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Original Article

Fatty acid composition and antibacterial potential of *Cassia tora* (leaves and stem) collected from different geographic areas of India

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ABSTRACT

The comparative analysis of the fatty acid composition of *Cassia tora* (leaves and stem) was determined using gas chromatography–mass spectrometry. Twenty-seven fatty acids were identified in *C. tora* (leaves and stem) which was collected from three different geographical areas of India: Lucknow (Uttar Pradesh), Nainital (Uttarakhand), and Bhavnagar (Gujarat), coded as CT-1, CT-2, and CT-3, respectively. The gas chromatography–mass spectrometry analysis showed the presence of various saturated and unsaturated fatty acids. The major fatty acids found were palmitic acid, linoleic acid, linolenic acid, margaric acid, melissic acid, and behenic acid. The highest amounts of saturated fatty acids were found in leaves of *C. tora* collected from Bhavnagar (Gujarat) (60.7% ± 0.5%). Thus, the study reveals that *C. tora* has a major amount of nutritionally important fatty acids, along with significant antimicrobial potential. Fatty acids play a significant role in the development of fat products with enhanced nutritional value and clinical application. Remarkable differences were found in the present study between fatty acid profiles of *C. tora* collected from different locations in India. To the best of our knowledge there is no previously reported comparative study of the fatty acids of *C. tora*.

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Original Article

Comparative Analysis of Fatty Acids and Antioxidant Activity of *Betula utilis* Bark Collected from Different Geographical Region of India

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ABSTRACT

Objective: The present study investigated the comparative analysis of fatty acid and antioxidant activity from the bark of *Betula utilis*, collected from Kashmir and Sikkim coded as BUK and BUS respectively. **Methods:** Fatty acid constituents were analyzed by GC-MS (gas chromatography mass spectroscopy) in BUK and BUS bark. *B. utilis* bark extracts of both the locations were phytochemically investigated and radical scavenging activity was evaluated by DPPH in all solvent fractions. **Results:** Phenolic content were found to be higher in methanolic extracts of BUK bark, 5.8 ± 0.1 mg/gm and flavonoid content were higher in the water extract of BUK bark, 6.16 ± 0.2 mg/gm. The radical scavenging activity was found to be higher methanolic, alcoholic and water extracts of BUK bark. The lowest IC_{50} value for radical scavenging activity of methanolic and water extracts of *B. utilis* bark collected from Kashmir were found 18.7 ± 1.1 and 18.2 ± 0.3 µg/mL, respectively. Thirteen fatty acids were identified in the sample BUK as well as BUS in which the major fatty acids were found-Palmitic acid, linoleic acid and oleic acid. BUK possess the highest amount of Palmitic acid (18.07%) in oily portion of the bark. **Conclusion:** The present study concluded that BUK and BUS extracts have shown significant antioxidant activity in comparison to standard but BUK possess potent radical scavenging activity over BUS, and higher amounts palmitic acid, linoleic acid and oleic acid was present in the extract, and may a play an important role in nutritional and pharmaceutical applications.

Key words: *Betula utilis*, Free radicals, Antioxidant, Total phenol, Flavonoid.

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INTRODUCTION

Betula utilis D. Don or Himalayan Silver Birch (*Betulaceae*) commonly known as Bhojpatra (Hindi). *B. utilis is* a moderate-sized tree that grows up to 20 m in height. The bark is smooth, shining, reddish white or white, with white horizontal lenticels, the inner layers pink. It is widely distributed in northern India and is generally known for its therapeutic applictions.[1] Traditionally, bark was used for the treatment of astringent, acrid, antibacterial, anticonvulsant, constipation, expectorant and as a tonic. The bark contains betulin, lupeol, oleanolic acid, acetyloleanolic acid, betulinic acid, lupenone, sitosterol, methyle betulonate, methyl betulate and a new triterpenoid, karachic acid. It is aromatic and has the antiseptic properties.[2,3]

The Fatty acids are widely occurring in natural fats and dietary oils and they play an important role as nutritious substances and metabolites in living organism. Recent studies have also clearly shown the important impact of fatty acids in particularly unsaturated fatty acids on human health in the prevention of, Human diseases.[5]

In the present study, the fatty acid analysis and antioxidant activity from the bark of *B. utilis* collected from two different geographical locations (Kashmir and Sikkim) in India was studied. Earlier the fatty acid composition from the bark of *B. utilis* has been reported which was collected from Uttarakhand, but comparative analysis of fatty acids and antioxidant activity not yet reported previously.

