

Full Length Research Paper

Medicinal plants diversity at King Salman Bin Abdulaziz Royal Natural Reserve in Saudi Arabia and their conservation management

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King Salman Bin Abdulaziz Royal Natural Reserve (KSRNR) is the largest protected area in the Middle East. This literature review study considered the primary survey on the native medicinal plant diversity at KSRNR in the Kingdom of Saudi Arabia (KSA). KSRNR flora, until now, has about 260 plant species, representing about 12% of the KSA flora. Information was gathered through an extensive literature survey, which resulted in 91 plant species (35% of KSRNR species) that have traditional medicinal uses. These plant species belong to 68 genera and 29 families. Asteraceae and Brassicaceae have the highest number of species (14 and 8, respectively), while 14 families have only one species. The medicinal plants were categorized into three life forms; shrubs were the dominant (40% of the total species), while trees were the lowest (2%). Among the species, 50% of them use the whole plant for treatment, followed by the leaf (20%), while less than 1% use their latex. Additionally, twenty-three medicinal species were used to treat a single disease. It is worth noting that the majority of KSRNR plant species (62%) were uncommonly distributed in the KSRNR regions. This study underscores the importance of prioritizing conservation efforts and sustainable development for wild medicinal plant species in KSRNR and KSA.

Key words: KSRNR, Medicinal plant, traditional uses, conservation.

INTRODUCTION

Traditional knowledge is the interaction between local people and the surrounding environment (Bargali et al., 2003; Padalia et al., 2015). This interaction includes using and managing natural resources (Luna-José and Aguilar, 2012).

Local communities' livelihood depends on agricultural and animal products and other natural resources, such as plants (Alam et al., 2011; Polat et al., 2017). Plant

diversity provides essential resources and shelter for higher trophic-level organisms (Moreira et al., 2016; Schuldt et al., 2019). Worldwide, local communities have developed their knowledge of plant resources and use in addition to natural resource management and conservation (Cotton, 1996; Alam et al., 2011; Moreira et al., 2016; Schuldt et al., 2019).

The unsustainable use of wild medicinal plants and

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their habitats by many factors, such as overcutting, overgrazing, and urban development, leads to a decline in plant diversity and degraded habitats. The greatest challenge to the future conservation agenda of plant resources is the extinction of wild plant species (Al-Mutairi et al., 2015; Alharbi, 2017).

Medicinal plants have historically played a vital role in alternative medicine and have been integral in the development of new medications, thus contributing significantly to the healthcare of populations worldwide (Newman et al., 2000; Ullah et al., 2020). In the early nineteenth century, plants were the basis for 80% of medicines, but with the growth of the pharmaceutical industry driven by the scientific revolution, synthetic pharmaceuticals took over (Gilani and Atta-ur-Rahman, 2005; Shinwari and Qaiser, 2011; Ullah et al., 2020). Local communities prefer using plants to treat various diseases since they are considered safe and effective treatments with few side effects and are relatively inexpensive (Odhav et al., 2013; Ullah et al., 2020). Traditional medicine knowledge is the heritage that follows from generation to generation, verbally or in writing. Traditional inheritance generally faces extinction and needs insurance to transmit from the old to the new generation (Aziz et al., 2018; Ullah et al., 2020). Traditional medicine uses various plant parts, including the bark, flower, fruit, leaf, resin, rhizomes, roots, seeds, and stems, that contain chemically effective compounds that have specific physiological effects on the human and animal bodies (Alqethami et al., 2017; Briskin, 2000; Alqethami and Aldhebiani, 2021).

Across the ages, in Arab and Islamic countries, medicinal plants have an essential role in healthcare as they strongly correlate with the Prophetic and Islamic medicine systems and the presence of many great medical scientists (Aati et al., 2019; Alqethami et al., 2020). Since ancient times, plant species in different regions of the Kingdom of Saudi Arabia (KSA) have been under tribal protection. Until now, KSA people have used medicinal plants to treat many common diseases by traditional healers who were considered primary references for the traditional uses of medicinal plants information (Khalil et al., 2018; Tounekti et al., 2019). Many studies reported that from 1990, the local Saudi population returned to relying on alternative medicine and medicinal plants in their daily lives (Abulafatih, 1987; Tounekti et al., 2019; Ullah et al., 2020; Organization, 2001; Rahman et al., 2004).

Bodeker and Ong (2005) concluded that numerous ethnobotanical surveys conducted in KSA revealed that many of the country's residents depend on traditional medicine, either on its own or in conjunction with modern medicine. For example, three ethnobotanical surveys showed that 80% of the sampled persons had used medicinal plants for treatments, while the other studies resulted in 20 and 70% (Ullah et al., 2020). For chronic

diseases in Saudi Arabia, some studies have shown that some medicinal plants have been used in the treatment of diseases such as cancer, asthma, and neurological and hepatic diseases (Al Moamary, 2008; Jazieh et al., 2012; Mohammad et al., 2015; Ullah et al., 2020).

KSA is a vast arid desert in Asia, covering about 2,026,213 km²; it occupies the most significant part of the Arab Peninsula. The kingdom has various habitats, such as mountains, gravel plains, sand plains, dunes, and salt sheets (El-Ghanim et al., 2010; Alharbi, 2017; Tounekti et al., 2019). Recently, KSA has been exposed to the effects of desertification, such as drought, soil erosion, and drought that disturb the ecosystem balance. Also, there is a negative human impact on the resource of nature (e.g., overgrazing, overcutting, and urbanization) that lead to the decadence of many ecosystem types (El-Sheikh et al., 2013). This is where the importance of establishing nature protectorates comes into play, aiming to preserve the natural resources of KSA. In 2018, KSRNR was designated as a protected area to safeguard the natural environment, local traditions, and culture while enhancing vegetation and wildlife, as well as promoting eco-tourism. It is notable as one of the world's largest protected areas, the largest in the middle east (UNEP-WCMC and IUCN, 2023), and features a wide range of habitats, including sand plains, dunes, gravel plains, and sand sheets, which provide a sanctuary for numerous mammal, bird, and plant species. KSA has good flora; about 2250 plant species belong to 835 genera and 142 families. The endangered species compose about 30% of the total species of Saudi flora (Collentette, 1999). The wild vegetation, unfortunately, faced threats (e.g., overgrazing, wood cutting, and invasive species) that significantly changed plant species composition and disappeared from some regions and habitats (Alfarhan, 1999; Al-Mutairi et al., 2016; Alharbi, 2017). The flora of KSA has a high percentage of medicinal plants; more than 30% of the flora are medicinal plants that include some endangered and endemic species (Rahman et al., 2004; Alqahtani et al., 2014; Abdel-Sattar et al., 2015; Tounekti et al., 2019; Alqethami et al., 2020).

