



Anti diabetic potential of some selected traditionally used Medicinal Plants in Western Ghats of India w.s.r to *Prameha*

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Abstract

Traditional remedies are gaining worldwide acceptability. In the developing country like India safe, efficient and economic indigenous remedies are gaining popularity among the urban and rural areas. Diabetes is one of the major lifestyle disease which remains without a promising management solution in conventional medicine. In *Ayurveda*, this disease can be largely equated to a disease process called *Prameha*. The Western Ghats consists of unusual flora of Sahyadri hills representing dense and diversified vegetation. The people here are largely dependent on the available natural resources for food and medicine at primary level in treatment of diabetes. Not much work has been done so far for exploration of anti diabetic activity of these medicinal plants in correlation with its mode of action in perspective of *Ayurveda* texts and modern literature collectively. So the paper will highlight the anti diabetic potential of some selected medicinal plants used here for diabetic treatment through available *Ayurveda* literature and recent researches done so far.

Key Words: Traditional medicinal plants, Western Ghats (India), Anti diabetic potential, *Prameha*.

Introduction

Since time immemorial plants have been the basic source of therapeutic agents due to its easy availability, abundance and economic. World has gain success in inventing new modern interventions in the treatment of diseases but still a large number of population are utilizing the plant genetic resources as medicine occurring in their surrounding vegetation. About 80% of the people in the world rely on traditional medicine including ethno medicine for primary health care (WHO). Traditional medicines give a clue to further drug development from available natural resources. As per *Ayurveda* literature, not a single plant available in nature is devoid of medicinal properties¹ and so if used rationally can proved of paramount importance in treatment of complex disorders. Some plants acts through their *rasa* (taste), some through their *virya* (active principle), some through their *vipaka* (end metabolism) and some through their *prabhava* (specific action)². Biological actions of plants used as an alternative medicine to treat disease are related to their chemical composition.

Diabetes is a serious, chronic disease that occurs either when the pancreas does not produce enough insulin (a hormone that regulates blood glucose), or when the body cannot effectively use the insulin it produces³. It

has been the major problem rising more rapidly in middle and low income countries. WHO projects that diabetes will be the 7th leading cause of death in 2030. According to latest data the International Diabetes Federation estimated that 194 million people live with diabetes worldwide and this number will rise to 333 million in 2025⁴. It is a complex metabolic disorder, as such difficult to cure completely using single health care system. So there is need to search for easily available natural plant resources to mitigate this problem entirely. In *Ayurveda*, this disease can be largely equated to a disease process called *Prameha*. The cardinal feature of *Prameha* is '*Prabhutavila Mutrata*' which means frequent and copious urine with turbidity (*Vagbhata*).

The Western Ghats, one of the hottest biodiversity hotspots characterized with high degree of biodiversity in floristic composition, second only to the great Himalayan Mountain ranges in India. It extend from the Satpura Range in the north, stretching from Gujarat to Tamil Nadu crossing the states of Maharashtra, Goa, Karnataka, and Kerala. The region receives heavy rainfall annually and it therefore abounds in a variety of fairly unusual flora. Due to dense and diversified vegetations local healers are largely dependent on their traditional healing system for the primary healthcare. Several medicinal plants used traditionally have been described in the scientific and popular literature as having anti diabetic activity. The paper will discuss the anti diabetic potential of some selected medicinal plants used here for diabetic treatment through the basic pharmacological principles (*Rasapanchaka*) of plants and naturally occurring bio active constituents.

Enumeration of anti diabetic activity of some traditionally used medicinal plants.

Amalaki [*Phyllanthus emblica* L.]

Amalaki, one of the most commonly used important herbs in *Ayurveda* system of medicine. The fruit has five rasa (tastes), with *Amla* (sour) and *Kashaya* (astringent) being the most dominant, including *madhura* (sweet), *tikta* (bitter) and *katu* (pungent). *Virya* is *sheeta* (cold potency), *vipaka madhura* (Sweet) and *guna* (qualities) *laghu* (easy to digest), *ruksha* (that which causes dryness in the tissues). It pacifies all three *dosha* - *vata*, *pitta* and *kapha*. Fruit is edible and taken in the form of food or medicine in diabetes⁵. It is a rich source of Vit C content, which is effective in controlling diabetes. It stimulates the pancreas and enables it to secrete insulin, thus reducing the blood sugar in diabetes⁶. Tannins, alkaloids and phenolic compounds are constituents of *amla*. Tannoids of *Phyllanthus emblica* L inhibits osmotic stress and prevents hyperglycemia-induced oxidative stress due to the inhibition of the polyol pathway possibly⁷. Polyphenols is abundant in fruit juice (541.3 mg gallic acid equivalent/1 g extract) which might be accountable for glucose and lipid lowering effects, also might be responsible for cardioprotective effects⁸.