MATERIAL & METHODS

Plant Material

B. utilis bark collected from Kashmir and Sikkim codes as BUK and BUS respectively. The plant materials were authenticated at the Herbarium of the CSIR-National Botanical Research Institute, Lucknow, where voucher specimens BUK (253494) and BUS (255812) are deposited. The bark was collected and washed thoroughly, dried in shade and then powdered in a mixer-grinder and used for the further study.

Extraction and fractionation

Shade-dried bark of *B. utilis* were milled into powder and then extracted with methanol and alcohol in an extractor for 36 h. The extract was evaporated in a rotatory evaporator and dried by vacuum pump. The methanol extract was suspended in water and extracted successively with hexane, ethyl acetate, chloroform, and water for five times at room temperature. The resulting four extracts were evaporated under vacuum to dryness the hexane, ethyl acetate, chloroform and water fractions. They were quantitatively re-dissolved in methanol. The stock solution was kept at 4°C in the dark until further analysis.

Determination of Total Phenolic Content

Total Phenolic content was determined by the folin-ciocalteu method[6] and calculated using gallic acid as a standard. 20 µl, 40 µl, 60 µl, 80 µl, 100 µl (1 mg/ml) of methanol, alcohol, hexane, ethyl acetate, chloroform and water extract of BUK and BUS (bark), 0.5 ml of the folin-ciocalteu (50%) reagent was added while mixing gently. After 2 min, 1 ml of sodium carbonate (20% solution) and 12.5 ml of distilled water was added. The content were mixed and allowed to stand for 2 h. The optical density of the samples was measured at 720 nm and total phenolic content were expressed as equivalent to Gallic acid.

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Chemical Composition and Antibacterial Activity of Essential Oil from Leaves of *Justicia adhatoda* Against Methicillian Resistant and Sensitive Strain Along with Their Clinical Isolates

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Abstract: Higher and aromatics plants have traditionally been used in folk medicine as well as to extend the shelf life of foods, showing inhibition against bacteria, fungi and yeasts. Most of their properties are due to essential oils produced by their secondary metabolism. Essential oils and extracts from several plant species are able to control microorganisms related to skin, dental caries, and food spoilage, including Gram-negative and Gram-positive bacteria. The present study is based on the evaluation of antimicrobial activity of the essential oil of the fresh leaves of *Justicia adhatoda* and to identify the chemical constituents responsible for antimicrobial potential. The chemical constituents of essential oil were identified by gas chromatography-mass spectrometry (GC-MS). The essential oil was evaluated for the antimicrobial potential against methicillin resistant and sensitive *Staphylococcus aureus* along with its clinical isolates. GC-MS analysis revealed that the major constituents of the essential oil were phytol (57.8 %), n-hentriacontane (3.92 %), nonacosane (3.65 %), pentacosane (2.65 %), β-Eudesmol (1.14 %), heneicosane (1.13 %). Result indicates that *J. adhatoda* leaves essential oil has a strong antimicrobial activity against mentioned microorganisms (MIC: 62.5-250 µg/mL).

Key words: *Justicia adhatoda;* essential oil; antimicrobial activity; GC-MS, multiplex PCR.

