTS	28.56±1.32	36.12±0.87	47.81±0.67	59.63±1.01	70.45±0.89
Ascorbic acid	37.04±0.12	46.12±0.19	59.21±0.11	68.52±0.53	81.32±0.18
H2O2	25.72±0.87	36.81±1.20	46.34±0.89	57.12±0.87	75.20±1.04
Ascorbic acid	38.32±0.53	49.74±0.51	57.21±0.50	69.35±0.53	78.13±0.76
NO	33.48±0.34	43.91±0.88	57.11±0.65	68.51±0.89	79.37±0.28
Ascorbic acid	43.12±0.23	51.44±0.11	63.31±0.65	79.65±0.33	87.43±0.46

M. sericea: Mundulea sericea

Table 5: Antidiabetic activity of MSLE leaf extract of *M. sericea*

Concentration µg/ml	*Percentage of inhibition*		
	α-amylase inhibition	*α-glucosidase inhibition*	*Acarbose*
100	22.84±0.27	24.83±0.26	43.81±0.53
200	35.64±0.60	33.54±0.71	54.81±0.35
300	45.09±0.86	46.69±0.54	61.74±0.66
400	57.82±0.57	55.75±0.77	73.75±0.69
500	69.59±0.50	70.70±0.60	81.78±0.46

M. sericea: Mundulea sericea

belonging to fat, protein, starch, and phenolic acid. These results agree with the findings of many researchers.[37,38]

Antioxidant compound in our food has a key role as a health-protecting factor. Hence, it is considered as useful nutraceuticals on account of many health benefits.[39-41] The most important function of antioxidant is trapping the free radical, particularly reactive oxygen species (ROS) and reactive nitrogen species (RNS) which are involved in the pathogenesis of several chronical and degenerative diseases such as cancer, inflammation, neurodegenerative diseases, cardiovascular diseases, and aging-related disorders.[42] Recently, the use of natural antioxidants has been promoted and become important concerns regarding the safety of synthetic ones.[43] Hence, the current work of antioxidant activity of MSLE extract was done with different concentration. The extract reported good antioxidant activity in nitric oxide with 79.37% inhibition. The nitric oxide free radical scavenging may be done by various bioactive compounds of this extract. In particular, some antioxidant property compounds are identified from MSLE extract that is N-Hexadecanoic acid, pentadecanoic acid, tetradecanoic acid, tetradecanal, heptacosane, hentriacontane, tetratetracontane, and pentatriacontane [Table 3].

The antioxidant compound in our food has a key role as a health-protecting factor. Hence, it is considered a useful nutraceutical on account of many health benefits.[39-41] A major function of antioxidants is the trapping of free radicals, especially ROS and RNS, which are integral in the pathogenesis of several chronic and degenerative diseases including cancer, inflammation, cardio disease, and aging.[42] Recently, the use of natural antioxidants has been promoted and has become an important concern regarding the safety of synthetic ones.[43] Therefore, MSLE extract antioxidant activity has been studied with varying concentrations.

Diabetes is a metabolic disorder, with an increasing rate every year. In the control of glucose homeostasis, insulin plays a key role. The metabolism of carbohydrates, fats, and proteins is affected by less insulin secretion.[44,45] The intestinal human is home to enzymes called α-amylase and α-glucosidase, which are involved in the digestion of carbohydrates including starch and oligosaccharides. In comparison with plant-based medicines, synthetic drugs usually cause side effects such as abdominal pain, diarrhea, and soft faces in the colon. In the present research, the study has been carried out to screen of antidiabetic activity of MSLE extract. The result of this study was observed potential antidiabetic activity when sample concentration increased. Phytochemical constituents of MSLE extract inhibit the α-amylase and α-glucosidase enzymes as potentially.

Conclusion

The present study of phytochemical analysis, antioxidant, and antidiabetic activities is evaluated by *M. sericea* leaf extracts. Different kinds of phytocompounds are identified in each extract. Among these extracts, MSLE extract was reported to have several phytocompounds with bioactive uses. Based on these studies, MSLE extract has a good and novel therapeutic property so that sample is needed for further investigation to identify as a drug for antioxidant- and antidiabetic-based diseases.

Acknowledgment

Authors thank VIT Educational Institute, Vellore, Tamil Nadu, India, for phytochemical studies. Also thank JSS Pharmacy, Ooty, Tamil Nadu, India, for pharmacological studies.

