

Full Length Research Paper

DNA fingerprinting for the authentication of *Ruta graveolens*

Salim Khan^{1*}, Khanda Jabeen Mirza² and Malik Zainul Abidin²

¹Department of Botany and Microbiology, College of Science, King Saud University, Riyadh, 11451, Kingdom of Saudi Arabia.

²Centre for Transgenic Plant Development, Jamia Hamdard, New Delhi-110062, India.

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***Ruta graveolens* is a small aromatic shrub and has been used medicinally and magically, since ancient times. In this study, random amplified polymorphic DNA (RAPD) was employed to develop reproducible markers for authentication of this species from its adulterant *Euphorbia dracunculoides*. The random decamer oligonucleotide primers (42) were screened for identification of genuine and adulterant samples using the DNA isolated from the dried leaf, seed and stem of both samples. Out of 42 primers, 10 gave faint band, 12 gave species-specific reproducible unique band and the remaining did not amplify the DNA. RAPD could thus, serve as a complementary tool for quality control.**

Key words: Adulterant, *Euphorbia dracunculoides*, herbal drugs, random amplified polymorphic DNA.

INTRODUCTION

Medicinal plants are well known for their reputed medicinal properties; however, most of them are empirically used in Indian system of medicine to cure several human ailments. According to an estimate of the World Health Organization (WHO; <http://www.who.int/research/en>), about 80% of the world population still uses herbs and other traditional medicines for their primary health care needs. Correct identification and quality assurance is indispensable to ensure medicinal quality of herbal drugs. Authentication is especially useful in cases of those medicinal herbs that are frequently substituted or adulterated with other species or varieties which are morphologically and phytochemically indistinguishable. Several herbal drugs on the market still cannot be identified or authenticated based on their morphological or histological characteristics. Use of a wrong herb may be ineffective or

it may worsen the condition. Traditional Chinese medicine (TCM) contaminated with plants *Aristolochia* species in Belgium has resulted to an epidemic of subacute intestinal nephropathy in patients and many of them required kidney transplantation when examined histologically (Cosyns et al., 1999).

Several plants of *Rutaceae* family are used in traditional medicine world-wide. The most common medicinal plant of this family is *Ruta graveolens* (L.), known as rue and native to Europe. It is an ornamental evergreen shrub of one meter high (approximately), aromatic with sharp unpleasant odor and culinary. The leaves are small, oblong, deeply divided, pinnate and glandular dotted. The ramified stem has small yellow flowers in clusters and each has four petals except for the central flower which has five petals during spring and summer season. The fruits are small, rounded, lobulated and brown in color. The taste of the fruit is slightly stinging but is masked by a strong bitter taste (Zargari, 1990).

The roots and aerial parts of this plant contain more than 120 compounds of different classes of natural products such as acridone alkaloids, coumarines, essential oils, flavonoids and furoquinolines (Kostova et al., 1999; Kuzovkina et al., 2004) and is the main source of furanocoumarins such as psoralen, xanthotoxin (8-meth-

*Corresponding author. E-mail: salimkhan17@yahoo.com

Abbreviations: RAPD, Random amplified polymorphic DNA; TCM, traditional Chinese medicine; PCR, polymerase chain reaction; CTAB, cetyltrimethylammonium bromide; EDTA, ethylenediaminetetraacetic acid; PVP, polyvinylpyrrolidone.

