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TRADITIONAL MEDICINAL PLANTS OF SARISKA TIGER RESERVE USED IN DIABETES

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ABSTRACT: Sariska Tiger Reserve, one of the 42 Tiger Reserves of India, is located near the civil district of Alwar in Rajasthan. The Sariska Tiger Reserve in Aravallis has its own importance and specific characteristics with unique biodiversity. The forest of Sariska Tiger Reserve has a great diversity of flora. This paper gives an account of antidiabetic medicinal plants found in Sariska Tiger Reserve, along with their local name, family, habit, and medicinal uses. Due to lack of awareness, unsustainable research utilization, and encroachments on these groups of the plant in this area, people of this region are unaware of the wealth of this heritage, and several persistent medicinal plant species are on the verge of extinction. The present paper highlights useful ethnobotanical information about the uses of these plants by the tribal of Rajasthan as food, fodder, medicine (fever, diarrhea, diuretic, skin-problems, diabetes, hypertension, jaundice, *etc*.) timber, fire-wood, tannin, dye, oil, fiber, alcohol, gum, resin, *etc*.

INTRODUCTION: Rajasthan is quite rich in floristic diversity, probably due to the presence of different variables and diversified climatic, physiographic, edaphic, and habitat conditions [1]. The Sariska tiger reserve in Aravallis has its own importance, and specific characteristics endowed with unique biodiversity [2]. Sariska National park is situated between the latitude (76 * 17'-76 * 34' Nand 27 * 5'-27 * 33'E) and longitude in the Alwar District of Rajasthan [3]. It became a wildlife sanctuary in 1955 and a Tiger reserve in 1982. According to Department of Forest, Government of Rajasthan, the total area of the Sariska Tiger Reserve is 866.0 km^{-2}, of which 302.2 km^{-2} is a buffer zone, and 497.8 km^{-2} is core zone.

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Sariska core zone is comprised of three isolated; pockets: core-I (273.8 km^{-2}), II (126.5 km^{-2}.), and III (97.5 km^{-2}). The status of the core I have been notified as a National park in 1982. Sariska is undulating to hilly and has numerous narrow valleys. The forest being scattered and sparse over a large area on various geological and soil formation and vary greatly in composition. Sariska is very rich in biodiversity with a wide spectrum of flora and ample of wildlife [4].

Anogeissus pendula (Dhok) is a dominant species in the undulating area and on the hills. *Boswellia serrata* (Salar) *Opuntia elatior* (Prickly pear) and *Lannea coromandelica* (Garjan) grows on steep rocky areas. *Acacia catechu* (Khair), *Zizyphus mauritiana* (Bordi), *Kydia calycina* (Pulao), and *Butea monosperma* (Dhak) are found in valleys [5]. A total number of 403 indigenous and naturalized plant species belonging to 271 genera under 86 families can be observed in Sariska Tiger Reserve. This also includes four species of pteridophytes belonging to three genera and three families and a

species of gymnosperm. **Table 1** includes the number of families, genera, and species, under dicotyledons and monocotyledons, pteridophytes, and gymnosperm. Except for poaceae (56 species) and cyperaceae (17 species) the monocotyledons are poorly represented. The remaining 16 species of monocotyledons belong to 10 different families [6]. A total of 110 species of plants representing 88 genera and 43 families in Sariska used as a traditional medicine in various disorders such as fever, diabetes, diarrhea, dysentery, skin-problems, jaundice, rheumatism *etc* [7]. Moreover, several difficult diseases have a problem related to vitality, diabetes; memory loss could be cured effectively by the use of herbal medicine, which is generally not possible by the allopathic medicines [8]. In the present study, an attempt has been made to ascertain the current status of plant species, which has medicinal and economic importance for the livelihood of local peoples inside and outside the Sariska Forest.

The present paper highlights the floristic richness along with ethnobotanical wealth of Sariska Forest. This review focuses on Indian herbal drugs and plants from Sariska Forest used in the treatment of diabetes.