Beejaka [*Pterocarpus marsupium* Roxburgh]

Beejaka, an 'Indian Kino tree' is considered as one of the potent anti diabetic drugs of herbal origin. Bark has been used in treatment of diabetes in folklore^{5,9}. *Beejaka* is *kashaya*, *tikta* in *rasa*, having *ushna virya* (hot potency), *katu* (bitter) *vipaka* (end metabolism) and *laghu*, *ruksha* properties. It pacifies *kapha* and *pitta dosha*. Bark extract was found to induce insulin release from pancreatic cells¹⁰. Phenolic-C-glycosides present in the heart wood are the active constituents responsible for the antihyperglycemic activity¹¹. *Marsupsin* and *pterostilbene*, phenolic constituent, present in heartwood were found to reduce blood glucose level¹².

Guduchi [*Tinospora cordifolia* (Willd.)]

Guduchi is one of the non controversial and extensively used herbs in *Ayurveda* medicine. A large climber with succulent corky and grooved stems distributed almost throughout India. Stem and leaf has been use in diabetes in ethno medical practice¹³. It is *tikta* (bitter), *kashaya* (astringent) in *rasa*, having *ushna virya*, *katu vipaka* and *guru* (heavy to digest), *snigdha* (unctuousness) properties. It pacifies all three *dosha*- *vata*, *pitta* and *kapha*. Recent researches proved that *isoquinoline* alkaloid rich fraction and three alkaloids viz., *palmatine*, *jatrorrhizine* and *magnoflorine* derived from stem showed insulin-mimicking and insulin-releasing effect¹⁴. Stem extract induced regeneration of the pancreatic islets cells¹⁵ and increased glycogen

storage in the liver¹⁶. Ethanolic extract of leaf showed anti diabetic action through some peripheral mechanisms, either by increasing the glycogen storage in the liver or by decreasing the glucose release from the liver¹⁷.

Haridra [*Curcuma longa* L.]

Haridra, popularly known as ‘Turmeric’ is extensively used as a spice. In the *Ayurveda* literature it is most commonly used herb both internally and externally in the treatment of various ailments. Rhizome has been used for diabetes treatment in folklore¹⁸. It is *tikta, katu* in rasa, having *ushna virya, katu vipaka* and *laghu, ruksha* properties. It is *tridosha shamaka* (pacifies all three *dosha – vata, pitta* and *kapha*). *Curcumin*, an active constituent present in rhizome was found to protect the islets β -cell, decreases the insulin resistance and the oxidative stress¹⁹. *Curcumin, demethoxycurcumin, bisdemethoxycurcumin, and ar-turmerone*, the main constituents of rhizome suppressed the increase blood glucose level and contributed to the effect via peroxisome proliferator-activated receptor (PPAR)-gamma activation²⁰.

Jambu [*Syzygium cumini* (L.) Skeels.]

Jambu, a well known drug used in alternative health care system. Fruits are edible and its seeds and bark has been used commonly in the treatment of diabetes in folklore¹³. It is *kashaya, madhura* in rasa, having *sheeta virya, katu vipaka* and *laghu, ruksha* properties. It pacifies *kapha* and *pitta dosha*. The ethyl acetate and methanol extracts of seed showed anti diabetic activity. The isolated compound, *mycaminose* from seed was responsible to decrease in blood sugar level. The possible action may be by potentiation of the insulin effect of plasma by increasing either the pancreatic secretion of insulin from beta-cells of the islets of Langerhans or its release from the bound form²¹. Bark showed the presence of flavonoids or polyphenolics compounds such as *quercetin, isoquercetin, myricetin, anthocyanin* etc. Flavonoids or polyphenols present are reported for their anti diabetic activity²². *Anthocyanins*, the natural colorants have also been shown to stimulate insulin secretion from pancreatic beta-cells in vitro²³. *Myricetin*, a naturally occurring flavonoid, lowered blood glucose through improved glucose utilization²⁴.