Few studies are related to the traditional uses of plant species in KSA (Akbar and Al-Yahya, 2011; Nadi, 2017; Abdel-Kader et al., 2018; Tounekti et al., 2019). Documentation of the traditional uses knowledge of plant species needs more studies as this knowledge is considered a crucial part of Saudi Arabia's history.

Especially in arid regions, the vital conservation goal is to preserve medicinal plant species threatened by overexploitation and their natural habitats (Megersa et al., 2013). In KSA and most Arabian countries, collecting medicinal plant species for personal use, trade, or the therapeutic industry is expected. Overutilizing these plants is one of the main factors that harm biodiversity. It reduces the plant species richness and leads to the extinction of some species and economic contributions to

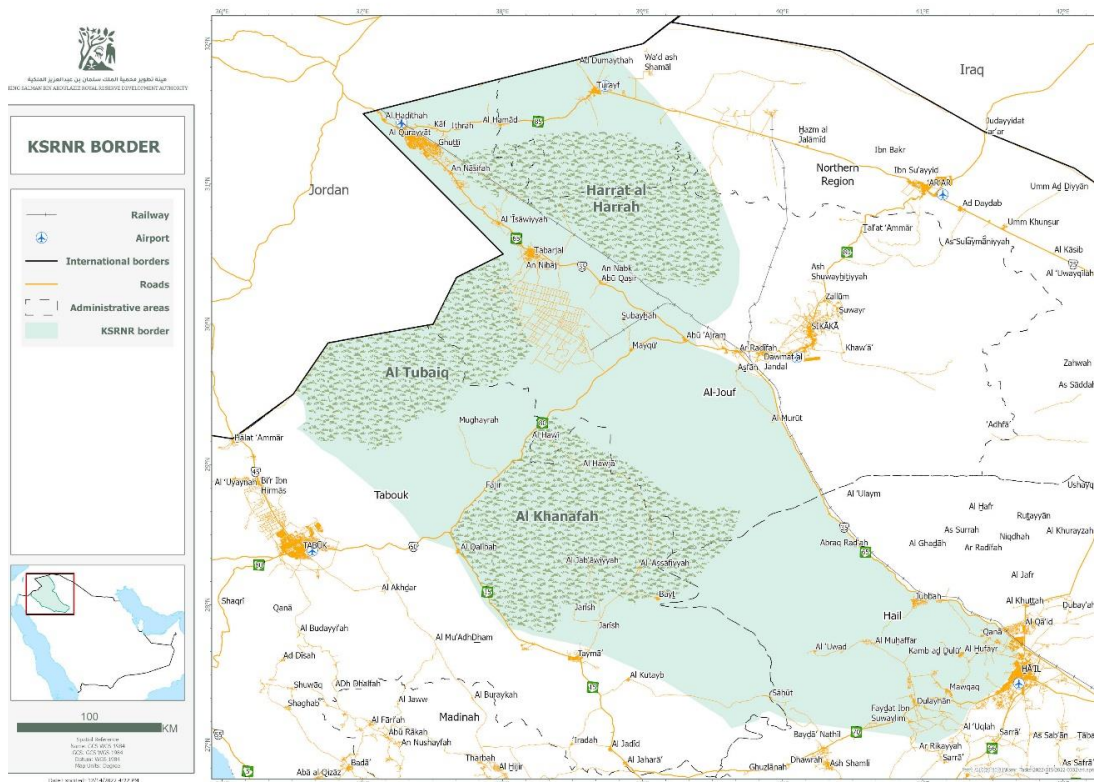


Figure 1. Map of King Salman Bin Abdulaziz Royal Natural Reserve in the Kingdom of Saudi Arabia (created by KSRNR team).

local communities (Rahman et al., 2004; Tounekti et al., 2019).

The present review study is the first to document the traditional knowledge of medicinal plant uses in KSRNR. It aims to (1) determine the medicinal plant species diversity in the flora of KSRNR for conservation priorities and (2) document the traditional medicinal uses of wild plants. It may help preserve traditional knowledge of medicinal plant uses and make local people aware of the importance of medicinal plants, leading to biodiversity conservation in KSRNR.

LITERATURE REVIEW

King Salman Bin Abdulaziz Royal Natural Reserve is located in the northern part of KSA, covering about 130,700 km² of land, representing 6.1% of the total area of the kingdom, making it one of the largest protected areas in the world. The reserve extends along the northern border of the kingdom with Jordan. Additionally, the reserve is connected to surrounding cities and towns through a network of roads. The reserve covers four main regions: Hail, Tabuk, Al Jouf, and Northern borders. It has various habitats, such as mountains, sand plains and

dunes, and gravel plains (Figure 1) (KSRNR, 2022).

KSRNR regions have an arid hot climate with erratic and irregular rainfall and a hot summer. The Hail region is characterized by a mean minimum and maximum temperature of 10.8 and 34.1°C, respectively with an annual mean temperature of 25.6°C. Its average annual rainfall is 116.4 mm/annual (El-Ghanim et al., 2010; Almazroui et al., 2012).

The AL-Jouf area's mean minimum and maximum temperatures were (9.8 and 33.8°C, respectively), and the mean annual rainfall was 56.4 mm (Gomaa, 2012; Almazroui et al., 2012). The Tabuk region had 29.3 mm of mean annual precipitation. The mean minimum and maximum temperatures were 6.9 to 37.81°C, respectively with an average annual temperature around 22.1°C (Almazroui et al., 2012; Abushandi, 2016; Elkordy et al., 2022).

MATERIALS AND METHODS

Data collection and analysis

Currently, the KSRNR flora list contains about 260 plant species. KSRNR flora list resulted from the plant baseline survey (KSRNR,

2022). The plant species with medicinal properties and their traditional uses were identified from the KSRNR flora list by collecting information from 14 published papers in scientific journals (Al-Said, 1993; Rahman et al., 2004; El-Ghazali et al., 2010; Al-Asmari et al., 2014; Yusuf et al., 2014; Alharbi, 2017; Aati et al., 2017; El-Shabasy, 2017; Aati et al., 2019; Tounekti et al., 2019; Alqethami and Aldehbiani 2020; Ullah et al., 2020; Al Kazman, 2021; Alqethami and Aldehbiani, 2021). These published papers were only conducted in Saudi Arabia on people living in KSA.