References

1. Nostro A, Germano MP, Angelo V, Marino A, Cannatelli MA. Extraction methods and bioautography for evaluation of medicinal plant antimicrobial activity. Lett Appl Microbiol 2000;30:379.
2. Ncube NS, Afolayan AJ, Okoh AI. Assessment techniques of antimicrobial properties of natural compounds of plant origin: Current methods and future trends. Afr J Biotechnol 2008;7:1797-806.
3. Umamaheswari A, Niveditha G. Anticancerous effect of *Hibiscus sabdariffa* leaves on hepatocellular carcinoma cell line Hep 3B. Res J Medicinal Plant 2007;3:100-5.
4. Gnanaraja R, Prakash V. Preventive effect of *Tephrosia Purpurea* against N,N-diethylnitrosamine induced hepatocellular carcinoma in Swiss albino mice. J Biol Life Sci 2014;5:1-9.
5. Kamboj VP. An examination of the importance of plants in tradition ayurvedic system. Herbal medicine. Curr Sci 2000;78:35-9.
6. Gaudin O, Vacherat R. Rotenone and the ichthyotoxic power in some plants of the French Sudan. Bull Sci Pharmacol 1938;45:385-94.
7. Teesdale C. Freshwater molluscs in the east province of Kenya, with notes on an indigenous plant and its possible use in the control of bilharziasis. E Afr Med J 1954;31:351-65.
8. Kokwaro J. Medicinal Plants of East Africa. Nairobi, Kenya: East Africa Literature Bureau; 1976.
9. Arnold HJ, Gulumian M. Pharmacopoeia of traditional medicine in