Kaidarya [*Murraya koenigii* (L.) Spreng.]

Kaidarya, also known as curry tree is commonly used in Indian food recipe. Leaf has been used by tribals in diabetes¹⁸. It is *tikta, kashaya* in rasa having *sheeta virya, katu vipaka* and *laghu, ruksha* properties. It pacifies *kapha* and *pitta dosha*. Recent researches proved that leaf extract - increases insulin secretion and enhances the glycogenesis process²⁵. *Mahanimbine, carbazole* alkaloid from *Murraya koenigii* leaves has alpha amylase inhibitory and alpha glucosidase inhibitory effect useful in management of postprandial hyperglycemia. *Mahanimbine* increases the pancreatic secretion of insulin from beta cells of islets of langerhans and the peripheral glucose uptake²⁶.

Kaalmegh [*Andrographis paniculata* Nees.]

Kaalmegh, ‘The King of Bitters’ frequently used in traditional medicines and *Ayurveda* health care system to treat array of diseases. Due to its strong bitter taste, folklore believed to utilize this plant in the treatment of diabetes²⁷. It is *tikta* in rasa, having *sheeta virya, katu vipaka* and *laghu, ruksha* properties. It pacifies *kapha* and *pitta dosha*. The ethanolic extract of leaf is known to possess anti diabetic activity. *Andrographolide*, an active principle in the leaves increases glucose utilization to lower plasma glucose in diabetic rats lacking insulin²⁸ Ethanolic extract of leaf was found to be non toxic as seen by the normal creatinine and urea levels in the extract fed normal rats. There was an increase in the activity of liver antioxidant enzymes. Histopathological study of pancreas revealed the islet cell restoring and regenerative ability of *A. paniculata* extract²⁹.

Saptachakra [*Salacia sp.*]

Several species have been reported as *Saptachakra* on the basis of its root characteristics (seven circles on cross section). *Salacia chinensis* L., *Salacia macrosperma* Wight and *Casearia esculanta* Roxb. are some of the important ones used traditionally in the treatment of diabetes⁵. The root decoction of these plants has been found to be effective. *Saptachakra* is *kashaya* (astringent), *tikta* (bitter) in rasa, having *ushna virya* (hot potency), *katu vipaka* (pungent product after end metabolism) and *laghu* (easy to digest), *ruksha* (that which causes dryness in the tissues), *tikshna* (fast acting or that which is stimulatory in action) properties. It pacifies *kapha* and *pitta dosha*. Recent researches showed that *salacinol*, *katnanol*, *mangiferin*, the active principles present in root of *Salacia* sp inhibited α -glucosidase enzyme and slowed down the absorption of glucose in intestine³⁰. *Mangiferin* isolated from *Salacia chinensis* regulated the kidney carbohydrate metabolism in diabetic rats³¹ and effectively regenerated insulin secreting islet cells³². Ethanolic extract of root of *Casearia esculanta* stimulated insulin secretion from the remanent β cells or/and from regenerated β cells³³. Its root extract was found to be effective in oxidative stress induced diabetes.

Kutaja [*Holarrhena antidysenterica* (Linn.)Wall.]

Kutaja, a small deciduous tree commonly found in tropical parts of India. *Charaka* quoted *Kutaja tvak* (bark) as the best *Sangrahaka* (Anti diarrheal) *dravya*. *Kutaja* is *tikta*, *kashaya* in rasa, having *sheeta virya* (cold potency), *katu vipaka* and *laghu*, *ruksha* properties. It pacifies *kapha* and *pitta dosha*. Traditionally bark has been used in the treatment of diabetes⁵. Presence of flavonoides, phenolic compounds present in bark were found to be responsible for antioxidant and antidiabetic activity³⁴. Bark extract showed improvement in liver glycogen and glucose uptake³⁵.

Meshashringi [*Gymnema sylvestris* R.Br]

Meshashringi, popularly called as *Gudmar* (destroyer of sweet taste) in Hindi as chewing the leaves cause loss of sweet taste. Leaves are extensively used in the diabetes management both by folk and traditional *vaidya*²⁷. It is *tikta*, *kashaya* in rasa, having *ushna virya*, *katu vipaka* and *laghu*, *ruksha* properties. It pacifies *kapha* and *vata dosha*. Recent researches proved that, the *gymnemic acid* (glycoside), a bitter principle found in leaf extracts significantly increased the regeneration of β -cells in Type 2 diabetic. This may be due to regeneration of beta cells^{36, 37}.