oxyporsalen; 8-MOP) and bergapten (5-methoxy-porsalen; 5-MOP) (Milesi et al., 2001). *R. graveolens* is being widely used for medicinal purpose in various clinical conditions from very ancient time but rationality of use is still controversial. In homeopathy, rue is an important remedy for deep aching pain and rheumatism besides being used for eyestrain-induced headache (Miguel, 2003). It has also been used as a remedy for gastric disorders, stiff neck, dizziness, headache and so on (Conway and Slocumb, 1979). Besides, rue is widely used as sedative, antihelmintic (Skidmore-Roth, 2001), hypotensive (Chiu and Fung, 1997; Trovato et al., 2000), anti-inflammatory, antiviral, antiplasmodial (Yamamoto et al., 1989; Raghav et al., 2006; Queener et al., 1991), antimicrobial, cytotoxic (Ivanova et al., 2005), antifungal (Oliva et al., 2003; Meepagala et al., 2005), as herbicide (Hale et al., 2004) and contraceptive (Maurya et al., 2004; Harat et al., 2008). The polyphenolic and alkanoid fractions of *R. graveolens* showed protective effects on acute and chronic inflammation in rat (Ratheesh et al., 2009) and total extract (70% ethanol) showed *in vitro* cytotoxicity against tumor cell lines of different origin (Varamini et al., 2009). This medicinal shrub also has some adverse effects such as anti-fertility and abortion in female which have been reported from countries, viz., Brazil (de Freitas et al., 2005), India (Gandhi et al., 1991), Peru (Gutierrez-Pajares et al., 2003) and Mexico (Conway and Slocumb, 1979). Another specie of different genus with similar morphology named '*Euphorbia dracunculoides* (L.)' is being sold in local markets or used clinically as a replacement of *R. graveolens* at a relatively reduced cost under the local name 'suddaba' (Rahman et al., 2003). This may result in reducing the efficacy and quality of *R. graveolens* and may have adverse effects such as epistaxis, nausea/vomiting and haematuria (Rahman et al., 2003). Limitations of chemical and morphological markers for authentication have generated a need for newer methods in quality control of *R. graveolens*. However, DNA-based molecular markers are important tools in quality assurance and preservation of germplasm of medicinal plant species. Genuine sample specific markers (*R. graveolens*) are needed to maintain the quality and efficacy for herbal formulations. Our major objective therefore, is to develop DNA-based molecular tool for accurate identification of *R. graveolens* from its adulterant *E. dracunculoides*.

MATERIALS AND METHODS

The genuine sample of *R. graveolens* was provided by the Central Council for Research in Unani Medicine (CCRUM), Hyderabad. The samples for authentication were purchased from local markets of Khari Baoli, Delhi, India. The material was identified at the National Institute of Science Communication and Information (NISCAIR) by Dr. H. B. Singh and voucher (NISCAIR/RHMD/consult/-2007-08/937/121) was kept in the herbarium. Leaves powder of 100 mg each was used for DNA extraction using modified cetyltrimethylammonium bromide (CTAB) method (Khan et al., 2007). The total

genomic DNA was used in random amplified polymorphic DNA (RAPD)-polymerase chain reaction (PCR) to develop fingerprints for the authentication of genuine as well as adulterant samples.

Reagents and chemicals

The stock solution concentration were: CTAB 3% (w/v), 1 M Tris-Cl (pH 8), 0.5 M ethylenediaminetetraacetic acid (EDTA) (pH 8), 5 M NaCl, absolute ethanol (AR grade), chloroform-IAA (24:1 (v/v)), polyvinylpyrrolidone (PVP) (40,000 mol wt) (Sigma) and β -mercaptoethanol. All the chemicals used in the experiments were of analytical grade. The extraction buffer consisted of CTAB 3% (w/v), 100 mM Tris-Cl (pH 8), 25 mM EDTA (pH 8) and 2 M NaCl, respectively. The PVP and β -mercaptoethanol were prepared freshly and added.

RAPD analysis

RAPD reaction was performed according to the method developed by McClelland et al. (1995). The total volume of reaction was performed in 25 μ l. PCR reaction for RAPD analysis consisted of 15 mM MgCl₂, 2.5 μ l 10x buffer, 2 μ l 2 mM dNTPs (mix), 1.5 U Taq polymerase in buffer, 25 ng/ μ l of each primer, 30 ng/ μ l plant DNA and sterile water of 18 μ l. All reagents were supplied by Bangalore Genei Pvt. Ltd (Bangalore, India) except for primers, which were supplied by Genetix Biotech Asia Limited (Bangalore, India). For DNA amplification, a Techne thermal cycler was programmed for 1 cycle of 3 min at 94°C, 30 s at 35.5°C and 1 min at 72°C followed by 45 cycles of 1 min at 94°C, 30 s at 35.5 and 72°C for 1 min, then final extension for 5 min at 72°C. The RAPD fragments were separated on 1.2% agarose gel by electrophoresis in 1xTAE buffer and stained with ethidium bromide.