1.1 Diabetes and Their Management: Diabetes is a chronic disorder of carbohydrate, fat, and protein metabolism characterized by increased fasting and postprandial blood sugar levels. Diabetes mellitus is a complex metabolic disorder resulting from either insulin insufficiency or insulin dysfunction. Type I diabetes (insulin-dependent) is caused due to insulin insufficiency because of a lack of functional beta cells. Patients suffering from this are therefore totally dependent on an exogenous source of insulin while patients suffering from type II diabetes (insulin-independent) are unable to respond to insulin and can be treated with dietary changes, exercise, and medication. Type II diabetes is the more common form of diabetes, constituting 90% of the diabetic population.

Symptoms for both diabetic conditions may include: (i) high levels of sugar in the blood; (ii) unusual thirst; (iii) frequent urination; (iv) extreme hunger and loss of weight; (v) blurred vision; (vi) nausea and vomiting; (vii) extreme weakness and tiredness; (viii) irritability, mood changes *etc.* [9]. Diabetes is rapidly growing worldwide and affected 422 million people in 2014 and resulted in over 3 million deaths [1].

The world health organization (WHO) estimated that diabetes would be the seventh leading cause of death by the year 2030 and suggested that a healthy lifestyle and right medication and regular screening can prevent and avoid the consequence of diabetes, respectively. For many decades, medicinal plants have been beneficial resources for the treatment of several diseases, including diabetes. Some well-known drugs in current-use for diabetes have been developed from plants such as metformin drug derived from the *Galega officinalis*. Many studies have also indicated the advantages of medicinal plants in therapeutic development, for example, availability and acceptable risk-benefit ratio. Though the ethnobotanical community has reported a list of anti-diabetic medicinal plants, in the search for new treatments and cures, yet more medicinal plants are being explored for their therapeutic development [10].

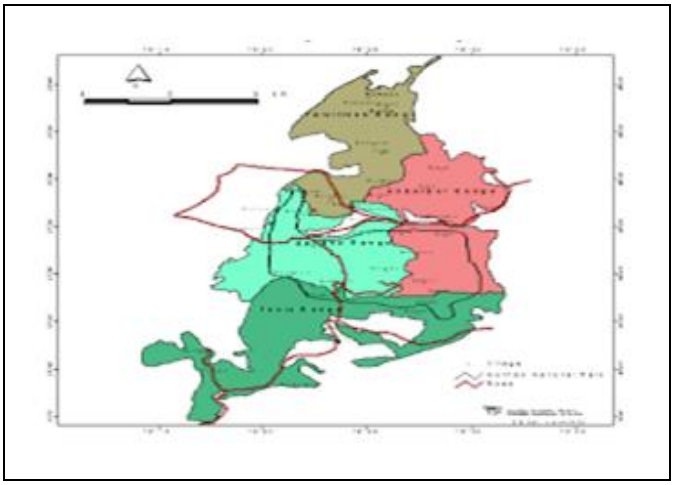

FIG. 1: MAP SHOWING SARISKA TIGER RESERVE RAJASTHAN (RANGE, VILLAGE, ROAD) [3]

Today, many treatments that involve the use of medicinal plants are recommended. Most plants contain carotenoids, flavonoids, terpenoids, alkaloids, glycosides and can often have anti-diabetic effects. The anti-hyperglycemic effects that result from treatment with plants are often due to their ability to improve the performance of pancreatic tissue, which is done by increasing insulin secretions or reducing the intestinal absorption of glucose [11]. Treatment includes diet, exercise, and medication.

Currently, the main and effective treatment for diabetes is the use of insulin and hypoglycemic drugs, but these compounds also have many adverse side effects [9]. Medicinal plants have a long history of usage and today, they are being extensively used for various diseases. There are several reasons for increasing the use of medicinal plants. Many plants from different parts of the world have been investigated for ant diabetic effects [12].