Other information collected were updated nomenclature (scientific name), used APG IV (Angiosperm Phylogenetic Group 2016), common name (Arabic, written in English), families, parts used from the plants, and traditional medicinal uses. In addition, the distribution status of plant species in the KSRNR regions is expressed by common and uncommon species. Data analysis was performed using an Excel program (Microsoft 360) and a statistical analysis program (SYSTAT).

RESULTS

KSRNR flora includes about 260 native plant species, resulting from plant baseline surveys, and it is expected to increase after conducting complete plant surveys (KSRNR, 2022). Among 260 wild species, we recorded 91 wild plant species have medicinal properties belonging to 29 families, representing about 35% of the KSRNR flora list (Table 1).

Table 1 describes the information on 91 native medicinal plant species with scientific and local names, families, life forms, distribution status in KSRNR regions (common and Uncommon), plant parts used, and traditional medicinal uses.

Asteraceae was the dominant family with the highest number of species, followed by Brassicaceae, Amaranthaceae, and Fabaceae (14, 8, 7, and 7, respectively), while Apiaceae, Capparidaceae, Caryophyllaceae, Cleomaceae, Colchicaceae, Cucurbitaceae, Cynomoriaceae, Ephedraceae, Euphorbiaceae, Malvaceae, Orobanchaceae, Rhamnaceae, Rosaceae, and Urticaceae (14 families among 29) have only one species (Figure 2). The medicinal plant species belong to 68 genera, 11 of which have more than two species (Table 1). In the KSRNR regions, the main portion of wild medicinal plants (62%) was uncommonly distributed.

The medicinal plants were categorized into three life forms: the dominant forms were herbs (51 species, 56%), followed by shrubs (36 species, 39.5 %), while the lowest life form was represented by trees (4.5 species, 4%) (Figure 3).

The proportion of plant parts used in treating various diseases is presented in Figure 4. 50% of plant species can use whole individuals to treat different ailments, followed by leaf (20%) and seed (7%). The resin, bark, and latex were the lowest parts used for treatment at 2, 2, and 1%, respectively.

Table 1 includes the most frequent diseases that

medicinal plants treat. They were gastrointestinal problems, ulcers, respiratory, urological, skin diseases, toothache, diabetes, and allergy. There were 23 medicinal plant species used to treat only one disease such as *Chrozophora tinctoria*, *Polycarpaea repens*, and *Teucrium oliverianum* while the most significant species (67) were used for treating more than one like *Capparis spinosa*, *Citrullus colocynthis*, and *Malva parviflora* (Table 1).

DISCUSSION

The loss of biodiversity primarily affects ecosystem functioning and poses threats to various ecosystem services vital for human well-being (Chapin III et al., 2000; Quijas et al., 2010). Plant species serve as significant natural resources with a wide range of potential benefits, including the production of oils, cosmetics, medications, and food (Al-Said, 1993; Ghazanfar, 1994; Al-Sodany et al., 2013; Alharbi, 2017; Alqethami et al., 2020). Traditional medicine is a significant part of Saudi Arabia's heritage and has been widely practiced until now (Al-Essa et al., 1998; El-Ghazali et al., 2010). A significant number of medicinal plant species are present in the flora of Saudi Arabia, with about 1200 plant species in the flora (Yusuf et al., 2014). Alharbi (2017) concluded that Saudi people widely used about 319 medicinal plant species, about 15% of the Saudi flora. In Al-Rass province, 47 medicinal plant species belonging to 28 families were commonly used by local people (El-Ghazali et al., 2010). In the KSRNR, the number of medicinal plant species (91) and their families corresponding with the previous study was conducted in northern KSA (overlapping with some areas of KSRNR); they recorded 81 medicinal plant species belonging to 30 families (Alharbi, 2017). Al-Mutairi et al. (2016) recorded 96 medicinal plant species distributed in different habitats in the Tabuk region. Jazan province in the Southwest of KSA includes 124 medicinal plants belonging to 48 families (Tounekti et al., 2019).

Medicinal plant species included in the flora of KSA belong to many families, such as Lamiaceae, Asteraceae, Polygonaceae, Euphorbiaceae, Fabaceae, Amaranthaceae, and Solanaceae (Collentette, 1999; Mohammed et al., 2010; Al Kazman, 2021). The KSRNR plant species and families are represented in the flora of KSA (Collentette, 1999; Chaudhary, 2001; Al-Hassan, 2006). In the KSRNR (Figure 2), the dominant families mostly coincide with the following studies: Alharbi (2017) reported that Fabaceae (9 species) and Asteraceae (8 species) are the most represented medicinal plant species in the Tabuk area of northern KSA; also, the Asteraceae (10.48%), Fabaceae (7.25%), and Apocynaceae (7.25%) families were the most represented in Jazan province (Tounekti et al., 2019).

Table 1. List of medicinal plant species recorded in King Salman Bin Abdulaziz Royal Natural Reserve (KSRNR), Saudi Arabia (KSA), with the local name of species, families, life form, parts used, distribution status, treatment, and citations number.