RESULTS

R. graveolens was chosen to test the reliability of quality control using RAPD technique. *E. dracunculoides* was found as an adulterant in the local market samples, when identified later at NISCAIR, New Delhi (voucher no, NISCAIR/RHMD/consult/-2007-08/937/121). The dried leaves, fruits and stem of *E. dracunculoides* is more or less similar in morphology with those of *R. graveolens*, there-by difficult to differentiate from each other (Figure 1). It leads to confusion among customers and *E. dracunculoides* is bought mistakenly instead of *R. graveolens* due to low cost. The RAPD technique was carried out in replicate (two) on both plants for reproducibility using 42 decamer primers. Out of 42 primers, 12 generated unique, monomorphic and polymorphic fragments, whereas remaining primer did not give amplification using genomic DNA extracted from leaves, seeds and stem, respectively. The unique fragments generated in RAPD profile have shown differentiation between genuine and adulterant samples. RAPD fingerprints generated from genomic DNA isolated from dried leaves, fruits and stem was same with all decamer primers. The total number of unique fragments specific to genuine as well as adulterant samples with different primers is summarized in Figures 2 - 4 and Table 1.



Figure 1. Morphological slides of genuine and adulterated samples. **A.** Genuine samples of *R. graveolens* provided by Central Council for Research in Unani Medicine (CCRUM) Hyderabad; **B.** adulterated samples of *R. graveolens* with *E. dracunculoides* purchased from Khari Baoli, New Delhi, India.