Introduction

Justicia adhatoda is a species of plant in the Acanthaceae family. It is a shrub growing throughout India especially in the lower Himalayan regions. The name, *J. adhatoda* L. and *Adhatoda zeylanica* Medic are used synonymously. It is commonly known as Vasaka or Malabar nut. It is a perennial, evergreen and highly branched shrub (1.0 m to 2.5 m height) with unpleasant smell and bitter taste [1]. It has opposite ascending branches with white, pink or purple flowers. The plant has potent anti-periodic, astringent, diuretic and purgative action; it is a highly valued Indian medicinal plant which is used in the treatment of respiratory diseases like asthma, cough, bronchitis and tuberculosis [2]. The leaves have been reported to contain alkaloids, vasicinone, vasicinol, adhatodine, adhatonine, adhavasinone, anisotine and peganine

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Rapid quantitative analysis of multi-components in *Andrographis paniculata* using UPLC-QqQ$_{LIT}$-MS/MS: Application to soil sodicity and organic farming

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ABSTRACT

An ultra performance liquid chromatography-triple quadrupole-linear ion trap mass spectrometry method in multiple-reaction monitoring mode was developed for the rapid determination of 12 bioactive compounds in the leaf and stem of *Andrographis paniculata* (*A. paniculata*). Different soil conditions i.e., soil sodicity and use of organic manure was manually prepared and its effect on the extractive yield and quantity of bioactive phytoconstituents was studied. A good linear regression relationship (r^2, 0.9988–0.9999), intra-day precision (RSD, 0.17–3.22%), inter-day precision (RSD, 0.31–3.44%), stability (RSD, 1.19–3.09%), and recovery (RSD, 1.03–3.20%) were obtained for all the analytes. The results showed significant differences in the content of diterpenoids, flavonoids, phenolics and triterpenoid compounds. Major markers i.e., andrographolide and neoandrographolide (187.5 mg/g and 109.0 mg/g, respectively) were detected highest in silty clay loam soil with addition of 3.5% organic manure in leaf of *A. paniculata*. This study was designed to benefit the cultivators by suggesting them about the suitability of soil and manure conditions to enhance the quantity of major bioactive compounds from *A. paniculata*. The present work described a highly specific, sensitive and rapid determination method of 12 bioactive compounds.

1. Introduction

Andrographis paniculata Nees. (Acanthaceae), also known as Kalmegh, is an erect herb well known in Asia. It occurs widely in the plains of India, Mainland China, Taiwan and Sri Lanka (Gamble, 1956). The entire plant has been used as anti-inflammatory and antipyretic agent for the treatment of fever, cold, laryngitis, diarrhea and inflammatory diseases (Chang et al., 1986). The crude extract of *A. paniculata* and its major constituents such as andrographolide and neoandrographolide has been attributed for the therapeutic activity of this herb and are reported to display a number of biological activities such as antiviral (Yao et al., 1992), anti-bacterial (George and Pandalai, 1949), immune stimulatory (Puri et al., 1993), hepatoprotective (Kapil et al., 1993; Raina et al., 2013) anti-fertility (Akbarsha et al., 1990), anti-thrombotic (Zhao and Fang, 1991), anti-diabetic (Zhang and Tan, 2000a,b), anti-cancer (Matsuda et al., 1994; Rajagopal et al., 2003), anti-oxidant and anti-inflammatory (Rafat et al., 2010; Sheeja et al., 2006). Phytochemical investigations of chemical composition have shown that ent-labdane diterpenoid lactones (Chen et al., 2008; Matsuda et al., 1994; Mishra et al., 2007), phenolics (Satyanarayan et al., 1978) and flavonoids (Gupta et al., 1996, 1983; Jalal et al., 1979; Kuroyanagi et al., 1987) are the main classes of compounds in *A. paniculata*.

Soil sodicity is a major problem affecting plant growth and productivity in the arid and semiarid regions of the country. This leads to elevated soil pH which influences the availability of certain plant nutrients resulting in severe crop loss (Prasad et al., 2006; Sharma, 2006; Tiwari et al., 2012). As per a recent National Remote Sensing Centre (NRSC) report more than 50 million hectare (ha), or 16% of Indian land area is wasteland. Uttar Pradesh is the largest state of the country which alone contributes 2.55 lakh ha^{-1} equal to 37.51% saline and sodic land area of the country (Government of India

Abbreviations: ds m^{-1}, decisiemens per meter; t ha^{-1}, tonns per hectare.