Venda. J Ethnopharmacol 1984;12:35-74.
10. Luyeng L, Lee IS, Mar W, Fong HH, Pezzuto JM, Kinghorn D. Rotenoids and chalcones from *Mundulea sericea* that inhibit phorbol ester-induced ornithine decarboxylase activity. Phytochemistry 1994;36:1523-6.
11. Van Zyl JJ, Rall GJ, Roux DG. The structure, absolute configuration, synthesis, and 13C NMR spectra of prenylated pyranoflavonoids from *Mundules sericea*. J Chem Res M 1979;3:1301-20.
12. Fellows LE, Hinder RC, Bell EA. 3-[2-Amino-2-imidazolin-4(5)-yl] alanine (enduracididine) and 2-[2-amino-2-imidazolin-4(5)-yl] acetic acid in seeds of *Lonchocarpussericeus*. Phytochemistry 1977;16:1957-9.
13. Ciulci I. Methodology for the Analysis of Vegetable Drugs. Chemical Industries Branch, Division of Industrial Operations. Romania: UNIDO; 1994. p. 1-24.
14. Trease GE, Evans WC. Text Book of Pharmacognosy. 15th ed. London: Sannders WB, Company Limited; 2002. p. 1-585.
15. Roopashree TS, Dang R, Rani SR, Narendra C. Antibacterial activity of anti-psoriatic herbs: *Cassia tora*, *Momordica charantia* and *Calendula officinalis*. Inter J Appl Res Nat Prod 2008;1:20-8.
16. Kokate CK. Practical Pharmacognosy. 4th ed. New Delhi, India: Vallabhprakashan Publication; 1999.
17. Camporese A, Balick MJ, Arvigo R, Esposito RG, Morsellino N, De Simone F, *et al*. Screening of anti-bacterial activity of medicinal plants from Belize (Central America). J Ethnopharmacol 2003;87:103-7.
18. Whistler RL, BeMiller JN. Industrial Gums; Polysacchraida and their Derivatives. London, UK: Academic Press; 1993.
19. Sanker SD, Nahar L. Chemistry for Pharmacy Students General, Organic and Natural Product Chemistry. England: John Wiley and Sons; 2007. p. 283-359.
20. Szabo M, Idiuoiu C, Chambre D, Lupea A. Improved DPPH determination for antioxidant activity spectrophotometric assay. Chem Papers 2007;1:214-6.
21. Re R, Pellegrini N, Proteggente A, Pannala A, Yang M, Rice-Evans C. Antioxidant activity applying an improved ABTS radical cation decolorization assay. Free Red Bio Med 1999;26:1231-7.
22. Ruch RJ, Cheng SJ, Klaunig JE. Prevention of cytotoxicity and inhibition of intracellular communication by antioxidant catechins isolated from Chinese green tea. Carcinogenesis 1989;10:1003.
23. Hazra B, Biswas S, Mandal N. Antioxidant and free radical scavenging activity of *Spondias pinnata*. BMC Complement Altern Med 2008;8:1472-6882.
24. Saincheq-Moreno C. Review: Methods used to evaluate the free radical scavenging activity in foods and biological systems. Food Sci Technol Int 2002;8:121-37.
25. Worthington V. Alpha amylase. In: Worthington, V, editor. Worthington Enzyme Manual Freehold. New Jersey: Worthington Biochemical Corporation; 1993. p. 36-41.
26. Apostolidis E, Kwon YI, Shetty K. Inhibitory potential of herb, fruit, and fungal enriched cheese against key enzymes linked to Type 2 diabetes and hypertension. Innov Food Sci Emerg Technol 2007;8:46-54.
27. Gu R, Wang Y, Long B, Kennelly E, Wu S, Liu B, *et al*. Prospecting for bioactive constituents from traditional medicinal plants through ethnobotanical approaches. Biol Pharm Bull 2014;37:903-15.
28. Ifesan BO, Fashakin JF, Ebosele F, Oyerinde AS. Antioxidant and antimicrobial properties of selected plant leaves. Eur J Med Plants 2013;3:465.
29. Ansari N, Khodagholi F. Natural products as promising drug candidates for the treatment of Alzheimer's disease: Molecular mechanism aspect. Curr Neuropharmacol 2013;11:414-29.
30. Nichenametla SN, Taruscio TG, Barney DL, Exon JH. A review of the effects and mechanisms of polyphenolics in cancer. Crit Rev Food Sci Nutr 2006;46:161-83.
31. Vikrant A, Arya ML. A review on anti-inflammatory plant barks. Int J PharmTech Res 2011;3:899-908.
32. Calabrese V, Cornelius C, Dinkova-Kostova AT, Iavicoli I, Di Paola R, Koverech A, *et al*. Cellular stress responses, hormetic phytochemicals and vitagenes in aging and longevity. Biochim Biophys Acta. 2012;1822:753-83.
33. Kasolo JN, Bimenya GS, Ojok L, Ochleng J, Ogwal-Okeng JW. Phytochemicals and uses of *Moringa oleifera* leaves in Ugandan rural communities. J Med Plant Res 2009;4:753-7.
34. Ovensná Z, Vachalková A, Horváthová K, Táthová D. Pentacyclic triterpenoic acids: New chemoprotective compounds. Neoplasma 2004;51:327-33.
35. Anyasor GN, Ogunwenmo KO, Oyelana OA, Akpofunure BE. Phytochemical constituents and antioxidant activities of aqueous and methanolic stem extracts of Costus afer Ker Gawl (*Costaceae*). Afr J Biotechnol 2010;9:4880-4.
36. Eberhardt TL, Li X, Shupe TF, Hse CY. Chinese tallow tree (*Sapium sebiferum*) utilization: Characterization of extractives and cell-wall chemistry. Wood Fiber Sci 2007;39:319-24.
37. Chukwuma CI, Ibrahim MA, Islam MS. Myo-inositol inhibits intestinal glucose absorption and promotes muscle glucose uptake: A dual approach study. J Physiol Biochem 2016;72:791-801.
38. Lin H, Bean SR, Tilley M, Peiris KH, Brabec D. Qualitative and quantitative analysis of sorghum grain composition including protein and tannins using ATR-FTIR spectroscopy. Food Anal Methods 2021;14:268-79.
39. Droge W. Free radicals in the physiological control of cell function. Physiol Rev 2002;82:47-95.
40. Lee J, Koo N, Min DB. Reactive oxygen species, aging, and antioxidative nutraceuticals. Comprehen Rev Food Sci Food Saf 2004;3:21-33.
41. Valko M, Leibfritz D, Moncol J, Cronin MT, Mazur M, Telser J. Free radicals and antioxidants in normal physiological functions and human disease. Int J Biochem Cell Biol 2007;39:44-84.
42. ShangXia PA, XingFen Y, LinQing YA., Qing W, Ying Y, GuangNing XU, *et al*. Human GSTs polymorphisms in the Hakka population of south China and their associations with family history of several chronic diseases. Biomed Environ Sci 2011;24:491-8.
43. Shahidi F. Antioxidants in food and food antioxidants. Food Nahrung 2000;44:158-63.
44. Gandhi GR, Sasikumar P. Antidiabetic effect of *Merremia emarginata Burm.* F. in streptozotocin induced diabetic rats. Asian Pac J Trop Biomed 2012;2:281-6.
45. Frier BM, Fisher M. Diabetes mellitus. In: Boon NA, Colledge NR, Walker BR, Hunter JA, editors. Davidson's Principle and Practice of Medicine. 20th ed. Ediburgh: Churchill Livingstone Elsevier; 2006. p. 805-45.