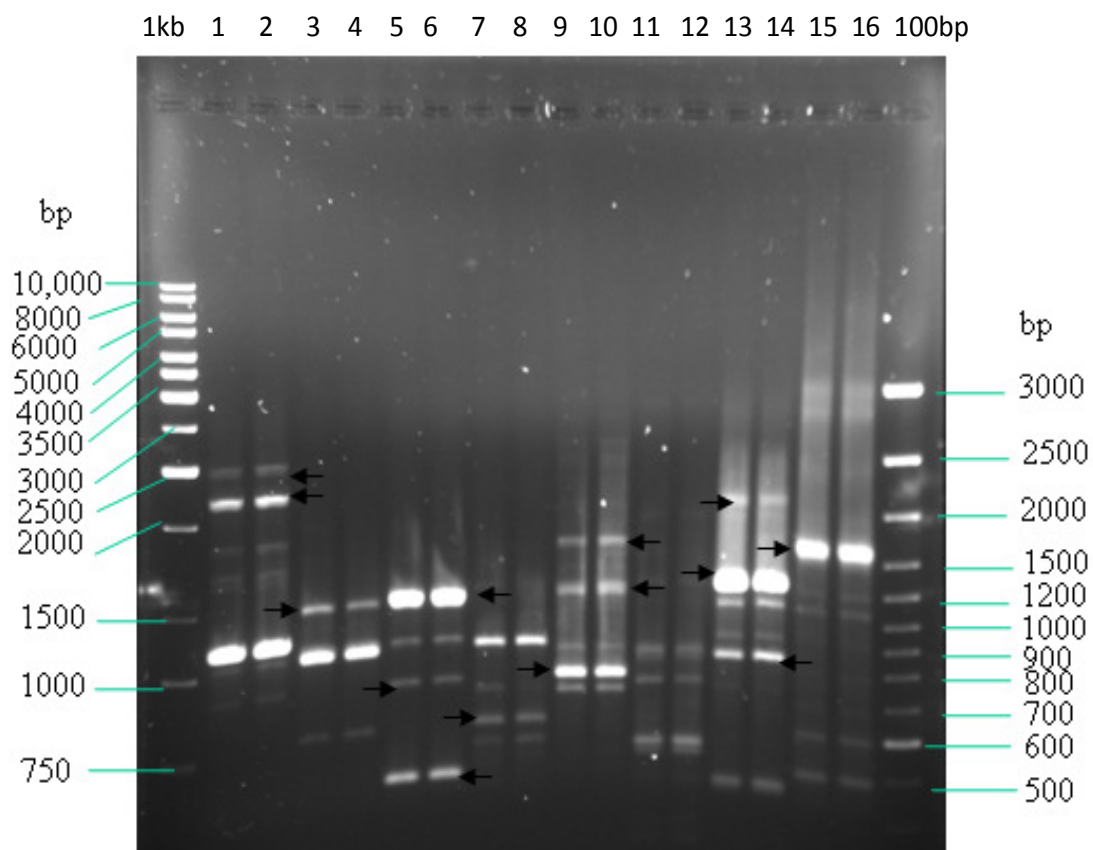


Figure 2. RAPD analysis carried out with primers. P-11 (lanes: 1 - 4), P-12 (lanes: 5 - 8), P-13 (lanes: 9 - 12), P-14 (lanes: 13 - 16) on genomic DNA extracted from leaf of *R. graveolens* (lanes: 1, 2, 5, 6, 9, 10, 13 and 14) and *E. dracunculoides* (lanes: 3, 4, 7, 8, 11, 12, 15 and 16). 1 kb and 100 bp are DNA ladder.

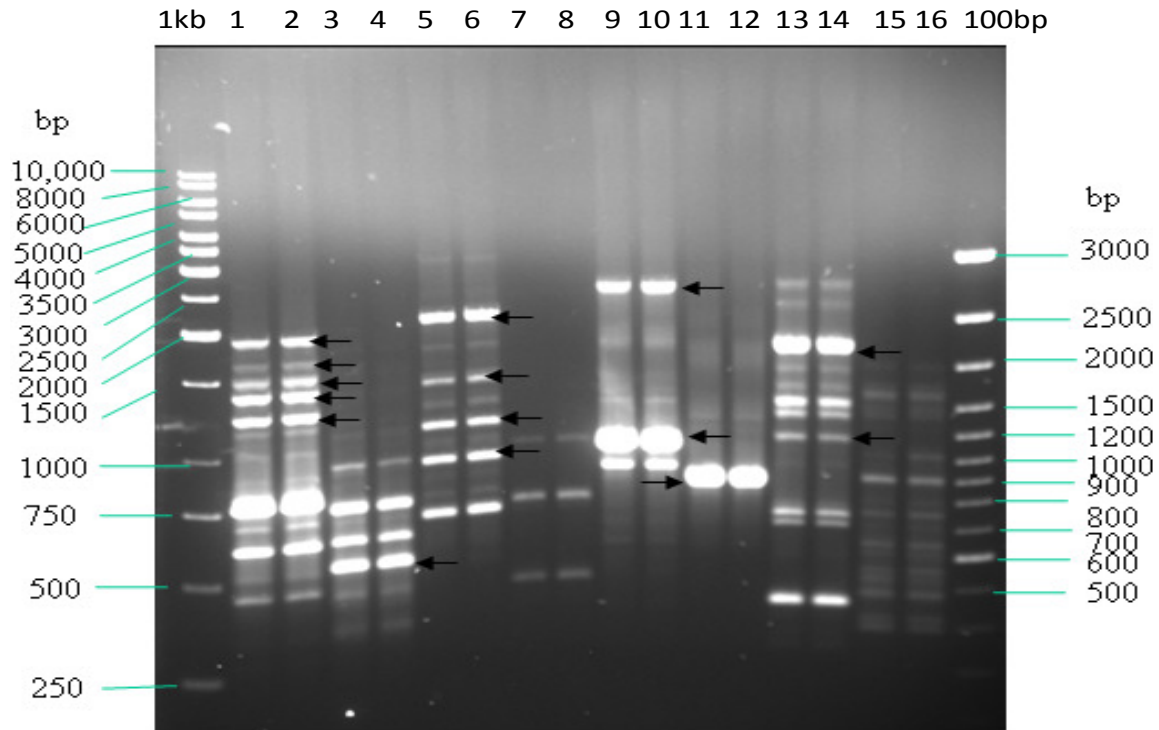


Figure 3. RAPD analysis carried out with primers. OPC-1 (lanes: 1 - 4), OPC-2 (lanes: 5 - 8), OPC-3 (lanes: 9 - 12), OPC-4 (lanes: 13 - 16) on genomic DNA extracted from leaf of *R. graveolens* (lanes: 1, 2, 5, 6, 9, 10, 13 and 14) and *E. dracunculoids* (lanes: 3, 4, 7, 8, 11, 12, 15 and 16). 1 kb and 100 bp are DNA ladder.