No.	Species name	Local name	Family	Life form	Part used	Distribution status	Treatment	Citation Nos.
1	<i>Blepharis ciliaris</i> (L.) B.L.Burt	Zaghaf	Acanthaceae	Herbs	Whole plant	Uncommon	Toothache, skin wounds ever, astringents, appetizers, cough, asthma, wounds, sores and pruritic	4
2	<i>Mesembryanthemum crystallinum</i> L.	Samh	Aizoaceae	Herb	Whole plant	Uncommon	Antimicrobial and brd making	1
3	<i>Aizoon canariense</i> L.	Moleh	Aizoaceae	Herb	Whole plant	Uncommon	Indigestion, flatulence, and hypertension	1
4	<i>Bassia muricata</i> (L.) Asch.	Znaban	Amaranthaceae	Herb	Whole plant	Common	Sore throat and antimicrobial, Kidney diseases, and antirheumatic	2
5	<i>Aerva javanica</i> (Burm.f.) Juss. ex Schult.	Rabl	Amaranthaceae	Shrub	Whole plant	Uncommon	Toothache	5
6	<i>Atriplex halimus</i> L.	Kataf	Amaranthaceae	Shrub	Leaf and seed	Uncommon	Diabetes and emetic	2
7	<i>Atriplex turcomanica</i> (Moq.) Boiss.	Raghel	Amaranthaceae	Shrub	Leaf	Uncommon	Decrease stomach acidity	1
8	<i>Haloxylon salicornicum</i> (Moq.) Bunge ex Boiss.	Remth	Amaranthaceae	Shrub	Whole plant	Common	Diabetic, cold, and stomach pain	5
9	<i>Caroxylon imbricatum</i> (Forssk.) Moq.	Akhret	Amaranthaceae	Shrub	Whole plant	Uncommon	Anthelmintic	3
10	<i>Traganum nudatum</i> Delile	Dmaran	Amaranthaceae	Shrub	Leaf and stem	Common	Gastric problems	1
11	<i>Bupleurum semicompositum</i> L.	Debk	Apiaceae	Herb	Fruit	Uncommon	Stomach troubles, carminative, and mental disorders	1
12	<i>Calotropis procera</i> (Aiton) W.T.Aiton	Aeshar	Apocynaceae	Shrub	Whole plant and latex	Uncommon	Respiratory system, anticancer, joint inflammation, antibacterial, purgative, expectorant, dysentery, and psoriasis	4
13	<i>Pergularia tomentosa</i> L.	Ghalafa	Apocynaceae	Shrub	Whole plant	Uncommon	Skin diseases and purgative	4
14	<i>Rhazya stricta</i> Decne.	Harmel	Apocynaceae	Shrub	Leaf and flower	Uncommon	Antirheumatic, pain relief, antibacterial, allergy, constipation, anthelmintic, improving bad breath, and skin rash	6
15	<i>Artemisia scoparia</i> Waldst. & Kit.	Sleka	Asteraceae	Herb	Whole plant	Common	Purgative, earache, antibacterial, antipyretic, antiseptic, diuretic, vasodilator, jaundice, hepatitis, inflammation of the gall bladder and treatment of scorpion sting	2
16	<i>Calendula arvensis</i> L.	Honowa	Asteraceae	Herb	Whole plant	Uncommon	Central nervous system stimulation	2
17	<i>Centaurea sinaica</i> DC.	Mrar	Asteraceae	Herb	Whole plant	Uncommon	Central nervous system stimulation	1
18	<i>Reichardia tingitana</i> (L.) Roth	Hawa	Asteraceae	Herb	Leaf	Uncommon	Colic and constipation	1
19	<i>Atractylis carduus</i> (Forssk.) C.Chr.	Shok Al Gamal	Asteraceae	Herb	Whole plant	Common	Cardiac depression	2
20	<i>Achillea fragrantissima</i> (Forssk.) Sch.Bip.	Kisoum	Asteraceae	Shrub	Whole plant	Common	Anthelmintic, carminative, central nervous system stimulation, and antimicrobial	4
21	<i>Anvillea garcinii</i> (Burm.f.) DC.	Nakd	Asteraceae	Shrub	Whole plant	Uncommon	Colds, diabetes, digestive troubles, and pulmonary affection	4
22	<i>Artemisia herba-alba</i> Asso	Sheh	Asteraceae	Shrub	Leaf & flowery tips	Common	Dental hygiene, abdominal pain, colic, and liver failure	2
23	<i>Artemisia judaica</i> L.	Boithran	Asteraceae	Shrub	Leaf and flower	Common	Antipyretic, menstruation regulator, nerve system trouble,	2

Table 1. Contd.

							carminative, anthelmintic, and cold	
24	<i>Artemisia monosperma</i> Delile	Azer	Asteraceae	Shrub	Leaf and flower	Common	Constipation, anthelmintic, antirheumatic, cold	2
25	<i>Artemisia sieberi</i> Besser	Sheh	Asteraceae	Shrub	leaf	Common	Anthelmintic	3
26	<i>Asteriscus graveolens</i> (Forssk.) Less.	Nakd Asfer	Asteraceae	Shrub	Leaf, stem, and flower	Common	Diarrhea and abdominal pain	1
27	<i>Pulicaria undulata</i> (L.) C.A.Mey.	Gethgath	Asteraceae	Shrub	Whole plant	Common	Central nervous system depression, promotes menstruation and treatment of scorpion stings, antimicrobial, liver cancer, and diuretic	3
28	<i>Rhanterium epapposum</i> Oliv.	Arfag	Asteraceae	Shrub	Whole plant	Common	Antimicrobial, diabetes, allergy, edema, and toothache	3
29	<i>Anchusa milleri</i> Lam. ex Spreng.		Boraginaceae	Herb	Whole plant	Uncommon	Central nervous system stimulant, fever, cough, and syphilis	3
30	<i>Arnebia hispidissima</i> (Sieber ex Lehm.) A.DC.	Demem Ghazal	Boraginaceae	Herb	Whole plant	Uncommon	Antipyretic	3
31	<i>Trichodesma africanum</i> (L.) Sm.	Hamm	Boraginaceae	Herb	Whole plant	Uncommon	Cough and cold	3
32	<i>Heliotropium ramosissimum</i> (Lehm.) Sieber ex DC.	Remram	Boraginaceae	Herb	Whole plant	Uncommon	Snake bites	1
33	<i>Heliotropium arbainense</i> Fresen.	Remram	Boraginaceae	Shrub	Whole plant	Uncommon	Hypertension and antimicrobial	2
34	<i>Heliotropium digynum</i> (Forssk.) Asch. ex C.Chr.	Remram	Boraginaceae	Shrub	Whole plant	Uncommon	Skin diseases and antimicrobial	4
35	<i>Anastatica hierochuntica</i> L.	Kaf Marium	Brassicaceae	Herb	Whole plant	Uncommon	Purgative, facilitate labor, Antimicrobial, and diabetic	8
36	<i>Diplotaxis acris</i> (Forssk.) Boiss.	Garger	Brassicaceae	Herb	Leaf	Common	Antidiabetic and wound healing	2
37	<i>Diplotaxis harra</i> (Forssk.) Boiss.	Khfish	Brassicaceae	Herb	Whole plant	Uncommon	Antimicrobial	2
38	<i>Farsetia aegyptia</i> Turra	Greba	Brassicaceae	Herb	Whole plant	Common	Toothache and rheumatism	4
39	<i>Morettia parviflora</i> Boiss.	Thagher	Brassicaceae	Herb	Whole plant	Uncommon	Antimicrobial	2
40	<i>Savignya parviflora</i> (Delille) Webb	Klikelan	Brassicaceae	Herb	Whole plant	Common	Central nervous system stimulant and cardiac	2
41	<i>Schimpera arabica</i> Hochst. & Steud.	Safra	Brassicaceae	Herb	Whole plant	Common	Cardiac stimulant	2
42	<i>Zilla spinosa</i> (L.) Prantl	Sella	Brassicaceae	Shrub	Leaf and flower	Common	Purgative "toxic at high dose"	3
43	<i>Capparis spinosa</i> L.	Shflah	Capparaceae	Shrub	Fruit, root, bark, and leaf	Uncommon	Tonic, diuretic, diabetic, expectorant, anthelmintic, carminative, ulcers, dropsy, hypertension, inflammation, emmenagogue, anemia, rheumatism, and dropsy	6
44	<i>Polycarpea repens</i> (Forssk.) Asch. & Schweinf.	Makr	Caryophyllaceae	Herb	Whole plant	Common	Antidote against snake bites	2
45	<i>Cleome amblyocarpa</i> Barratte & Murb.	Mrioaha	Cleomaceae	Herb	Whole plant	Common	Antimicrobial, rheumatism, anti-inflammatory, nausea, gastralgia, vomiting, and colic	5
46	<i>Colchicum ritchii</i> R.Br.	Asansal	Colchicaceae	Herb	Leaf	Uncommon	Abdominal trouble, emetic and purgative	1
47	<i>Citrullus colocynthis</i> (L.) Schrad.	Hanzal	Cucurbitaceae	Herb	Root, seed, and fruit	Common	Ulcers, enlargement of the spleen, dyspepsia, constipation, diuretic, emetic, expectorant, jaundice, ascites, analgesic, anti-HIV, antiaging, allergy, antiasthmatic, antibacterial, diabetic, sedative, antimalaria, antioxidant, antiseptic, antitumor,	7