TABLE 1: SHOWS CURRENT STATUS OF VEGETATION IN SARISKA TIGER RESERVE [2]

	Families	Genera	Species
Monocotyledons	13	59	90
Dicotyledons	69	208	308
Total angiosperm	82	267	398
Pteridophytes	3	3	4
Gymnosperm	1	1	1
Total	86	271	403

TABLE 2: VEGETATION AND LAND COVER IN SARISKA NATIONAL PARK [13]

S. no.	Vegetation / land cover type	Area (sq. km)	Percentage
1	Anogeissus dominated forest	283.3	35.43
2	Scrubland	152.5	19.07
3	Boswellia dominated forest	123.5	15.50
4	Agriculture/habitation	74.7	9.34
5	Zizyphus mixed forest	63.6	7.95
6	Butea dominated forest	47.5	5.94
7	Acacia mixed forest	32.2	4.02
8	Barren land	20.6	2.58
9	Water body	1.6	0.20
	Total	799.432	100

2. Medicinal Plants of Sariska Forest used Traditionally as Antidiabetic:

2.1 *Aegle marmelos*: *Aegle marmelos* (Bael) fruit and leaves exhibit antidiabetic, antihyperlipidaemic and antioxidant properties. Oral administration of *Aegle marmelos* fruit extract at doses of 125 and 250 mg/kg twice daily to diabetic rats for a period of 30 days resulted in a significant increase in body weight, weight of the pancreas, and insulin levels associated with a significant decrease in fasting blood glucose levels. The fruit extract treated groups showed the improved functional state of the pancreatic ss-cells and partially reversed the damage caused by streptozotocin to the pancreatic islets [14].

2.2 *Acacia nilotica*: Pods and tender leaves are considered very beneficial in folk medicine to treat diabetes mellitus. *Acacia nilotica* has been used traditionally for management of diabetes mellitus. The aqueous leaf extracts of *A. nilotica* showed anti-diabetic activity. The intraperitoneal route of herbal extract administration was found to be more effective than the oral route. Qualitative and quantitative phytochemical screening of aqueous leaf extracts of *A. nialotica* indicated the presence of phenols, alkaloids, flavonoids, tannins, and saponins [15].

2.3 *Anogeissus pendula*: A study was carried out by to evaluate the anti-diabetic potential of *Anogeissus acuminata* on streptozotocin-induced diabetes mellitus. In this study DM was induced in rats by injecting streptozocin. Rats have then treated with *Anogeissus acuminata* extracts for 8 weeks at doses of 100 and 300 mg/kg. After that, plasma glucose levels and oxidative stress was assessed at weeks 1, 2, 4, and 8. The study results showed that methanolic extract of AA leaves produced a hypoglycemic and antioxidant effect. Urinary function was also improved. The study concluded that *Anogeissus acuminata* leaf extract demonstrated ant diabetic and antioxidant action [16, 17].

2.4 *Azadirachta indica*: (Neem) is a medicinal plant, used in Ayurveda for treating various diseases, one of which is diabetes mellitus. It is known to possess anti-inflammatory, antipyretic, antimicrobial, anti-diabetic, and diverse pharmacological properties. The hypoglycaemic effect was observed with *Azadirachta indica* when given as a leaf extract and seed oil in normal as well as diabetic rabbits. The effect, however, was more pronounced in diabetic animals in which administration for 4 weeks after alloxan-induced diabetes, significantly reduced blood glucose levels. The hypoglycaemic effect was comparable to that of glibenclamide. Pre-treatment with *A. indica* leaf extract or seed oil administration started 2 weeks prior to alloxan, partially prevented the rise in blood glucose levels as compared to control diabetic animals [18].

2.5 *Butea monosperma*: *Butea monosperma* (Fabaceae), commonly known as palash, is widely used in the treatment of various diseases and disorders, including diabetes [19]. The anti-

hyperglycemic activity of the ethanolic extract of *Butea monosperma* (BMEE) was studied in glucose-loaded and alloxan-induced diabetic rats. Single-dose treatment of BMEE (200 mg/kg, p.o.) significantly improved glucose tolerance and caused a reduction in blood glucose level in alloxan-induced diabetic rats. Repeated oral treatment with BMEE (200 mg/kg/day) for 2 weeks significantly reduced blood glucose, serum cholesterol, and improved HDL-cholesterol and albumin as compared to diabetic control group [20].