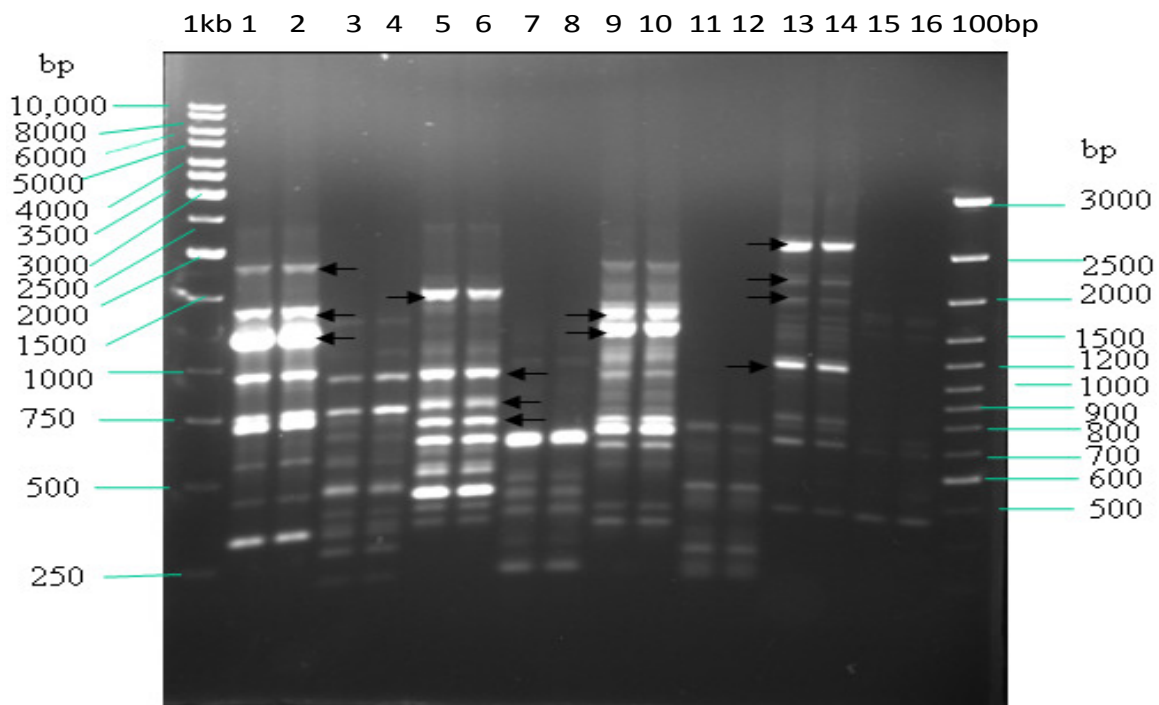


Figure 4. RAPD analysis carried out with primers. OPC-11 (lanes: 1 - 4), OPC-12 (lanes: 5 - 8), OPC-13 (lanes: 9 - 12), OPC-14 (lanes: 13 - 16) on genomic DNA extracted from leaf of *R. graveolens* (lanes: 1, 2, 5, 6, 9, 10, 13 and 14) and *E. dracunculoids* (lanes: 3, 4, 7, 8, 11, 12, 15 and 16). 1 kb and 100 bp are DNA ladder.

Table 1. The unique amplicons specific to *R. graveolens* and *E. dracunculoides* samples with 12 decamer oligonucleotides primers obtained in PCR amplification.

Plant species	Size of unique fragments (bp)				Size of unique fragments (bp)				Size of unique fragments (bp)			
	P-11	P-12	P-13	P-14	OPC-1	OPC-2	OPC-3	OPC-4	OPC-5	OPC-6	OPC-7	OPC-8
<i>R. graveolens</i>	2400, 2200	1200, 800, 550	1800, 1300, 800	2300, 1300, 900	2400, 2000, 1800, 1500, 1400	2500, 1900, 1400, 1000	2800, 1200	2400, 1200, 450	2500, 1900, 1500	2000, 1100, 900, 850	1900, 1600	2600, 2200, 2000, 1200
<i>E. dracunculoides</i>	1200	650	-	1600	600	-	950	-	-	-	-	-
Total no of unique fragments/ primer	3	4	3	4	6	4	3	3	3	4	2	4