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SHORT COMMUNICATION

Fatty acid composition of *Sonchus arvensis* L. roots

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The roots of *Sonchus arvensis* L. were extracted with petroleum ether to afford the extract 2.39 % yield to the fresh weight of the material. The fatty acid methyl esters (FAME) was prepared from the extract and analyzed by GC and GC-MS. Eighteen fatty acids were identified and major fatty acids found to be Myristic acid (26.23 %), Palmitic acid (26.23 %), Linoleic acid (19.94 %), Pentadecanoic acid (3.11 %), Stearic acid (1.49 %), Behenic acid (1.27 %). The most abundant fatty acid identified was Myristic acid (26.23 %).

Keywords: *Sonchus arvensis*, Field-milk Thistle, Fatty acids, Myristic acid, Linoleic acid, Palmitic acid.

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Introduction

Sonchus arvensis L., Field-milk Thistle, is an annual plant, easy to grow in rainy and sunshine areas such as on river banks, ridges of rice field and abandoned fields 50-1650 m above sea level. The plant is a native to Eurasia with a tapered root and produces bitter latex. It is considered the most economically detrimental[1-2].

As a class of edible wild plants, *Sonchus* species are widely distributed in China[3]. The aerial parts of *Sonchus* species, popularly known as 'kucai', which remain the cheapest source of proteins, vitamins, minerals and essential amino acids in the diet of many people, may be of great importance in helping to alleviate hypoalimentation-associated problems[4]. In China wild species of *Sonchus* are used as vegetables and as infusion or decoction they are administered orally or externally to treat acute icterohepatitis, cancer, inflammation, rheumatism, diarrhoea and snake venom poisoning[5]. *S. arvensis* is one of the medicinal herbs used in traditional medicines, in which the leaf extract is used as a diuretic, lithotriptic and antiurolithiasis agent; also indicated for fever, poisoning and swelling or abscess. *S. arvensis* has long been used as folk medicine for the treatment of fever, stasis and inflammation. They also have effects through the detoxification and mobilization of blood circulation[6]. The plant is valued as a delicious and nutritional herb and has been used for the treatment of caked breasts, asthma, coughs and other chest complaints and for calming the nerves. It also has insecticidal properties and anti-inflammatory activity[7]. Phytochemically, *S. arvensis* has been studied mainly for the presence of flavonoids, triterpenoids, eudesmanolids, quinic acid derivatives and phenylpropanoids[8-9].

There are three main types of fatty acids such as saturated, monounsaturated and polyunsaturated. The percentage of these compounds differs in each vegetable oil. Fatty acids that are required by the human body but cannot be made in sufficient quantity from other substrates, and therefore, must be obtained from food, are called essential fatty acids. Two essential fatty acids are linoleic acid (LA) and alpha-linolenic acid (ALA). They are widely distributed in plant oils. There are some specific benefits of essential fatty acids, viz. they boost our immune system, muscle of our body and the heart. These essential fatty acids are also vital in providing help in many functions involving the brain and help in soothing inflammations such as joint pains or back pains. Fatty acids with unsaturation, either monounsaturated or polyunsaturated, have been used in lowering the risks of heart diseases against inflammation and in enhancing the immunity or immune system[10]. In recent times the biological importance of fatty acids has gained considerable importance in food evaluation and also in the diagnosis of certain diseases and pharmacology[11-12].

To the best of our knowledge, studies on the fatty acids of root of *S. arvensis* have not yet been undertaken. The composition of fatty acids from the root of *S. arvensis* is needed in order to explore new frontiers for their pharmacological importance.

Materials and Methods

Plant Material

The fresh roots of *S. arvensis* were collected from Nawabganj, District-Unnao, U. P. India. The plant was

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