Manjistha [*Rubia cordifolia* Linn.]

Manjistha, commonly known as Indian madder is famous as *Rakta shodhaka* (blood purifier) in the traditional medicine, also used for treatment of various ailments like diabetes¹⁸, cancer etc.. It is *tikta*, *kashaya*, *madhura* in rasa, having *ushna virya*, *katu vipaka* and *guru*, *ruksha* properties. It pacifies *kapha* and *pitta dosha*. Root was found to show the presence of phenols and flavonoids³⁸, which are reported to possess anti diabetic activity.

Nimba [*Azadirachta indica* A. Juss.]

Nimba most commonly used plant in the indigenous system of medicine in the treatment of skin diseases. It is *tikta*, *kashaya* in rasa, having *sheeta virya*, *katu vipaka* and *laghu*, *ruksha* properties. It pacifies *kapha* and *pitta dosha*. The anti diabetic activity of the leaf used ethno medicinally¹³ can be attributed to its action to stimulate sufficient production of insulin by the pancreas and regenerate the β -cells to carry out its functions³⁹. Few researches carried out reported that *quercetin*, *rutin*, and *nimbodin* the active components present in leaf extract were responsible for anti diabetic activity. *Rutin* and *quercetin* (flavonoids) both possessed high antioxidant activity⁴⁰. *Rutin* had the ability to scavenge free radicals, inhibit lipid prooxidation and protect the β cells of the pancreas⁴¹ whereas *quercetin* found to preserve pancreatic β cell integrity⁴².

Sadampushpa [*Catharanthus roseus* Linn.]

Sadampushpa commonly known as the Madagascar periwinkle or *Vinca rosea* is well known in modern medicine for its anti cancer effect. The flower and leaf has been used by local healers to treat diabetes^{5, 13}. It is *tikta* (bitter), *kashaya* (astringent) in rasa, having *ushna virya* (hot potency), *katu vipaka* and *laghu*,

ruksha properties. It pacifies *vata* and *kapha dosha*. Antihyperglycemic activity reported which found to increase plasma insulin concentration⁴³ and insulin sensitivity. Alkaloids- *vindoline I*, *vindolidine II*, *vindolicine III* and *vindolinine IV* present in leaf extract were attributed to anti diabetic activity through high glucose uptake in pancreatic beta cells⁴⁴.

Saptaparna [*Alstonia scholaris* R.Br.]

Saptaparna popularly known as Devil's tree is a well known remedy known for the treatment of diabetes in the folk⁵ and various other disorders in *Ayurveda* system of Indian medicine. It is *tikta*, *kashaya* in *rasa*, having *ushna virya*, *katu vipaka* and *laghu*, *snigdha* properties. It pacifies *kapha* and *pitta dosha*. The antidiabetic effect of the bark extract found was possibly due to increased utilization of glucose by peripheral tissues, improved sensitivity of target tissues for insulin or it may be due to improved metabolic regulation of glucose⁴⁵.

Sariva [*Hemidesmus indicus* R.Br.]

Sariva, commonly known as Indian Sarsaparilla is generally used in the *Ayurveda* System of Medicine for treatment of skin diseases but root also has been used in diabetes in folklore¹⁸. It is *madhura* (sweet), *tikta* (bitter) in *rasa*, having *sheeta virya*, *madhura vipaka* and *guru*, *snigdha* properties. It pacifies all the three *dosha* - *vata*, *pitta* and *kapha*. The root extract showed stimulatory effect on the regenerating beta-cells and also on the surviving beta-cells⁴⁶. Root had Isovanillic acid 3-Hydroxy-4-methoxy-benzoic acid present in it which lowered the blood sugar level.