2.6 *Carissa carandas* L: *Carissa carandas* (CC) has been used in folklore medicine for the treatment of diabetes. Aqueous extract of CC (AECC) was most active and showed a fall of 67.08% in fasting blood glucose from 0 to 1h in glucose tolerance test (GTT). The ED50 of AECC was 300 mg/kg bw in streptozotocin-induced diabetic rats. Treatment of diabetic rats with ED50 of AECC for 28 days significantly reduced postprandial glucose (PPG) by 33.65% ($p<0.01$), glycosylated hemoglobin (HbA1c) by 45.79% ($p<0.01$) and increased insulin level by 69.7% ($p<0.05$). The results indicated that an increase in insulin secretion might be partly responsible for the anti-diabetic effect of AECC [21].

2.7 *Capparis deciduas*: *Capparis decidua* is xerophytic shrub, commonly known as Kair. Diabetes (type 2) was induced in rats of either sex, aged 48 ± 2 h, were injected with streptozotocin in citrate buffer (pH 4.5) at a dose of 90 mg/kg body weight intraperitoneal route. After 12-14 weeks, animals weighing above 150 gm were selected for screening in the NIDDM model, by OGTT (Oral-glucose tolerance test). For this purpose, blood was taken at 0 h from the tail vein from overnight (12 h) fasted rats, and they were fed glucose at a dose of 2.5 gm /kg body weight. Then blood was taken at 30, 60, and 120 min intervals.

The rats having blood glucose level 7-12 mmol/l at 0 hours and showing the highest rise at 60 min with the blood sugar level 234 to 360 mg/dl, which returned to their 0 h value at 120 min, were included in the study. A significant increase in the levels of serum glucose was evident in the diabetic control group. The serum glucose levels reduced by 81.4%, 60.48%, and 55.43% in fruit, flower, and bark extract treatments, respectively [22].

2.8 *Coccinia cordifolia*: *Coccinia cordifolia* (synonym *Coccinia indica*), an herb that belongs to the Cucurbitaceae family and that grows abundantly in Sariska Forest India, has been widely used in traditional treatment of diabetes. Roots are believed to heal illnesses associated with endocrine system disorders such as diabetes mellitus and are used to treat intestinal troubles [23, 24].

2.9 *Cayratia trifolia*: *Cayratia trifolia* Linn. Syn. *Vitis trifolia* (Family: Vitaceae) is commonly known as fox grape. The whole plant of *Cayratia trifolia* has been reported to contain yellow waxy oil, steroids/terpenoids, flavonoids, tannins upon preliminary phytochemical screening. The bark extract shows the antiviral, antibacterial, antiprotozoal, hypoglycemic, anticancer, and diuretic activity [25].

Treatment of streptozotocin-induced diabetic rats with ethanolic root extract (500 mg/kg) caused significant ($P < 0.01$) reduction in blood glucose (312-178 mg/dL), increase in body weight (181-219 g) and serum insulin (1.28-2.26 IU/dL). It also maintained lipid profile and tests of liver and kidney functions within the normal range as compared to diabetic control rats and almost at par with standard drug metformin. The oxidative stress-induced decline in glutathione and catalase in liver and kidney tissues showed recovery nearly too normal level as a function of treatment. The GC-MS profile of the extract showed a relatively high concentration of β-sitosterol, which was characterized by different spectroscopic and chromatographic techniques [26].

2.10 *Dipteracanthus prostratus*: *Dipteracanthus prostratus* (Poir) belongs to the Acanthaceae family. Wistar albino rats were used to evaluate the anti-hyperglycemic effect of toluene (TEDP, 100 mg/kg and 200 mg/kg, body weight) and methanolic (MEDP, 100 mg/kg and 200 mg/kg, body weight) extract of *D. prostratus*. Changes in body weight and blood glucose levels were evaluated at the beginning of the experiment and on days 7, 14, and 21 subsequently. Lipid profile and histopathological examination were also performed. TEDP at 200 mg/kg produced a significant stimulating body weight and reduced blood glucose level in treated diabetic rats from day 7, apart from that, MEDP also showed similar

activity from day 14. Furthermore, significant differences in lipid profiles by TEDP treated rats at 200 mg/kg, as compared to diabetic control and normal rats were also observed. Histopathological studies showed comparable regeneration of islet cells necrosed by streptozotocin, by both the extracts [27].