Table 1. Contd.

							carminative, fungicide, and herbicide	
48	<i>Cynomorium coccineum</i> L.	Trtroth	Cynomoriaceae	Herb	Whole plant	Uncommon	Astringents, constipation, and colic	2
49	<i>Ephedra alata</i> Decne.	Adam	Ephedraceae	Shrub	Whole plant	Uncommon	Central nervous system stimulant and antimicrobial	2
50	<i>Chrozophora tinctoria</i> (L.) A.Juss.	Nwela	Euphorbiaceae	Herb	Leaf	Uncommon	Emetic	1
51	<i>Trigonella anguina</i> Delile	Nafi	Fabaceae	Herb	Whole plant	Uncommon	Antimicrobial	2
52	<i>Trigonella stellata</i> Forssk.	Nafi	Fabaceae	Herb	Whole plant	Common	Abdominal pain, diarrhea, and dysentery	4
53	<i>Astragalus spinosus</i> (Forssk.) Muschl.	Ketad	Fabaceae	Shrub	Whole plant	Common	leukemia, promote wound healing, scorpion stings, and purgative	5
54	<i>Retama raetam</i> (Forssk.) Webb & Berthel.	Ratam	Fabaceae	Shrub	Leaf "little amount"	Uncommon	Anthelmintic, purgative, wound, making eye wash, and diarrhea	2
55	<i>Vachellia gerrardii</i> (Benth.) P.J.H.Hurter	Talh	Fabaceae	Tree	Resin and fruit	Uncommon	Burns, toothache, and antipyretic	1
56	<i>Vachellia seyal</i> (Delile) P.J.H.Hurter	Sial	Fabaceae	Tree	Bark, resin , root, and seed	Uncommon	Cold, ophthalmia, diarrhea, hemorrhage, leprosy, and burns, after abortion	3
57	<i>Vachellia tortilis</i> (Forssk.) Galasso & Banfi	Samar	Fabaceae	Tree	Leaf	Uncommon	Anthelmintic, antidiarrheal, ulcers and deep wounds, anti-inflammatory, and teeth cleaning	2
58	<i>Salvia lanigera</i> Poir.	Mremia	Lamiaceae	Herb	Whole plant	Common	Carminative and indigestion	4
59	<i>Salvia spinosa</i> L.	Lsan Al-Thor	Lamiaceae	Herb	Seed	Common	Toothache, gonorrhoea, and urethritis	3
60	<i>Teucrium oliverianum</i> Ging. ex Benth.	Aihel	Lamiaceae	Herb	Whole plant	Uncommon	Diabetes	4
61	<i>Teucrium polium</i> L.	Gada	Lamiaceae	Herb	Whole plant	Uncommon	Liver disease, jaundice, diabetes, fertility problems, cancer, anthelmintic, stomach, and intestinal troubles	5
62	<i>Lavandula dentata</i> L.	Daram	Lamiaceae	Shrub	leaf and flower	Uncommon	Headache, rheumatic pain, cold, urine retention and removal of stones from kidney and ureter, Wounds, diuretic, carminative, and antiseptic	4
63	<i>Malva parviflora</i> L.	Khobiza	Malvaceae	Herb	Whole plant	Common	Boils, anthelmintic, inflamed purulent wounds, laxative, promotes hair growth, and urinary tract infection	6
64	<i>Cistanche phelypaea</i> (L.) Cout.	Oeihera	Orobanchaceae	Herb	Whole plant	Common	Diarrhea, and intestinal troubles	1
65	<i>Plantago afra</i> L.	Robila	Plantaginaceae	Herb	Seed	Uncommon	Gastrointestinal tract disorder, duodenal ulcer, dysentery ulcerative, and colitis	1
66	<i>Plantago amplexicaulis</i> Cav.	Rebla	Plantaginaceae	Herb	Whole plant	Common	Renal disease and urinary tract purifier	4
67	<i>Plantago albicans</i> L.	Yanm	Plantaginaceae	Herb	Leaf	Uncommon	Diarrhea	1
68	<i>Plantago ciliata</i> Desf.	Kroina	Plantaginaceae	Herb	Leaf	Common	Dysentery, chronic, constipation, and duodenal ulcer	1
69	<i>Plantago ovata</i> Forssk.	Haba	Plantaginaceae	Herb	Seed	Common	Laxative, demulcent, chronic colitis	3

Table 1. Contd.