Discussion

The plants mentioned above are predominantly with *tikta* (bitter) *rasa*, followed by *katu* (bitter), *kashaya* (Astringent), *madhura* (sweet) and *amla* (sour) *anurasa* (sub-taste) having either *ushna* or *sheeta virya* (hot or cold potency). All plants have *katu vipaka* and are *laghu* (easy to digest), *ruksha* (Dryness or non-unctuousness) in *guna* (quality) except *amalaki* with *madhura vipaka*, *guduchi* with *madhura vipaka* and *guru*, *snigdha guna* (quality), *manjistha-guru*, *ruksha* in *guna* and *sariva* with *guru*, *snigdha guna*. Usually the bitter taste plants are found to be traditionally used in diabetes management. It may be due to a strong belief that plants having *tikta* (bitter) *rasa* (taste) alleviates symptoms of Diabetes and intake of *madhura* (sweet) *rasa dravya* (diet or drug) worsen the condition of diabetic patients. Diabetes is a metabolic disorder which can be correlated with *Prameha* mentioned in *Ayurveda* classics. *Charaka* quoted the general causative factor responsible for *Prameha* as especially intake of *kapha prakopaka* (that which vitiates *kapha dosha*) *ahara* (food) and *vihara* (Exercise)⁴⁷. *Kapha* causative factors either cause *kapha dosha* vitiation directly or in association with *pitta dosha* may cause obstruction in the channels thus responsible for *vata dosha* vitiation. Thus we can say in *Prameha* all the three *dosha* are vitiated which according to their dominance manifests their symptoms accordingly. Vitiating *dosha* affects *meda dhatu* (fat tissue), *mamsa dhatu* (muscle tissue) *kleda* (liquid element), etc. of body and draws the tissue elements into the urinary tract, which eventually causes the disease *Prameha*⁴⁸. *Tikta*, and *kashaya rasa* due to *ushna* and *tikshna guna* are *kaphashamaka* (alleviates vitiated *kapha*), absorbs *meda dhatu* and also *shareeraja kleda*, the important factor involved in *Prameha* which may indirectly maintain the expulsion of excessive urine^{49,50,51,52}. *Tikta* and *katu rasa* also by its *deepana* (digestive stimulant) and *pachana* (digestant) action improves the impaired digestion involved in the pathogenesis of *Prameha*. *Tikta*⁵¹ and *kashaya rasa*⁵² has *lekhana* (scrapping) action whereas *Charaka* quoted action of *katu rasa* as 'Margaana Vivrunoti' (i.e clears the obstructed channels)⁴⁹. Thus, *tikta*, *katu rasa*, *katu vipaka*, *ushna virya* and *ruksha guna* facilitate to take out the excess *meda* deposition in the body, thereby ultimately contributing to break down the pathogenesis taking place in obstructed channels. Some plants found to possess *madhura-tikta rasa* where *madhura rasa* in association with *tikta rasa* can provide strengthening to the organs of urinary system thereby reducing the further complications of diabetes. *Ushna virya* of plants due to their *deepana* and *pachana* action also improves digestion in association with *tikta*, *katu rasa*. Considering the *guna* (quality) of plants, even *laghu*, *ruksha* and *tikshna guna* may also contribute in reducing vitiated *kapha* and involved

kleda and *medodhatu*. Immunomodulatory drugs like *amalaki*, *guduchi*, *haridra*, *sariva* due to their specific *bhoutika* configuration (*vichitra pratyayarabdhatwa* - exhibit pharmacological activity not according to its structural constituents) or *rasayana* (rejuvenating) *prabhava* (special action) maintains the *dhatu kshaya* (tissue emaciation) taking place in diabetes, regulates the disturbed metabolism thus reducing the symptoms of diabetes and the complications involved.

The above data revealed that the presence of naturally present various flavonoids, polyphenolic compounds or alkaloids in the plant are responsible for anti diabetic activity. They act either by promoting regeneration of islet cells, increasing insulin secretion or increasing sensitivity of tissues to insulin or reducing absorption of glucose from gastrointestinal tract or by lowering blood glucose level through improved peripheral utilization of glucose. Flavonoids also act as good anti oxidant⁵³. Anti oxidant property of plants pacifies oxidative stress induce diabetes either by inhibition of superoxide radicals or hydroxyl radical scavenging activity or inhibition of lipid peroxidation or by converting ROS (reactive oxygen species) to non reactive products.

Conclusion

This review presented a comprehensive detail of the factors attributed to the anti diabetic activity of plants. Usually naturally available plant based medicines used by people from every culture and various indigenous medicines are gradually being introduced into modern therapeutics. The above documented plants showed anti diabetic activity either through the presence of basic pharmacological principles (*Rasapanchaka*) of plants or through naturally occurring bio active constituents responsible for regeneration ability of beta cells of pancreas. So the people in the earliest stages of the disease could be treated to delay or prevent full-blow clinical diabetes. Thus the knowledge of traditional medicine and medicinal plants and their study of scientific chemical principles can prove beneficial in the discovery of newer and cheaper drugs.

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