2.11 *Euphorbia hirta*: *Euphorbia hirta* (Family-Euphorbiaceae) is widely used in the traditional system of medicine to treat diabetes in India. It is reported to contain alkanes, triterpenes, phytosterols, tannins, polyphenols and flavanoids [28]. Oral administration of *E. hirta* leaves extract (300 mg/kg b.w./rat/day) for a period of 30 days indicated the anti-diabetic nature of the leaves extract. Assay of enzymes such as serum aspartate transaminase (AST), serum alanine transaminase (ALT) and serum alkaline phosphatase (ALP) revealed the non-toxic nature of *E. hirta* leaves.

The hypoglycemic activity of the leaves extract was comparable with gliclazide, a standard reference drug [29].

TABLE 3: ETHNO MEDICINAL FLORA OF THE SARISKA FOREST USED IN DIABETES

S. no.	Plant name	Family and habit	Synonym	Part used	Traditional uses
1	*Aegle marmelos*	Rutaceae (T)	Bael, golden apple	Fruit	Fruit juice used traditionally in diabetes, antioxidant [39]
2	*Abutilon indicum*	Malvaceae (H)	Kanghi	Leaves, roots	Leaf and root extract used to treat diabetes, fever [3]
3	*Acacia nilotica Acacia arabica*	Mimosaceae (T)	Babul	Gum, bark	Powder of bark is applied externally in ulcers, extract used in diabetes [39]
4	*Anogeissus pendula*	Combretaceae (T)	Kardhai, dhak	Stem bark	Diabetes, dysentery, cough [40]
5	*Azadirachta indica*	Meliaceae (T)	Neem	Leaves, bark and fruit	Leaves extract used antiseptic, diabetes [39]
6	*Butea monosperma*	Fabaceae (T)	Palash, fire of forest	Flower	antibacterial, antifungal, hypoglycaemic [20]
7	*Capparis decidua*	Capparaceae (S)	Kair	Fruit and twig	antidiabetic and antioxidant [22]
8	*Carissa carandas*	Apocynaceae (S)	conkerberry		Stomachache, diabetic, anthelmintic [41]
9	*Cayratia trifolia*	Vitaceae	Amlabel	Bark	antiprotozoal, hypoglycemic, anticancer [25]
10	*Coccinia cordifolia*	Cucurbitaceae (T)	Tindora, tinda	Leaf, fruit, root	Antidiabetic, hepatoprotective, asthma [23]
11	*Dipteracanthus prostrates*	Acanthaceae (T)	Ruellia, nees	Ariel part	antiulcer, antioxidant, hypoglycemic [27]
12	*Euphorbia hirta*	Euphorbiaceae (H	Asthma weed	Leaf, flower, stem	Asthma, hypoglycemic [43]
13	*Gymnema sylvestris*	Apocynaceae (T)	Gurmar	Leaves	Hypoglycemic, hypolipidemic, [44]
14	*Hibiscus rosasinensis*	Malvaceae (S)	Rose mallow	Leaves	Extract used for hair growth and obesity hypoglycaemic [32]
15	*Hibiscus micranthus*	Malvaceae (S)	Chanak	Seed, leaf	Antifungal, antiviral, Febrifuge, hypoglycemic [32]
16	*Indigofera tinctoria*	Fabaceae (T)	True indigo	Leaves	Antidiabetic, asthma, fever [33]
17	*Kydia calycina*	Malvaceae (T)	Bharanga, bhoti, pula	Bark, leaves	Antidiabetic, skin diseases [35]
18	*Opuntia elatior*	Cactaceae (T)	Cactus, hathlathor	Fruit, leaf	antidiabetic, antihyperlipidemic, antioxidant [36]
19	*Sida acuta*	Malvaceae (H)	Bala	Leaf, roots	Astringent, cut,wounds, hypoglycemic [45]
20	*Sida cordifolia*	Malvaceae (H)	country mallow	Seed, leaves, root	Aphrodisiac, gonorrhea, anti-diabetic [46]
21	*ziziphus oenoplia*	Rhamnaceae (T)	Jackal jujube	Bark	Stomachic, hyperacidity, hypoglycemic [38]

2.12 *Gymnema sylvestris*: Gymnema is a woody climbing shrub native to India and Africa. The leaves are used to treat diabetes. Gymnema has a long history of use in India's Ayurvedic medicine. The Hindi name for gymnema means a destroyer of sugar [30]. Extract from the leaves of *Gymnema sylvestre*, in controlling hyperglycemia was investigated in 22 Type 2 diabetic patients on

conventional oral anti-hyperglycaemic agents. GS4 (400 mg/day) was administered for 18-20 months as a supplement to conventional oral drugs.