70	<i>Cutandia memphitica</i> (Spreng.) Benth.	Khafor	Poaceae	Herb	Whole plant	Uncommon	Central nervous system stimulant, and antimicrobial	4
71	<i>Cynodon dactylon</i> (L.) Pers.	Nigel	Poaceae	Herb	Whole plant	Uncommon	Diuretic, astringent, ophthalmic disorders, hemorrhage, rhinorrhagia, dysentery, urinary tract inflammation & dysuria.	4
72	<i>Panicum turgidum</i> Forssk.	Thomam	Poaceae	Herb	Whole plant	Uncommon	Eye Infection	4
73	<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	Kasab	Poaceae	Herb	Whole plant	Uncommon	Antiemetic and antipyretic	2
74	<i>Rumex spinosus</i> L.	Hombaz	Polygonaceae	Herb	Whole plant	Uncommon	Purgative, dyspepsia, stomach disorders and to relieve colic, stimulate appetite, and anthelmintic	7
75	<i>Rumex vesicarius</i> L.	Homed	Polygonaceae	Herb	Whole plant	Common	Carminative, purgative, astringent, dysentery, promote appetite, spleen, dyspepsia, vomiting, liver diseases, and toothache	6
76	<i>Calligonum comosum</i> L'Hér.	Orta	Polygonaceae	Shrub	Whole plant	Common	Anti-inflammatory and anti-ulcer, antimicrobial, and purgative	4
77	<i>Reseda muricata</i> C.Presl	Zanab Al-Dab	Resedaceae	Herb	Fruit	Uncommon	Menstruation Tonic	4
78	<i>Ochradenus baccatus</i> Delille	Grada	Resedaceae	Shrub	Whole plant	Uncommon	Backache, fistula, antimicrobial, and anthelmintic	4
79	<i>Ziziphus nummularia</i> (Burm.f.) Wight & Arn.	Sedr	Rhamnaceae	Shrub	Whole plant	Uncommon	Antispasmodic, emollient, anti-poison, joint pain, sore throat, and laxative	3
80	<i>Prunus arabica</i> (Olivier) Meikle	Leweza	Rosaceae	Shrub	Whole plant	Uncommon	Aphrodisiac	2
81	<i>Hyoscyamus muticus</i> L.	Sikaran	Solanaceae	Shrub	Whole plant	Common	Antitussive, expectorant, antiasthmatic, carminative, sedative, seasickness, toothache, gastric ulcer, and eyes problems	6
82	<i>Lycium shawii</i> Roem. & Schult.	Awsag	Solanaceae	Shrub	Fruit	Uncommon	Purgative, antibacterial, and mouth ulcers	5
83	<i>Tamarix nilotica</i> (Ehrenb.) Bunge	Tarfa	Tamaricaceae	Shrub	Leaf, seed, new stems, and bud	Uncommon	Diarrhea, intestinal colic, dermatitis, and leg varie	6
84	<i>Tamarix aphylla</i> (L.) H.Karst.	Athal	Tamaricaceae	Tree	Leaf and root	Uncommon	Wound infection and stomach ache	6
85	<i>Forsskaolea tenacissima</i> L.	Loseek	Urticaceae	Herb	Whole plant	Uncommon	Ulcers	3
86	<i>Tribulus terrestris</i> L.	Kotb	Zygophyllaceae	Herb	Leaf and seed	Uncommon	Astringents, hepatitis, stomatitis, tonic, diuretic, aphrodisiac, and renal colic	7
87	<i>Zygophyllum simplex</i> L.	Haram	Zygophyllaceae	Herb	Whole plant	Common	Ophthalmic disease, purgative, and anthelmintic	5
88	<i>Zygophyllum indicum</i> (Burm.f.) Christenh. & Byng	Shweka	Zygophyllaceae	Herbs	Whole plant	Uncommon	Smallpox and gout	3
89	<i>Zygophyllum bruguieri</i> (DC.) Christenh. & Byng	Shekaa	Zygophyllaceae	Shrub	Whole plant	Common	Astringents, digestive, diarrhea, dropsy, dysentery, dyspepsia, stomach ache, stomatitis, antipyretic, anti-asthmatic, antiemetic, typhoid, anti-toxic, blood and heart tonic, and ulcers	5

Table 1. Contd.

90	<i>Zygophyllum album</i> L.f.	Rotreet	Zygophyllaceae	Shrub	Whole plant	Uncommon	Diabetes, purgative, laxative, anti-virus and fungi, indigestion, asthma, diuretic, skin diseases, analgesic, rheumatism, and cardiovascular disease	4
91	<i>Zygophyllum coccineum</i> L.	Haram	Zygophyllaceae	Shrub	Whole plant	Uncommon	Anthelmintic, diuretic, colic, rheumatism, gout, cough, asthma, and hypertension	5

Source: Al-Said (1993), Rahman et al. (2004), El-Ghazali et al. (2010), Al-Asmari et al. (2014), Yusuf et al. (2014), Alharbi (2017), Aati et al. (2017), El-Shabasy (2017), Aati et al. (2019), Tounekti et al. (2019), Alqethami and Aldhebiani (2020), Ullah et al. (2020), Al Kazman (2021), and Alqethami and Aldhebiani (2021).