(Genders, 1994). Since, dried parts of this scented plant such as leaves, fruits and stem are used in herbal formulations, morphological characteristics of dried parts of genuine and adulterants are more or less similar, thereby presenting difficulty in discriminating by conventional methods (Figure 1). However, another species, named 'suddaba' (*E. dracunculoides*), is easily adulterated and/or substituted with *R. graveolens* in local herbal markets (Rahaman et al., 2003). The leaves of *R. graveolens* are bipinnate or tripinnate and obviate-oblong, whereas *E. dracunculoides* are lanceolate or linear oblong, subacute, base rarely rounded or subcordate. The odour and taste are not distinct in *R. graveolens* and *E. dracunculoides*. The fruit of *R. graveolens* is capsule, 4 - 5 lobed globose, numerous tiny blackish seeds triangular in shape, while fruit of *E. dracunculoides* is capsule with subglobose shape, 3-celled and seeds are ovoid-terete with gray or dark gray color. However, these morphological markers sometimes deviate for precise authentication of *R. graveolens* and leads to degradation of quality and efficacy of this medicinal shrub.

Our study showed clear discrimination of *R. graveolens* and *E. dracunculoides* based on unique fragments generated with 12 decamer primers. However, each fragment in RAPD is derived from a region of the genome that contains two short segments in inverted orientation on opposite strands and is complementary to the primer for reproducible amplification (Hon et al., 2003). The primer OPC-1 amplified more unique fragments such as 2400, 2000, 1800, 1500 and 1400 bp as compared to other primers which would be applicable at large scale for authentication of *R. graveolens* (Table 1). According to traditional usage and animal studies, both plants have different medicinal effects and adulteration of genuine sample may have undesirable effects. The developed RAPD fingerprints for genuine as well as adulterant samples would be helpful for correct preparation of herbal drug formulations. The RAPD analysis has been widely used for differentiation of a large number of medicinal species from their close relatives or adulterants, viz.,

Panax species (Shaw and But, 1995), *Coptis* species (Cheng et al., 1997), *Astragalus* species (Cheng et al., 2000), *Lycium barbarum* (Cheng et al., 2000), *Panax ginseng* (Um et al., 2001), *Echinacea* species (Nieri et al., 2003), turmeric (Sasikumar et al., 2004), *Astragali radix* (Na et al., 2004), *Dendrobium officinale* (Ding et al., 2005), *Typhonium* species (Acharya et al., 2005), *Dendrobium* species and its products (Zhang et al., 2005), *Tinospora cordifolia* (Rout, 2006), *Mimosae tenuiflorae* (Rivera-Arce et al., 2007), *Rahmannia glutinosa* cultivars and varieties (Qi et al., 2008), *Desmodium species* (Irshad et al., 2009), *Glycirrhiza glabra* (Khan et al., 2009), *Piper nigrum* (Khan et al., 2010) and *Cuscuta reflexa* (Khan et al., 2010). The components of *Rasayana churna* was identified by RAPD-PCR which have three Ayurvedic medicines such as dried stem of *Tinospora cordifolia*, dried fruit of *Emblia officinalis* and dried fruit of *Tribulus terrestris* (Shinde et al., 2007). The marker of size 600 bp was specific to *T. cordifolia*, 500 bp specific to *E. officinalis* and the remaining >1000 bp was present in *T. terrestris* (Shinde et al., 2007). The same species of *Selaginella* which has medicinal value was collected from different habitats and authenticated by RAPD marker (Li et al., 2007). The advantages of RAPD technique is their simplicity, rapidity, requirement of low amount of genomic DNA and avoidance of radioactive substances (Micheli et al., 1994). However, synthesis of decamer primers also avoids prior genetic information of studying plants. Our RAPD marker therefore, may prove to be reproducible under a wide variation of amplification conditions such as an annealing temperature, origin of the primer, *Taq* polymerase and thermal cycler. In this study, we could suggest that RAPD technique is convenient for identification of *R. graveolens* and its adulterant *E. dracunculoides* in the local herbal markets.

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