During GS4 supplementation, the patients showed a significant reduction in blood glucose, glycosylated hemoglobin and glycosylated plasma proteins and conventional drug dosage could be decreased. Five of the 22 diabetic patients were able to discontinue their conventional drug and maintain their blood glucose homeostasis with GS4 alone [31].

2.13 *Hibiscus rosasinensis*: Hibiscus rosasinensis, known as *Chinese hibiscus*, China rose, is a species of tropical hibiscus, a flowering plant in the Hibisceae tribe of the family Malvaceae. The ethanol extract of flowers of *Hibiscus rosasinensis* at doses of 250 mg/kg and 500 mg/kg significantly reduced the blood glucose level in both acute (1, 3, 5 h) and sub acute (1, 3, 5, 7 days) treatments [32].

2.14 *Indigofera tinctoria* (Fabaceae): In Traditional system of medicine, it has medicinal properties as it is used in constipation, liver disease, heart palpitation, gout, diabetes, bitter, thermogenic, laxative, trichogenous and expectorant [33]. The methanolic extract of dried leaves of *Indigofera tinctoria* Linn showed significant decrease in blood glucose level of rabbits as estimated by Folin-Wu method; alloxan is used as diabetes inducing agent [34].

2.15 *Kydia calycina*: *Kydia calycina* is an evergreen tree growing 10-20 meters tall. Commonly known as Pula, Pattha, Pulia, belong to family Malvaceae. Traditionally used in Boils, diabetes, febrifuge, rheumatism *etc.* [35]

2.16 *Opuntia elatior*: *Opuntia elatior* Mill. (Cactaceae), a folklore plant known as Nagaphani or Hathlo-thore is widely available across the globe and in India. *O. elatior* is being used traditionally in different disease conditions like abscess and wound, burning sensation in the stomach, diabetes, diphtheria, asthma, and anemia. The principal constituents present in the plant are â-sitosterol, opuntiol and opuntiol acetate. Plant shows notable pharmacological activities such as haematinic, anti-inflammatory, analgesic, anti-leukemic and anti-ulcer activity including its safety reports during acute toxic study [36, 37].

2.17 *Ziziphus oenoplia*: At two different doses (200 mg/kg and 400 mg/kg b.w.) of aqueous and ethanolic extracts were observed antidiabetic effect for 12 consecutive days. BGL was monitored after 1, 3, 6 and 12 days and compared with metformin (250 mg/kg). Alpha-amylase and alpha-glucosidase activity of both extracts were also determined. Oral administration of both extracts showed significant ($P<0.05$) ant hyperglycemic activity in a dose dependent manner in alloxan-induced diabetic rats. The diabetic rats had significant ($P<0.01$) reduction in blood glucose. The ethanolic and aqueous extract reveals the reduction in the blood glucose level, inhibition of alpha amylase, and alphaglucosidase enzymes, which support anti-diabetic effect (reduce postprandial glucose levels) of *Z. oenoplia* and this may be due to presence of flavonoids constituents [38].

CONCLUSION: In this review, we discussed traditional medicinal plants from Sariska Forest District Alwar for the treatment of diabetes mellitus. Traditional medicinal plants are mostly used in rural areas. Therefore, treating hyperglycemia with a plant-derived product which is accessible and does not require laborious pharmaceutical synthesis seems highly attractive. In the present review, an attempt has been made to investigate the anti-diabetic medicinal plants from Sariska Forest and may be useful to the health professionals, scientists, and scholars working in the field of pharmacology, pharmacognosy, and therapeutics to develop hypoglycemic drugs.

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