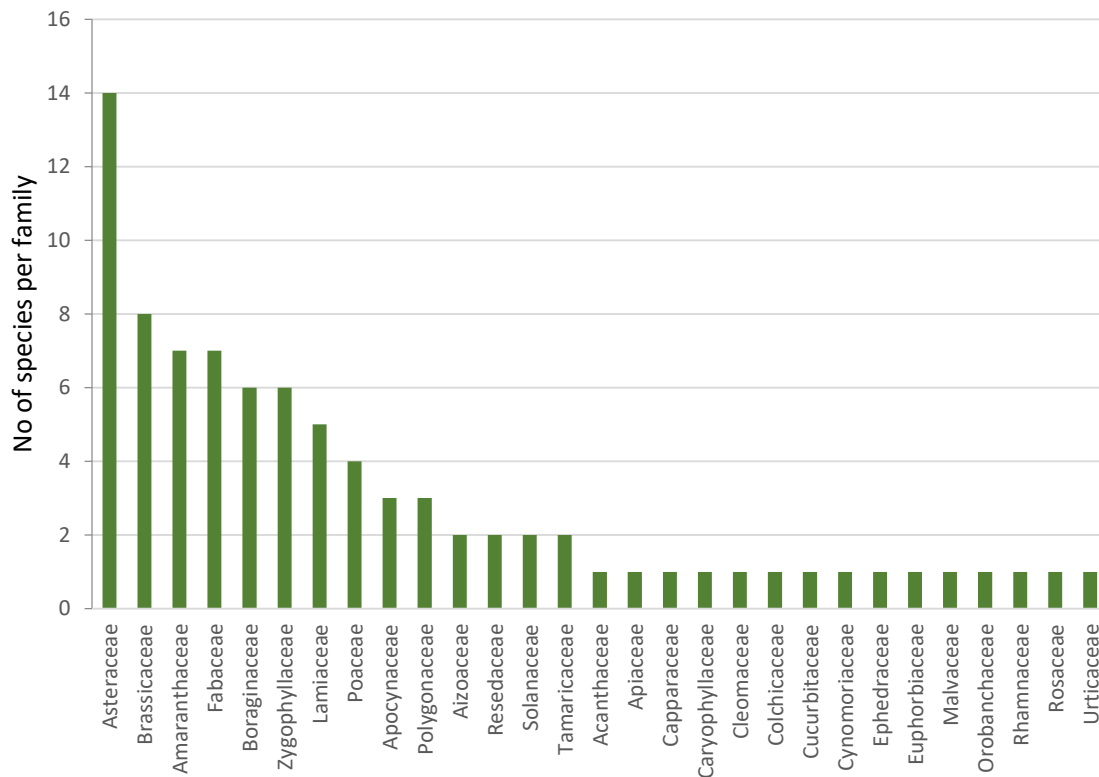


Figure 2. Number of medicinal plant species per family recorded in King Salman Bin Abdulaziz Natural Royal Reserve, Saudi Arabia.

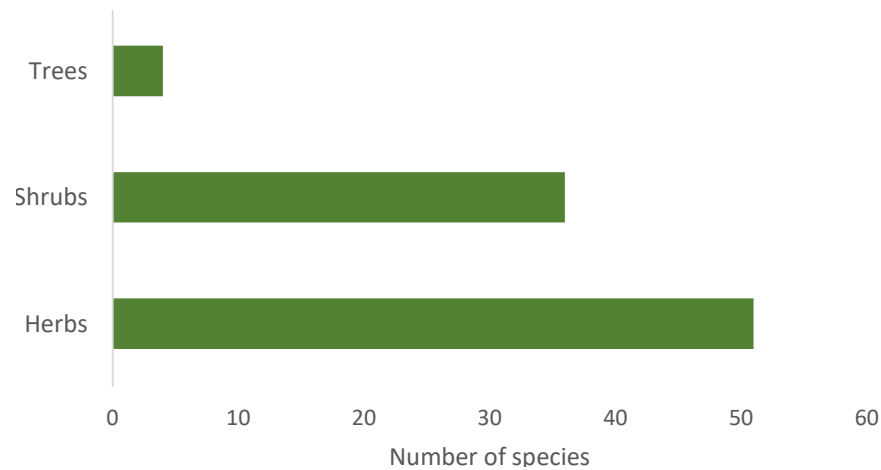


Figure 3. Number of medicinal plants per life form recorded in King Salman Bin Abdulaziz Natural Royal Reserve, Saudi Arabia.

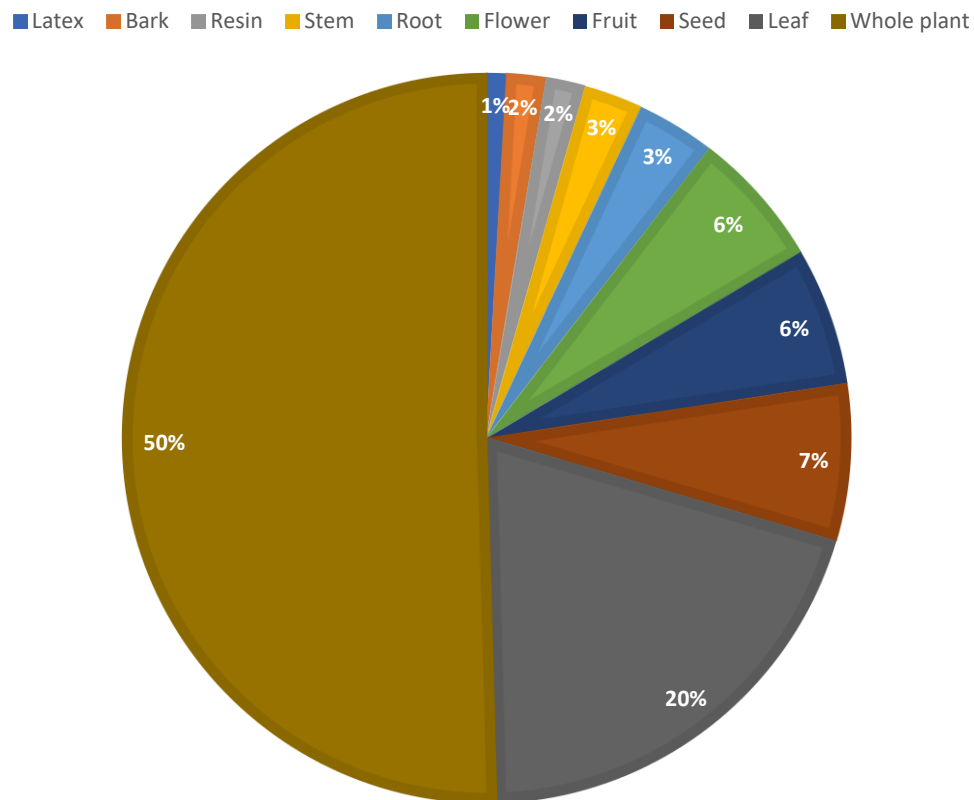


Figure 4. The percentage of medicinal plant parts used in the treatment in King Salman Bin Abdulaziz Natural Royal Reserve, Saudi Arabia.

KSA has a wide range of flora, including medicinal plant species with different life forms, herbs, shrubs, and trees (Mossa et al., 1987; Rahman, 2004). Herbaceous plants were the most significant of uses in the present study

(Figure 3); this indicates that the primary time to collect medicinal plant species is spring. Therefore, KSRNR protection activities must be concentrated in the springtime. Trees are the lowest percentage of species in

the KSRNR regions as the Arabian Peninsula is mostly shrubland (Ghazanfar and Fisher, 1998; Shabana, 2019), so they face danger from collecting them as medicinal plants. Alharbi (2017) reported that about 50% of medicinal plant life forms were herbs, and 36% were shrubs in the Tabuk region. Yusuf et al. (2014) studied medicinal species diversity in the flora of KSA for 15 families and resulted in 61 species, 72.13% herbaceous, 13.11% shrubs, and 14.75% trees. In Jazan province, the primary life forms of the medicinal plants were shrubs (45%), herbs, perennial and annual (40%), and trees (18%) (Tounekti et al., 2019).

In the KSRNR medicinal plant species, the result gives a dangerous indicator as people generally collect the whole plant for medicinal uses, especially the herbs, and shrubs, which may lead to disappearing species if there is no control over plant harvest, which leads to unsustainable use of the medicinal plant species. Tounekti et al. (2019) concluded that the main plant parts used in formulating traditional medicines were leaves, fruits, and whole plants (24, 18, and 16%, respectively). According to Ullah et al. (2020), the leaves, whole plants, seeds, and aerial parts (including all parts of the plant except roots) were the most commonly used parts as medicine with 29, 28, 7 and 5%, respectively, while roots, stems, latex, bulb, fruits, and bark were represented with a low percentage.

KSRNR has a wide variety of medicinal plants that can be used for sustainability in the future. Its results were consistent with previous studies such as El-Ghazali et al. (2010), where the most frequent diseases that medicinal plants treated were gastrointestinal problems, ulcers, respiratory, urological, skin diseases, toothache, diabetes, and allergy (Table 1). Some incurable diseases, such as cardiac depression, central nervous system stimulation, and leukemia, were treated by medicinal plants. Therefore, ensuring the effectiveness of these plants in treating acute diseases is required for not being harmful to the patient, in addition to studying the active substances in these plant species to manufacture medicine to use for treating these diseases on a large scale. Traditional uses of medicinal plants can lead to drug discovery to treat various illnesses (Balunas and Kinghorn, 2005; El-Ghazali et al., 2010).

Globally, more than 15,000 plant species may face extinction due to over-harvesting and habitat loss, meaning that the earth loses at least one potential drug to treat critical illness every two years (El-Ghazali et al., 2010; Saganuwan, 2010; El-Shabasy, 2017). Some studies in KSA referred to the most used plant species that may be exposed to extinction because traditional healers use wild plants, which harvest them in large quantities from their habitats (El-Ghazali et al., 2010). The main portion of KSRNR wild medicinal plants was uncommonly distributed. Wild medicinal plant species are highly affected by many threats, such as plant cutting,

uprooting, invasive species, urbanization, overgrazing, and the development of new infrastructure (Al-Mutairi et al., 2015). Therefore, more attention and action are required from KSRNR to preserve the local population's traditional knowledge concerning plant species' uses and conserve plant species' genetic resources to ensure their continuity in natural habitats.

In KSA, many studies reported that traditional medicinal knowledge is monopolized by the old generation and not passed easily to the new generation. Mainly, new-generation inhabitants depend on modern medicines and visit clinics and hospitals more than older people (El-Ghazali et al., 2010). Traditional knowledge could transfer through various windows, such as parents to kids and elders, friends, and internet and social media and elsewhere (Alqethami et al., 2017). In the Arabian Peninsula, traditional and modern medicine could be used simultaneously, but when modern medicine succeeds, traditional medicine tends to fade (Ghazanfar, 1994). Alqethami et al. (2020) observe that persons who prefer biomedicine know significantly less information about medicinal plants, and this is one of the main factors for the loss of traditional knowledge of medicinal plant's "treatment preferences among generations" (Ghazanfar, 1994; Azaizeh et al., 2003; El-Ghazali et al., 2010; Alqethami et al., 2017). At the same time, some regions in KSA still use medicinal plants to treat minor illnesses (Ghazanfar, 1994; Wayland, 2001). Therefore, medicinal plants still play a significant role in the health care of Saudi people (Press, 1978; Wayland, 2001; Azaizeh et al., 2003; Alqethami et al., 2020). The KSRNR detected some violations of some residents adopting the wrong methods in harvesting plants, for example, collecting large quantities from the same wild species population and removing plants from the roots. Many observations in KSRNR indicate that the local community still depends on wild medicinal plants simultaneously with modern treatment in treating many diseases. Therefore, attention must be paid to increasing environmental awareness in general for the local community, especially about medicinal plants, as well as strategies for protecting medicinal plant species, mainly those people use extensively and successively. Training the local people to standard methods for harvesting the medicinal plants and avoid damage and uprooting the species (KSRNR, 2023).

The documentation of the indigenous knowledge of traditional uses of medicinal plants and their conservation in both *in-situ* and *ex-situ* conditions through a national conservation strategy has to be given priority (Yusuf et al., 2014). We recommend prioritizing making a complete inventory of native medicinal plants in KSRNR, including interviews with the local population, to document the traditional medicinal uses. Collaborating with other concerned institutions in KSA is essential for developing a sustainable management plan and conservation strategy for native medicinal plant species. Protecting

plant germplasm is a priority, and this can be achieved through various methods, including raising public awareness. It is crucial to educate the public about the significance of these plants, familiarize them with their medicinal uses, and encourage cultivation of these plants on farms and in gardens.

Conclusion

Indigenous knowledge of medicinal plants is ancient in KSA and still exists among the tribal and village peoples and traditional practitioners. KSRNR's objective is to emphasize conservation priorities and the reserve's sustainment of various medicinal plants. This review inventoried 91 wild medicinal plant species traditionally used in KSRNR. It is helpful for documentation of traditional medicinal uses knowledge in the KSRNR area for taking appropriate conservation methods. It is suggested to conduct further research and surveys with interviews with the local population within the KSRNR region to document traditional knowledge which is considered an essential part of the cultural heritage of KSA. Also, the propagation of medicinal plant species is one of the solutions that must be regarded to reduce pressure on them in their natural environments and to preserve them. Conservation strategies of KSA and KSRNR for medicinal species must be prepared.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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